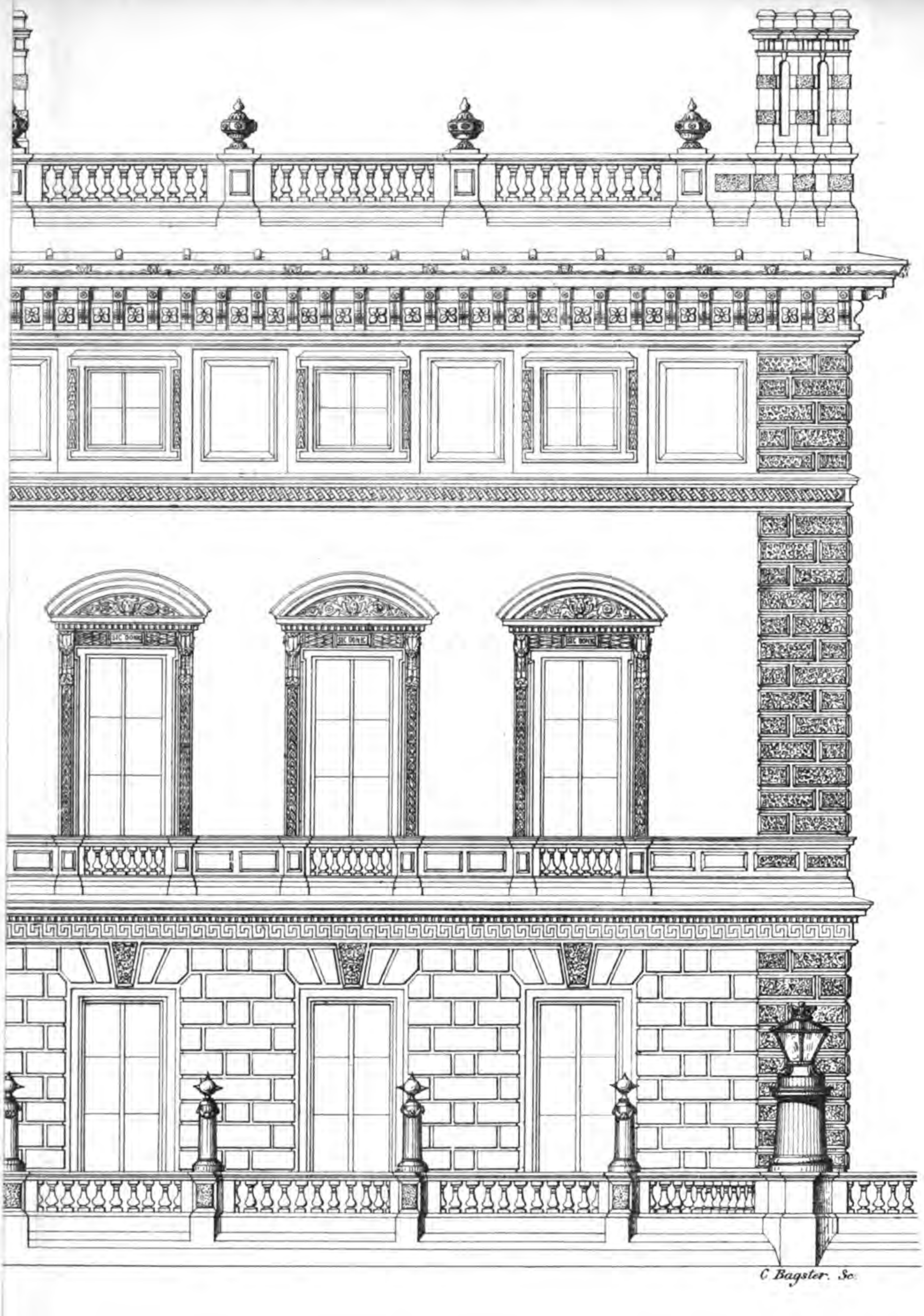

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THE

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THE

CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

BRIDGEWATER HOUSE.—Charles Barry, Esq., R.A., Architect.

(With an Engraving, Plate I.)

It is only exceptionally that any of our English nobility or aristocracy build for themselves mansions in the metropolis. In Italy, every city of any note is indebted for much of its architectural reputation to the private palazzi of noble families; which, if they sometimes exhibit very questionable taste, possess at least physiognomy, and have an air of patrician dignity. Here, on the contrary, rank and opulence do not seek to distinguish themselves by their habitations making any architectural display, externally: the abstinence from which may be partly attributed to indifference for architecture itself, but is also in a great measure owing to the system, prevalent here among even the wealthiest classes, of occupying houses only upon lease—a system almost prohibitory of the erection of town residences of a really palatial character. Like any other wholesale manufacturer, the speculator-builder can only provide such houses as are likely to meet the general requirements of a class of occupiers; and that class must suit themselves as well as they can from the stock provided for the market. Actual accommodation and *fashionableness* of situation are the two points chiefly considered by those who resort to that market; for as to the architectural fashion of the commodities, that must be taken for better or worse, or just as it can be had: and whatever the taste of it be, *that* is no affair of the occupiers, since they are "only lodgers here." A duke and a drysalter may be next-door neighbours to each other, and their dwellings Dromios,—two slices of the same piece, and consequently just of the same pattern. The speculator-builder cannot possibly tell beforehand who are to be his customers: duke or drysalter is to him all one. Besides, he cannot, or else fancies he cannot, afford to look to taste: had he a third eye, he probably might be able to do so; but as he has not, he must keep both the eyes he has upon *per cent.* People who build for themselves, build also for their posterity; but a speculator has no posterity,—he looks only to number one and *to-day*. Under such a system, what can we expect better than the mushroom architecture which has sprung up in that ultra-fashionable spot, Belgravia. As to Belgrave-square itself, it is to us far more unsatisfactory than Russell-square—the butt of the very vulgar and very flunkey wit of our Hoods and Crokers. The latter place is, at least, exempt from all paltry architectural pretension; which is more than can be said of the other. It honestly confesses itself to be very—or for "very" we should, perhaps, say "rather"—dull and stupid; whereas the other is a grimacing pretender, who gives himself what he fancies are high-bred airs. As architecture, Belgrave-square is only bloated insignificance; of design, properly so-called, there is not a particle in it. It is a compound of the most hackneyed ideas vulgarised. Where there is no aim, there is no miss; but there a good deal—at any rate, much more than was then usual—was evidently aimed at, and the result is intolerable insipidity of *ensemble*, and equally intolerable cockneyism of detail; the style, if such it may be called, being best described as *Cockneyfied-Italian*. Yet, what better can be expected from the present system of building streets and squares by wholesale? It would be objectionable enough, if only because it flings away opportunities for architectural design, a single idea repeated again and again being made to serve for several scores of houses. Merely such wearisome repetition would be bad enough; yet, as if it were not sufficiently so, the architectural pattern set for what is afterwards to be carried on *ad libitum*, is invariably of the most trumpery and tawdry character,—crude and unstudied—apparently the production of either the speculator-builder himself, or of one of his drawing-board journeymen.

Under such circumstances as these, Bridgewater House may be regarded as an architectural phenomenon in the British metropolis. The term "phenomenon," however, is not meant to imply that there is anything extraordinary in regard to the general idea, or to style or design. Being, strictly speaking, a *palazzo*, Bridgewater House identifies itself architecturally with a class of structures of very recent date in our metropolis. Any one unacquainted with the fact of its ownership, would, almost of course, take it for a clubhouse; it having, in every respect, far more the character of an edifice of that kind, than the appearance of being a private residence. Almost the only other mansion erected within our memory, which makes any pretension to rank as a work of architecture, is the neighbouring Stafford, *alias* Sutherland, House, originally designed by two of the Wyatts as a residence for the late Duke of York. For this reason, and also on account of their propinquity, some comparison of the two mansions naturally suggests itself; and although comparisons are said to be odious, we may be very well satisfied with the result of the one on the present occasion, since it makes evident how greatly architectural taste has advanced among us in the interim between the dates of the two buildings, which may be taken as the representatives of the ante-Barry-an, and the Barry-an period. While the style of Sutherland House is essentially mean and undignified, and partakes of the regular or ordinary office drawing-board school of design, and is utterly devoid of aught approaching to gusto, it might be many degrees more faulty without being by several so trivial, flat, and mesquin in taste. It can find favour only in the eyes of a surveyor or builder, for there is not a single touch of the artist perceptible in it. Perhaps even such a piece of honest, unsophisticated dowdyism as Marlborough House is the less offensive of the two; for to be at once dowdy and pretentious is, if not intolerable, amusing—that is, ridiculous. Frederick of York was not a connoisseur of architecture himself, and he seems to have trusted to very ill-informed advisers, although the royal Duke might have known how dangerous it is either to trust or to be trusted.

Thanks to Barry, we are now got out of that humdrum sort of design which prevailed during the latter half of the last, and at the beginning of the present, century;—not that no mischief has attended his example, because, to say the truth, many of his followers, or those who fancy that they are following him, have only caricatured him. For Mr. Barry himself we do not claim any great originality or inventive power, but exquisite taste and tact he certainly possesses. There is artistic sensibility and sentiment in whatever he does, the value of which may be best estimated by the absence of those qualities in the same style as it is treated by others.

As is well known, solicitous carefulness of finish is Mr. Barry's *forte;* which being known, it would seem easy for others to rival him by bestowing equal attention on the more delicate touches of design—minor ones, perhaps, if considered only as so many separate matters of detail, but very important and influential as regards aggregate effect. Yet, although the means to be pursued seem to be plainly enough prompted, they are not acted upon—at least, not with anything like the same success. In their treatment of the same style, Mr. Barry's followers are apt to follow him *passibus haud æquis;* showing great inequality of taste, and exhibiting together with carefulness, perhaps, in some respects, carelessness in others.

Although like his two clubhouses, an astylar composition—consequently deriving character and embellishment chiefly from fenestration—this work of Mr. Barry's has, along with a certain family resemblance to them, many traits in which it differs from them; some of which are tolerably obvious. In the first place, the ground-floor is not so much raised above the level of the street; in the next, it is treated as a distinct, rusticated basement, without other dressing to the windows than what results from the articulation and jointing of the masonry, which last is properly expressed, because consistently so: whereas the other mode—now unfortunately too much in vogue—of showing the joints only in one direction, is not only un-Italian, but poor, monotonous, and solecistical, inasmuch as it does not express *bond.* Among other differences, besides that the principal cornice is here not so *prononcé* as those of the two clubhouses referred to, it does not terminate the elevation, but is surmounted by a balustrade. Instead of being *à la Sansovino*—both meagre in design, and so ridiculously enlarged as to contradict its apparent purpose, and to operate most disadvantageously, it being a scale by which the eye is apt to judge of the dimensions of other parts, the balustrade here is well proportioned, because it does not exceed the height to which a parapet is necessarily limited. A balustrade on the top of a building twice as high as those to the windows is a palpable absurdity, because either the former is proportioned only to giants, or the latter only to dwarfs. This may seem to amount to no more than saying that Mr. Barry has in that respect avoided an absurdity; but why do not others avoid it too? The design of the principal-floor windows may be called *astylar,* in contradistinction from the *microstylar* decoration of the windows on that floor, both in the Travellers' and the Reform Clubhouse; yet they are of not less ornate character—in some respects even more so, if only on account of the sculpture within their pediments—a touch of embellishment to which we are by no means accustomed, and which, though it may be deemed prodigal in regard to cost, is chaste in effect, and not at all inconsistent with the elaborate finish and richness of those window compositions.

We have omitted to mention that the building is intended to form a town residence for the Earl of Ellesmere, and is situated on the east side of the Green Park, and on the north side of Cleveland-row. The elevation which we have given in Plate I. is that of the south front, abutting on Cleveland-row, and is 142 ft. 6 in. in length, and 68 feet high above the ground-line to the top of the balustrade. The frontage next the Green Park is 122 feet. The whole of the building forms a square, of the above dimensions, and contains complete suites of apartments. The ground-floor is 20 feet high, and will be appropriated for the private apartments of the noble owner, and the floor above to state rooms. The north end of the mansion will be set apart for a noble gallery, to exhibit the splendid collection of pictures in the possession of the Earl.

CANDIDUS'S NOTE-BOOK,

FASCICULUS LXXXIX.

> "I must have liberty
> Withal, as large a charter as the winds,
> To blow on whom I please."

I. This Fasciculus is dedicated to James Fergusson. Had Candidus obtained—as he has endeavoured to earn—any palm of desert in criticism, he would transfer it to one whom he acknowledges his superior in æsthetic philosophy. As it is, I can only hold out my hand to him in token of sincere admiration and hearty approbation; and by merely doing that, I shall probably distinguish myself, mine being likely to be the only hand extended to him in cordial amity—thus publicly at least, for his book[*] abounds with such awful and fundamental heresies,—attacks stereotype opinions and time-hallowed prejudices so unsparingly, that it can hardly fail to excite a deep and rancorous feeling against it, although whether it will meet with a bold and open adversary is very doubtful. The writer has, as he himself says, thrown down his glove to all comers; but he must have more than ordinary courage who ventures to pick it up. Yet, whoever does so may be certain of having the good wishes, not to say the earnest prayers, of numbers for his success in the fearful combat—a combat upon the issue of which so very much would be at stake; because, should the public champion of established opinions and inveterate prejudices happen to be worsted—to be unsaddled in argument, instead of anything being gained, positive mischief would have been done to "the good old cause." What, then, is to be done? Will the Institute throw lots to decide who is to go forth to encounter the formidable æsthetic Goliath, who has started up to disturb their drowsy slumbers?—the arch-heretic, if not the arch-fiend, who speaks of "the monkey styles of modern Europe?" Monkey styles!—What a universal groan of horror must have responded to that most audaciously libellous characterization of our actual European architecture! Monkey!—the epithet is really so unendurable, that I venture to propose in amendment of it, that of—asinine.

II. In no quarter has Mr. Fergusson sought for popularity, or attempted to make himself friends, by flattering existing prejudices, and sparing, if not deferring to, erroneous yet long cherished opinions. His startlingly bold estimate of Roman literature and Roman art, must shock the classical scholar, and all those who are interested in upholding the present vicious mode of education established at our universities and public schools.—As little has he spared the feelings of the aristocracy, for he gives it as his opinion, that "there is not, as far as I am aware, one single individual in the upper ranks of society who really knows what art is, or is seriously anxious for its advancement"! Nor has he the grace to qualify such sweeping censure by adding: "the members of the Fine Arts' Commission alone excepted." At any rate, Mr. Fergusson shows himself to be no courtier.—Perhaps he has made friends with the painters: hardly that, when he observes that many pictures would rank as works of art, "below a good *soufflet* or a *vol-au-vent,* where I should certainly class many of the pictures annually exhibited in London"!! It must be left to Soyer and his fraternity to applaud what must scandalise the Royal Academy and all other picture-exhibiting societies.—With antiquaries and archæologists, Fergusson is not at all likely to stand in higher favour than with painters, when he talks of "the infamous drawing in the old paintings that adorn the walls or windows of our cathedrals;" and adds, in a note, "Among the strange manias to which a *false system* of art has led us, none is more *exquisitely* absurd than the attempts often now made by a set of archæological artists, to imitate these ancient productions, &c." Quite contrary, too, to the servile doctrine hitherto inculcated by architectural teachers of every sect and school, he ventures to declare that "freedom and hope are the first true principles of greatness in art, as in everything else; and servility and despair of doing better than has been done before, must cramp the noblest genius, and hide the highest aim." Noble and inspiring sentiment! Yet, how fraught is it with scornful reproach to an age which piques itself upon its talent for the most direct and mechanical copyism, and which preaches up the most abject servility, and the most cowardly despair; "and when, as in modern Europe, art is retrograde, and its fundamental principles retrogressive, either to Greece, or Rome, or to the Middle Ages."

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[*] "An Historical Inquiry into the Principles of Beauty in Art, more especially with reference to Architecture." London: Longman, 1849.

III. To the venerators of Vitruvius, Mr. Fergusson certainly does not look for applause, for presuming to characterise their idol as follows:—"If there were no other work to prove it, that of Vitruvius might alone suffice to show how little appreciation his countrymen had either of the spirit or the aim of true art. *From the first page to the last of his book, there is not one expression which shows that he had more sympathies for its beauties than might be possessed by an uneducated house-carpenter or stonemason:* he merely collects a set of dry formal rules from observed examples, and repeats them as if he were writing a catalogue of minerals......... That nation must have been singularly ignorant in art that could produce a work so cold and soulless as this, which shows so little knowledge of the common-sense prosaic properties of his art, and still less appreciation either of its beauties or its aims."—What, then, is to be said of those who adopt it as a code and an oracle? That Vitruvius was a poor, plodding creature, there can be little doubt; and if the man himself was not an arrant humbug, certain it is that his writings have been made the means of humbugging us moderns on the subject of architecture, and diffusing maudlin cant, and that worst sort of ignorance—learned stupidity. I have said as much as this before, and others besides Fergusson have ventured to impugn very freely the writings of Vitruvius; so that although many still speak of them, not for the purpose of vindicating their worth, but as if their former credit was entirely unimpaired, there is reason for hoping that the contemptible Vitruvian superstition will die out—in this country at least—with the present generation of those who have been trained up in it.—May the time not be far distant when the writings of the Roman architectural classic will excite not enthusiastic admiration, but unmitigated astonishment—merely contemptuous wonder that so much fustian and so much *old-womanism* should ever have been regarded as a compendium of architectural philosophy.

IV. As little as the admirers of Vitruvius will the fanciers of the "Invisible Curves of the Parthenon" feel obliged to Mr. Fergusson, who is somewhat sarcastic—my readers know that I am by far too innocent ever to deal in sarcasm myself—upon that subject. "The idea," he observes, "that a form, the existence of which can be detected only by the most perfect mathematical instruments, should be a cause of beauty in a visible and tangible object, is what I can neither understand nor appreciate. I hope, however, it will be tried in the next portico we build. Perhaps the failure of the experiment may convince men that something more is wanted to produce a true specimen of art than such abject servility as copying not only what we can see, but what our eyes will not enable us to detect even when pointed out. We have long copied what we do not understand: it seems carrying the system to its acme of absurdity, to attempt also to copy what we cannot see."—Truly so: the only way of refining upon such absurdity would be to have recourse to *ponderation*, and estimate buildings by the aggregate weight of their solid materials. It is, indeed, extravagant *à l'outrance* for people to direct their attention to the most exquisite hair-breadth minuteness of mere measurements, while they altogether overlook and take no account of those æsthetic qualities and effects which, although they elude the most *cunning* mechanical appreciation, contribute to the fascination of every genuine work of art.

V. Not the least, perhaps, among Fergusson's heresies, is his attaching the importance he does to Polychromy, a species of decoration for architecture all along considered, till very lately, a trait of barbaric taste, and not even so much as suspected to have been practised by the Greeks; and which although it excited attention as matter of curious inquiry some few years ago, has led to no results, and may be said to be again ignored.—It may, however, be remarked, *en passant*, that such practice of the Greeks has been, if not recommended for imitation, strongly extolled by Mr. R. N. Wornum, in a lecture on Greek Art, lately delivered by him to the School of Design, at Somerset House.—In this climate, polychromy is hardly to be thought of for external decoration: it would no more thrive here than would the plants of tropical regions; yet, as we rear the latter in conservatories and "palm-houses," as botanical curiosities and specimens of exotic vegetation, we might rear, under cover and protected from the weather, a few specimens of external polychromy. There would be nothing extravagant in erecting, at the extremity of an avenue in a so-called "winter-garden," a full-sized model of the Parthenon, with all its polychromatic embellishment restored;—not, indeed, a model of the entire structure, but merely of its façade and pronaos; for which no more costly material than wood would be required, nothing more being necessary than to exhibit *effect;* and such exhibition of it would be likely to settle the now doubtful question as to the taste which sanctioned polychromy, far better than a thousand pen-and-ink debatings about, it, *pro* and *con*. As to the cost of such an experiment, it would be to many a mere bagatelle—a far less expensive folly, should it happen to be called one, than many of those in which some of our *millionaires* indulge, or else do penance, in order to obtain a little brief newspaper notoriety, in exchange for some of their superfluous cash.—But *Cynthius aurem vellit*.

VI. If not externally, we easily enough might have architectural Polychromy internally,—by which term, something more than the employment of different-coloured materials, or painting for the general surface of the walls, is to be understood. Nevertheless, we have not yet advanced beyond the application of coloured marbles, or the imitation of them in scagliola, for what are considered the strictly architectural features in interior design and decoration. Go into any of our most palatial clubhouses or mansions, and scagliola shafts to columns and pilasters appear to be the *bout de leur Latin* of our architects in regard to architectural decoration, properly so called. For aught further they are content to be indebted to Mr. Sang, or Mr. Somebody-else, for whose brushes they provide blanks of ample verge and space enough to be filled up *ad libitum*.

VII. To return to Mr. Fergusson: were there nothing else that I admire in him, I should admire the utter absence in his book of that nasty, crawling, creeping, lickspittle, flunkeyism, which is the prevalent vice of a great part of the public press at the present day, though it is equally the disgrace of manhood and of criticism. Were he deficient in all besides, Fergusson is the very reverse of a flunkey sycophant, and possesses what in this age of wonders is the rarest, if not most wonderful, thing of all—moral courage. And of such courage it requires not a little to give utterance, as he has done, to some exceedingly strong truths, that are likely to be equally unpopular in every quarter. When Welby Pugin attacked his professional brethren, he imputed their degeneracy in a great measure to their Protestantism, and, no doubt, reckoned upon ingratiating himself with the Catholics—perhaps also with those whose antiquarian studies and feelings prejudice them in favour of art as it was cultivated in Catholic times. Mr. Fergusson, on the contrary, has placed himself in a very different position, and has made himself friends among no party—at least, no existing one. Pugin's cry was: Let us go *back!*—and backwards we have been going ever since; but Mr. Fergusson's is: Let us go *forward!*—a matter far more difficult of accomplishment than the other. Against that *Forward*, we have thrown up barricades in the shape of inveterate prejudices. Because we cannot get forward all at once, at a single bound, we are not to strive to get forward at all. Architecture has been brought into a complete *fix*. Yet, strange to say, instead of the impossibility—either real or imaginary—of getting architecture out of that "fix" being at all regretted, it is rather made matter for triumph and congratulation; for we have, ere now, been told that we ought not so much as to think of advancing a single step further than those who have gone before us, and whose stopping point ought to be considered the *ultima Thule* of the art, and of our ambition.

ON ISOMETRICAL PERSPECTIVE.

By R. G. Clark.

In my last article on "Isometrical Perspective" (vol. xi., p. 294), I gave an easy rule by construction to determine the axes of the ellipse, being the isometrical projection of a circle, the angle O A B being 30°, (see the figure in that article). But it is sometimes necessary to draw a vertical isometrical projection of a circle, as in the case of a water-wheel, or a wheel of a locomotive, thus (fig. 1): Let A B C D E F G be the isometrical projection of a cube, the side A B being in this case drawn horizontal; produce B to H, then the angle H B C = 60°; draw the two diagonals B F and C G. The two diameters can be determined by construction by the last rule. But as the angle C B G is in this case 30°, the multipliers are therefore different. The numbers to be used as multipliers to determine the two axes, are respectively 1·408 for the transverse, and ·365 for the conjugate.

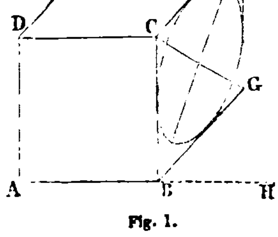


Fig. 1.

Ex.—Suppose the diameter of a locomotive wheel is 6 feet; required the transverse and conjugate diameters of its isometrical projection.

Here 6 × 1·408 = 8·448 = the transverse diameter, F B
6 × ·365 = 2·190 = the conjugate diameter, C G.

When the angle H B C is 30°, then the rule in last article applies. It appears, therefore, that the ellipse in last article is the isometrical projection, both of a vertical and a horizontal circle, when the angles C F G and C B G are each 30°. But when the angle H B C = 60°, then the ellipse, as alluded to in this article, is the isometrical projection of a vertical circle.

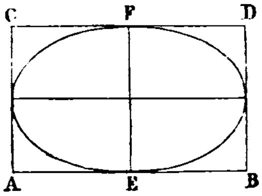


Fig. 2.

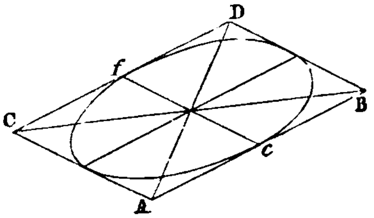


Fig. 3.

Sometimes it is necessary to find the isometrical representation of an ellipse, in the case of an elliptical form of buildings. In such case, when the transverse and conjugate diameters of the ellipse are given, the given ellipse must be circumscribed with the rectangle A B D C (fig. 2), and then its isometrical representation drawn as in fig. 3. Bisect *a b* in *c*, and *c d* in *f*; draw *c f* parallel to C A, and then the curve along the oblique axes can be drawn with a trammel. It will be also proper to remark that the curve has two pair of foci.

As many buildings are often required to be erected in the form of regular pentagons and hexagons, it would be desirable to exhibit some ways of drawing the isometrical representation of the two polygons.

1. First, with respect to the Pentagon: it is a form usually required in permanent fortification, especially in citadels. In this case, I shall give some numbers to enable any one to draw its isometrical representation in the most commodious form. Let A B C D E (fig. 4) be the isometrical representation of a pentagon; let A B be considered as unity: then will the whole height D F = ·889; F H = ·398; E H or H C = ·810; the semi-conjugate diameter of circumscribing ellipse = ·49, and the semi-transverse = ·89. By means of these numbers, we can easily draw the isometrical representation of the polygon when its side is given. The circumscribing ellipse is not required, but only the semi-conjugate D O, to determine the centre O, where all the corresponding radiating lines in the original figure must be drawn thereto. With regard to the making an isometrical representation of a fortification, as Vauban's First System, or of Cormontaigne's Modern Bastion system, in the form of a regular pentagon, it is only necessary to multiply the above numbers by 180, and then will be given the number of times in length of the constructive lines of the isometrical representation.

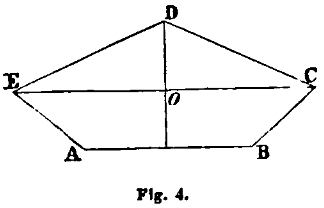


Fig. 4.

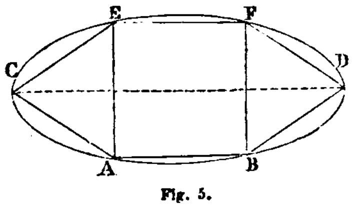
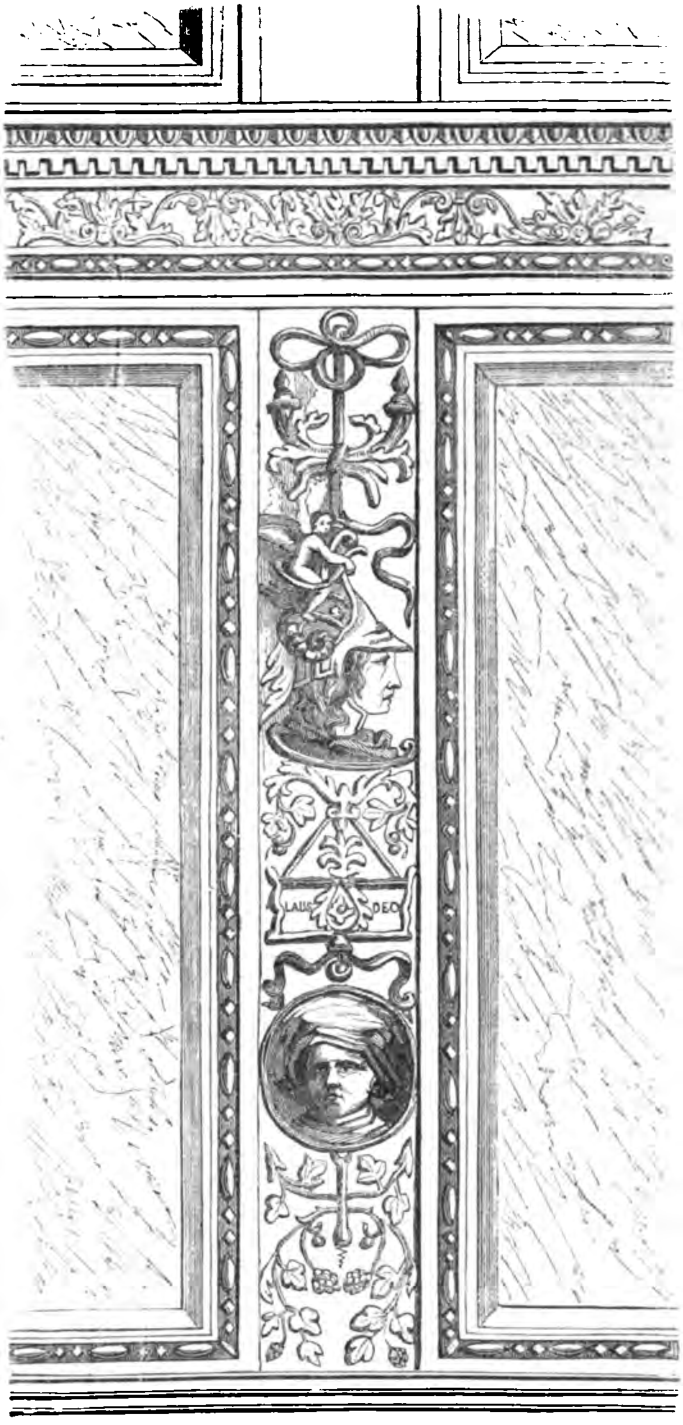


Fig. 5.

II. The Hexagon is commonly required, as being of a most convenient form for prisons, workhouses, &c., and can be easily drawn by a common-set square of 45°, as in fig. 4. First of all draw the front side A B, and construct a square ABEF, and then complete the remainder of the figure with the square, as before mentioned. The method of construction is clearly elucidated by fig. 5. Although the ellipse is exhibited, yet its representation is not necessary. Any other isometrical projection, as making it an angle of 30°, would be extremely unsightly. This method of projecting would, in many cases, be very convenient in drawing the nuts and bolts of machinery, when exhibited isometrically. The above method could be easily proved geometrically, but it was deemed quite unnecessary to enter on so simple a matter.

THE GIANTS' STAIRCASE, VENICE.



The celebrated Giants' Stairs, Ducal Palace, Venice (named from the two colossal statues, by Sansovino, of Mars and Neptune on its summit), is formed out of the beautiful white marble of Carrara, and deservedly admired on account of the splendid effect of the material, as also the art that has been displayed in its decoration. With great taste, purple (or *rosso*) marble is intermixed with the white in the square panellings into which its flanks are divided. From the exterior surfaces, beneath its perforated parapets, the annexed engraving is a sketch of one single slip of the sculpture, as an example of the *bassi-relievi* of this interesting structure. It appears that when originally planned, and when the sculptor worked upon it, no pains were spared, and no expense grudged, in making this ascent a fit, appropriate, and worthy approach to the Doge's palace—that the steps which the robed senators and great men of the Republic were accustomed to ascend could not be too rich or too nobly ornamented. On these steps, for the purpose of producing a contrast with the white marble, an inlay of metal was formerly introduced. Spoiled of these to-day, it is still an object of great admiration. The huge, rough, but expressive, tutelary divinities on the summit—emblems of the naval and military prowess of Venice—by Jacobo Sansovino, impart to it a high degree of interest, and have conferred upon it much of its celebrity. They were placed upon their present pedestals about the year 1566, though commenced by him some years previously.

The Giants' Stairs is vivid in the recollection of all who have seen it, and has been copied and contemplated by generations of artists. It has been a favourite study with our Prouts, our Leitches, our Stanfields, and our Turners. It abounds in historical and romantic associations; and no one who has read the history of the Doges, but would remember it was these marble stairs

"Down which the grizzly head of old Faliero
Roll'd from the block."

From Temanza's "Life of Sansovino,"* we have collected some of the following particulars of this excellent sculptor and architect. He was born in Florence, about 1479; died, aged 91, 1570. His first studies were from the well-known cartoon by Michael Angelo (the War of Pisa), which was ordered to be drawn for a painting in the Council-hall at Florence, and which Michael Angelo gained in competition over Leonardo da Vinci. It was a great object of study among the students of the day, and Sansovino upon this masterly production laid much of his foundation of drawing the figure, and knowledge of design. From Florence he repaired to the Eternal City, where he studied the Apollo Belvidere, &c. Bramante, then the Pope's architect, seeing Sansovino modelling in the Vatican, and pleased with a small vase which he held in his hand, that served him as an inkstand, and which he had designed, ordered him to model in wax from the celebrated statue of the Laocoon; giving the same example to three other young artists likewise to copy. Raphael was to decide as to which was the best among the four, and his approbation fell upon Sansovino. This model was cast in metal, and was considered to be a most perfect specimen. At this period, Sansovino derived advantages from his inhabiting the same house with San Gallo, being in consequence induced to go through a course of architectural studies. Subsequently, he was with Pietro Perugino, and enjoyed the company of the first literati and architects of the day, among whom was Cesare Cesariano (the commentator of Vitruvius), and Andrea del Sarto. The praises he now received, and the fame he acquired as a sculptor, though little more than the age of thirty, served as a stimulus to exert his talents and produce works from which he might command higher and yet higher commendation. Temanza says (note. p. 13), it is not easy to fix the true period in which Sansovino came to Venice. Vasari places it in 1527, after the sacking of Rome. In Venice he met with congenial spirits, and the friendship of Aretino and Titian; upon which Temanza truly remarks—"*E tutti e tre formarono un Triumvirato in cui trovavono le bell' Arti come la lor residenza*" (p. 15). In 1529, Buono, the architect of the Procuratie, dying, Sansovino was posted in his stead, with a provision from the State, and a house near the Orologia, on the Piazza. He was considered to have shown some skill in the mode in which he repaired, by means of circles of iron toothed and wedged, the cupola of St. Mark, which had been dilapidated for many years. Some of the work was assigned to him in the school della Misericordia, and in the church of S. Francesco della Vigna, though the elevation is Palladio's; and very beautiful are his bronze *bassi-relievi* to the doorway in the chapel royal of St. Mark, which are given by Cicognara in the 2nd vol. of his "Storia sulla Scultura." He built anew the Zecca, in 1535, which is constructed entirely of stone from Istria. The admired Loggia, at the foot of the Campanile, was erected about 1540; the pedestals, architraves, and cornices of which are of the beautiful *rosso* of Verona, the columns of the best Brescia and Grecian marbles, and the remainder of Carrara marble. It is richly adorned with statues, in niches, of Pallas, Apollo, Mercury, and Peace; and *bassi-relievi*, emblematical of the States of the Republic. The greater part of this most elegant building is by Sansovino; the rest by his pupils.

Frederick Lush.

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* Published in Venice, 1752, quarto, with portrait, engraved from a painting by Titian.

IMPROVED SAFETY-VALVES.

By Alfred Gregory, Esq., C.E

Fig. 1.

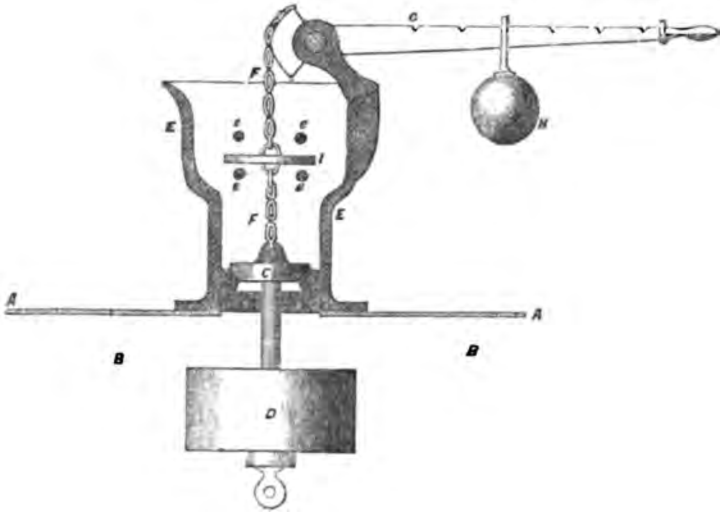
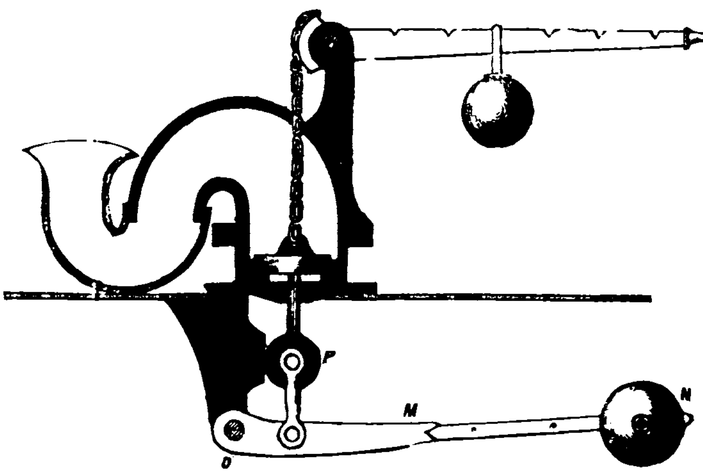


Fig. 2.



The above engraving shows an improved form of safety-valve for steam-boilers, invented by Mr. Alfred Gregory, and described in the *Mechanic's Magazine*, which has met with the approbation of several eminent engineers.

The advantages do not require to be much insisted on. The practice of overloading the safety-valve is much more common than is generally supposed: sometimes it is the act of *ignorance*, but most frequently that of *will*, not only endangering life, but injuring the *pocket* also, in the destruction (which is very serious) that ensues to the *boilers*, *fire-boxes*, &c. The number of fines levied on locomotive-enginemen furnishes sufficient evidence of the frequency of its occurrence.

Description.—Fig. 1, represents the safety-valve in a form appropriate for stationary use. Fig. 2, another modification, on the same principle, applicable to boilers of every description—locomotive, marine, and stationary.

A A, fig. 1, represent the top plates of boiler; B B, the steam space inside; C, the ordinary conical valve, having a perpendicular spindle, to which a weight, D, is attached; E E, valve-box; F F, a chain, which is connected to the valve at one end, and at its other end to the short curved part of the lever G; H is a regulating weight; I, a shield to protect the valve from injury or interference; *e*, *e*, *e*, *e*, four bars or stops to the shield I, for frustrating any attempt to damage the valve.

The mode of working is, for the steam to raise the valve, as usual, when its pressure exceeds that of the weight D, less the lifting power of the lever G, and weight H. The weight D, being inside the boiler, cannot be for any mischievous purpose got at; and it is equal to the *extreme* pressure allowed upon the boiler, or may be made so by hanging weights to the eye-loop of D, which additional weights may be reduced, or altogether removed, as the boiler deteriorates by wear. For any *less* pressure, according to the working necessities of the engine, the engineer has the same control over the valve as at present, by sliding the weight H, on the lever G, which operates in taking off weight, *regulating the reduction* as he pleases; but he cannot increase the load upon the valve beyond what the weight D, inside the boiler, gives; for, if hanging more weight on the lever G, he takes off, instead of increasing pressure; and, on the other hand, if raising the handle end of the lever, it has no effect upon the valve, on account of the connecting medium being *a chain*, which, of course, can only operate in one way, hanging loose, as it does, and throwing no stress upon the valve when moving downwards.

Fig. 2 is another form, involving the same action, but instead of the heavy weight attached to the valve-spindle, as before, there is, inside the boiler, a lever M, having a weight N, and fulcrum at O, equal in its effect to the extreme pressure allowed, and which may be reduced as the boiler, by use, weakens, by fixing the weight N, nearer the fulcrum, convenience for which is shown. Instead, also, of the protecting shield, as in No. 1, the blow-away steam is here carried off by a double ų-bent pipe, the accessible half of which is made of thin sheet copper, strong enough to carry away the steam as it blows freely into the air, there being then little or no pressure; but if the steam be confined within it, through any wilful attempt to plug the pipe up, the copper will *rend* (a result peculiar to that metal); and permit the necessary escape. There is likewise shown a small roller P, to counteract the curvilineal action of the lever M, and keep the valve-spindle from "sticking." But both this and the copper pipe are precautions no more necessary than at present with the best constructed valves, and might safely be dispensed with. The remaining parts and action of fig. 2, are the same as fig. 1.

Both plans represent the principle of a valve, the mechanical arrangement of which, however modified, embraces every advantage, as to security, of a "*locked valve*," in frustrating any attempt to overload it, either by accident or design, through ignorance or will, without the usual attendant disadvantages of inconvenience, expense. &c., of a second valve, and liability to "*stick*" by corrosion of parts through *standing long unused*, &c.—a liability which the present form has not, as it is the engineers' *frequent* "*working*" safety-valve, which is a *locked* and limited one, but possessing all the facility of regulating his pressure that he has now, though not allowed to exceed the fixed *extreme* safe point.

GEORGE STEPHENSON.

[The following communication was addressed to the author of the article on George Stephenson; but as it contains some interesting facts and corrections, we thought it far better to give the communication in the *Journal*. Our readers must see by the numerous quotations, that the papers written in the *Journal* have been got up with considerable labour, and that the writer has only stated that which is supported by some authority. We shall feel particularly obliged for any information regarding the Life of George Stephenson, as it is our anxious desire to make the memoir as complete as circumstances will allow. It being a life so intimately connected with the great advance of modern engineering, it is highly desirable to make it as perfect as possible. On this account, we have postponed the continuation of the memoir for another month.]

"Sir,—In reading the article on George Stephenson in the last number of the *Journal*, I noticed some errors connected with the description of the Stockton and Darlington Railway, which I thought it would be well to point out to the writer of that paper, and to endeavour to correct them as far as I am able. Speaking of the Stockton and Darlington Railway, you say, "this could hardly be named as more than a tramway":—now, from the very commencement, this line was indeed a veritable railway; it could not properly be called either a tramway or wagon-way:—In using those terms, we ought to be careful to apply them according to their proper and genuine signification, or serious errors may eventually creep into our descriptions of works of this class; and which, may, in course of time, become perpetuated, and the true meaning of the terms lost. Like railways, those three terms had their birth among the extensive collieries of Durham and Northumberland. The *tramways* are principally used *underground*, for the purpose of conveying the coals from the working district of the mine to the shaft, up which they have to be drawn. In some of the extensive collieries, these tramways will extend for three or four miles. The gauge of the road is about 18 *inches*: the carriage which runs upon this way is a small four-wheeled rolley or tram (hence the term tramway). Upon this carriage is placed the basket containing the coals. Previous to the introduction of tramways and trams, barrows were made for this purpose, the corf or basket being placed on the barrow, and a narrow flagged-way for the barrows to run on was laid down, called the barrow-way,—which term is even yet, in some cases, applied to the more modern tramway. It is perhaps 150 years since the barrows and barrow-way was superseded by the tram and tramway. The first tramways were made of wood, and may still be seen in some places. The two rails were fixed together by a cross-sleeper and a 6-foot length of double-way laid down at once. The wheels, of course, were without flanges, and at first were made of wood, with an iron rim: the wheel loose on the axle, and the axle also loose, to allow for "play" on going round the sharp curves or turns: after this, cast-iron tram-plates were introduced, and eventually malleable iron; the weight of the latter about 4½ lb. or 5 lb. per foot. The flange was still a portion of the plate, and not of the wheel: this form of plate is known as the "*edge-rail*."

The *wagonway* is used for conveying coals from the pit to the ships, &c. The wagons hold 53 cwt. of coals, the Newcastle chaldron, and are called chaldron-wagons: the wagon is placed on four wheels, about 2 ft. 6 in. or 3 feet diameter; the wheels have flanges, and are wedged fast to the axle: they are of cast-iron. The wagonways in the first instance were made of wood, and plated with iron at the curves. A specimen of this way may yet be seen in use at Mr. Curwens, Harrington Colliery, in Cumberland. The gauge of the Newcastle wagonway is 4 ft. 8½ in. The cast-iron fish-bellied ┬ rail superseded the wooden one, and eventually the malleable-iron rail took the place of the cast-iron one; the present wagonway rail weighs about 28 lb. to the yard. After wagonways, came *railways*, which I need scarcely define. Had the Stockton and Darlington line been made solely for the conveyance of coals from some individual colliery, it might have been called a wagonway; but even then it could not with any propriety have been named a tramway. But in the first instance, it was constructed as a public railway; not merely for the purpose of conveying coal-wagons, but for coaches, merchandise-wagons, and all kinds of carriages for the conveyance of passengers, coals from a great and extensive coal-field, lead, iron, and general merchandise. Passengers have travelled on it from the first—hence it was *different in its application and uses* from the old wagonway, and *different in its form* from the *tramway*. I believe it was sometimes at the first designated as a tramway, but improperly so, as you will see from my description of the latter: but in all cases it is well to give to things their ancient and proper names. *Edward* Pease, the *father* of Joseph Pease, who was the member of parliament, may be looked upon as the "Father of Railways." It was through his strenuous endeavours and support that the Stockton and Darlington Railway was constructed; and it was chiefly in consequence of his patronage and support, that George Stephenson was brought prominently before the public as a railway engineer.

For "Hobarts of Etherly Pit," read "Stobarts of Etherly."

Joseph Pease *was* treasurer for the Great North of England, but such is not now the case, I believe; it is in the hands of Hudson, or a portion of the York and Berwick.—The Peases, I believe, were never connected with the Liddels as bankers, as you state.

The line was not to ship coals from the "Dale of the Tees, between Darlington and Stockton:" there is *no* coal between Darlington and Stockton. It was to ship coals from the Auckland coal-field and the Dale of the Wear, not the Tees.—In 1847, they leased the Wear Valley, Bishop Auckland and Weardale, Weardale Extension, and a portion of the Stanhope and Tyne or Derwent Railways, also the Shildon Tunnel; the whole length, instead of being 55 miles as you state, is, I believe, now upwards of 90 miles.

Stephenson *never tried* any locomotives on the Hagger Leases Branch; it was not opened until after he had left the line. But, indeed, there was *never* a locomotive seen on this branch; it is worked [illegible] by horses, the [illegible]olton Incline preventing the [illegible] from getting o[illegible] [illegible]ly work from the place of [illegible] o the east [illegible]ton bank or New Sh[illegible]

[illegible] he wrong in[illegible] [illegible] passenger trains at [illegible] an hour in 18[illegible] [illegible] were worked [illegible] ding engines, [illegible] [illegible]er.

The greatest work on the line was the bridge over the Tees, at Stockton; it was originally a suspension bridge, of 281 feet span, erected by Samuel Brown, R.N.; it was the first and only application of the suspension principle for the support and continuation of a railway. The experiment was not successful: the bridge had to be supported, and was afterwards replaced by one of Robert Stephenson's trussed girder bridges, of about 90 feet span; this was, I believe, the first application of the trussed cast-iron girders to such extended spans. The present bridge has been strutted since the failure of the Dee Bridge at Chester.

You state, "the number of travellers was 428,514 (in 1847); of these, it is said, 33,222 were by horse-coaches (showing that some still ran on the line), and 1,840 by coal trains; each passenger travelling about $6\frac{1}{2}$ miles, and paying about 10*d.* as a fare." I cannot understand this statement at all as to the number of passengers conveyed by horse-coaches, and the inference drawn from it, seeing that there are *no horse*-coaches at all on the line. The passengers travel from Redcar to Wolsingham, about 50 miles, There are three through-trains each way in the day, with intermediate trains between Middlesbro' and Stockton, and Stockton and Darlington. The passenger-trains travel at about the same velocities as the ordinary passenger trains on other railways; but as to horse-coaches, there are none.

Again, you state, "It may be said that the manager (of the Stockton and Darlington Railway) is now Mr. George Stephenson, nephew of the engineer; so that the name is still kept up." This is not the case. There *is* a person of the name of George Stephenson connected with the line, but not as manager; he fills some subordinate situation, I believe, in looking after the coaching and traffic at the Darlington Station, but is no relation to the late George Stephenson, engineer. The present engineer of the line is Mr. John Dixon, who resides at Darlington, and is, since the death of George Stephenson, the oldest railway engineer on the list. They commenced together on the first of railways, the Stockton and Darlington; and after its completion he accompanied Stephenson to the Manchester and Liverpool, and had a portion of the line under Stephenson during its construction. After the line was opened he remained on it for many years as resident engineer, and was afterwards connected with several other of Stephenson's lines; and is now engineer on the original line, where he and Stephenson commenced their career as railway engineers upwards of a quarter of a century ago. Had you been aware of the fact, and applied to him, he could have given you every information on a subject which you regret so little is known about—viz., the Stockton and Darlington Railway, the first great work on which Stephenson's talents were more particularly developed, and especially interesting on that account. I have no doubt but he could also speak as to Stephenson's labours on the Manchester and Liverpool Railway, as they were together during the whole of its construction. He was intimately acquainted with Stephenson during the whole of his career as a railway engineer; and could speak of many little traits of character, acts, and opinions of that eminent man, which would have been of the greatest interest in your paper, as exhibiting more minutely the workings of his mind; which can be but imperfectly shown by the scattered facts from so many imperfect sources, which you have, with praiseworthy labour, laid before the readers of the *Engineer's Journal.*

The Stockton and Darlington Railway was the first public railway that was constructed, and the one on which Stephenson more particularly commenced his career of railway engineering, which was to do so much for the world. This was the beginning of that system of railways which was eventually, and within a very short period of time, destined to expand itself so rapidly, and to attain such a magnitude and influence as to completely revolutionise the previous system of travelling: within the short space of a quarter of a century it has grown into a gigantic system, affecting, and calculated to affect, the whole of the civilised world. When we consider what it has grown to, and the perfection it has attained, well may we look upon the Stockton and Darlington Railway, which stands as the first on record, with a degree of interest. It was a cheaply-constructed line; and being the first, it is a curious fact that this line, of all others, has been the most successful to the shareholders, by realising the greatest profits; and looking at it in an engineering point of view, we can scarcely detect any material difference between the line as a whole, its bridges, and other works, and that of the most recently-constructed railway of the present day; although, in the latter case, we have the experience and great practice of 25 years to effect, as one might naturally suppose, great changes and improvements. There is certainly a difference and improvement in the locomotives and carriages, &c., but scarcely any in the railway itself. It is reported that Hudson, or the York and Berwick Railway Company, have leased the line for 22 years, at 15 per cent., and the branches at 6 per cent., and is about to enter upon it on the 1st of January next: they have already given notice of going to parliament to get powers to lease.

Yours, &c.,

A Reader of the Engineer's Journal.

*** Had I been connected with the line, I might have given you more detailed information on some points; but from a long residence in the vicinity, and particular acquaintance with the facts, I can vouch for the correctness of my statements.

THE COMBINED VAPOUR ENGINE.

THE INVENTION OF M. DU TREMBLEY.

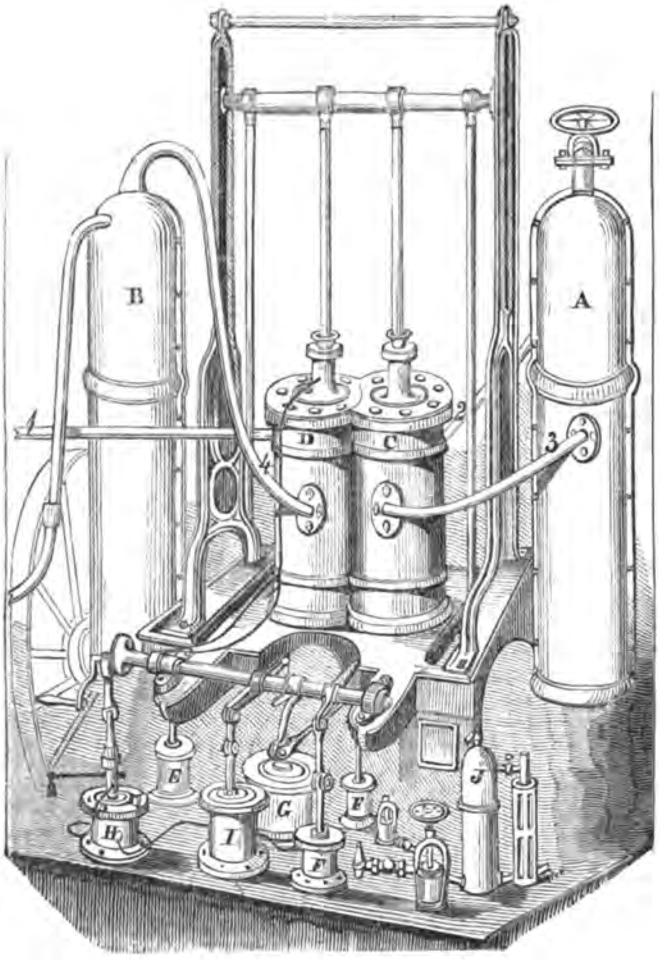
The Combined Vapour Engine has recently attracted considerable attention, in consequence of the announcements in the daily and weekly press, and caused a large concourse of scientific persons to assemble at the engine manufactory of Messrs. Horne, High-street, Whitechapel, to witness the performance of the engine. We were induced to pay two visits, to make ourselves acquainted with its action, and to ascertain whether it possessed the merits set forth by our contemporaries and the French commissioners; but in consequence of the clumsy character of the engine exhibited, which we understand was constructed in France, we were unable to satisfy ourselves as to the real value of the principle upon which it worked. We must, therefore, for the present simply record what we observed, and give some extracts from the Report of the commission, appointed by the French government to examine and report upon its merits. The commission appears to have devoted considerable labour and time in investigating the character and value of the invention. When a more perfect engine has been constructed, we hope we shall have an opportunity of again investigating the invention, and be able to lay before our readers a further description and the result of our examination.

The accompanying engraving is a back view of the engine exhibited. It will be perceived that there are two cylinders, each $8\frac{3}{4}$ inches diameter, with a stroke of 22 inches. The pistons of both are worked together, upwards or downwards, and are connected to the same cross-head. The steam-pipe was connected with a steam-pipe that was working another engine at rather high-pressure, and only a small quantity of the steam was allowed to pass through a throttle-valve, to work the Combined Engine. The quantity of *perchloride of formoyle* used in the engine was stated to be 40 lb., which costs 8*s.* per lb.; and the loss occasioned by evaporation in a month is not more than 1 lb. It is intended to use, instead of the formoyle, the perchloride of carbon, as being considerably cheaper, its cost being only 8*d.* per lb.

The invention is applied either to a single engine, with two cylinders and pistons (C and D), or, as is usual for maritime purposes, two distinct engines with a cylinder and piston each. In either case one of the pistons is acted upon by steam, and the other by the vapour of perchloride, or of any other easily-vaporised liquid. The steam-power is generated and applied as in the ordinary engine; but, upon the escape of the steam from the first cylinder (C), after having exerted its expansive force therein, it passes into an air-tight case, termed a vaporiser (A), containing a number of small tubes charged with perchloride or some easily-vaporised liquid, penetrates into the space between, and thus comes into contact with the entire surface of the tubes.

The faculty of absorbing caloric possessed by liquids of the before-mentioned class is so powerful, that, immediately upon the steam coming in contact with the surface of the tubes charged therewith, a large portion of the caloric of the steam is absorbed by the liquid in the tubes, which becomes thereby vaporised; and the steam, being thus deprived of its caloric, is immediately condensed, and is then returned into the steam-boiler, or, being by this process perfectly distilled, may be applied for culinary or any other purposes for which pure water is required.

The vapour thus obtained, by the action of the steam upon the perchloride or other liquid in the tubes (A), is conducted into the second cylinder (D), and, after exerting its elastic force (which is greater than that of steam), upon the piston in the second cylinder, is condensed, and, by means of a force-pump, is returnedinto the vaporiser (A), which it thus keeps regularly supplied, and is alternately vaporised and condensed.



THE COMBINED VAPOUR ENGINE.

References to Engraving.

A, Vaporiser of the perchloride, serving also as a condenser of the steam. B, Condenser of the vapour of the perchloride.—C, Cylinder in which the steam acts.—D, Cylinder in which the vapour of perchloride acts.—E, Air-pump withdrawing the water resulting from the condensation in apparatus A.—F, Air-pumps withdrawing the perchloride after condensation in apparatus B, and conveying it hack to feed-apparatus A.—G, Pump re-conveying the condensed steam to feed the steam-boiler.—H, Pump to supply water to the apparatus used to prevent the escape of the perchloride ahout the piston rods.—I, pump conducting cold water from the well to apparatus B, to condense the perchloride vapour.—J, Apparatus to cause the vacuum in the different parts of the engine where the perchloride acts.

No. 1, Pipe through which the steam is supplied to cylinder C.—2. Pipe through which the perchloride vapour is supplied to cylinder D.—3, Pipe through which the steam escapes for condensation in apparatus A, after having performed its work in cylinder C.—4, Pipe through which the perchloride vapour escapes for condensation into apparatus B, after having performed its duty in cylinder D.

We take the following extract from the Report of the French Commissioners, appointed in 1846, to test the capabilities of the Combined Vapour Engine, which extract explains the principle of the engine, and the mode and result of the experiments thereon:—

"The ether-hydric apparatus was constructed in consequence of the favourable opinion given by the Board of Works as to the possibility of making use of the caloric lost in the ordinary mode of condensation to vaporise ether. Two engines, of 10-horse power each, were coupled upon the same beam: the one supplied from a boiler (for 10-horse power) acts in the usual manner, by the introduction of steam and its discharge after expansion. The condensation of this steam takes place in a receiver containing a number of small tubes previously filled with ether. This liquid, owing to its avidity for caloric, robs the discharged steam of its heat, and is vaporised at a pressure depending upon the temperature and volume of the discharged steam. The other engine, identical with the former as to its diameter and the motion of its piston, works under the influence of ether-vapour: it receives this vapour during a portion of its motion, and discharges it after expansion into a receiver, similar to the former, kept constantly at a very low temperature by a continual injection of cold water.

"Taking care to adapt to each engine a proper expanding apparatus, we are enabled to regulate, at will, the introduction and the expansion of vapour in each cylinder, and thus combine these two elements of power—expansion and volume of steam for the former, and expansion and volume of ether-vapour for the latter; so as to arrive at a total maximum force, with the smallest expenditure of steam, or, which is nearly the same thing, with the smallest expenditure of fuel. The working of the two engines was satisfactory, and the apparatus fit to be employed without any alteration whatever in its construction.

"Having once ascertained the certainty of its ability to work in perfect security, we have endeavoured to ascertain the force developed under the three following cases: 1st, of a steam-engine working alone by waste steam; 2nd, engines coupled, the one put in motion by the expansion and condensation of steam, and the other likewise by the expansion and condensation of ether; 3rd, of an engine working alone by expansion and condensation of ether.

Force produced.—"The index was placed over the cylinders during the various experiments; a lever acted constantly on the main axle. The general conclusions we arrived at are as follows:—As regards the force measured upon the piston by means of the index. The diagrams drawn by the ether-vapour exhibit always an excess of power over those drawn by the steam. The final pressure of the ether is generally greater than that of the steam; rarely upon a level with it, but never less. The two cylinders being equal, it follows that, when a volume of steam is discharged at a given pressure into the ether-vaporiser, a volume of ether-vapour is obtained—at the very least, equal, and of the same pressure. Several times an excess of pressure was gained of 10, 20, and 30 per cent., with an equality of volume. If then we consider the combined effects of these engines proportionally to the mean pressure given by the diagrams, we must conclude that, by the employment of ether, a force measured by 100 becomes at at least 200, at times 210, 220, 230, with the same expenditure of fuel.

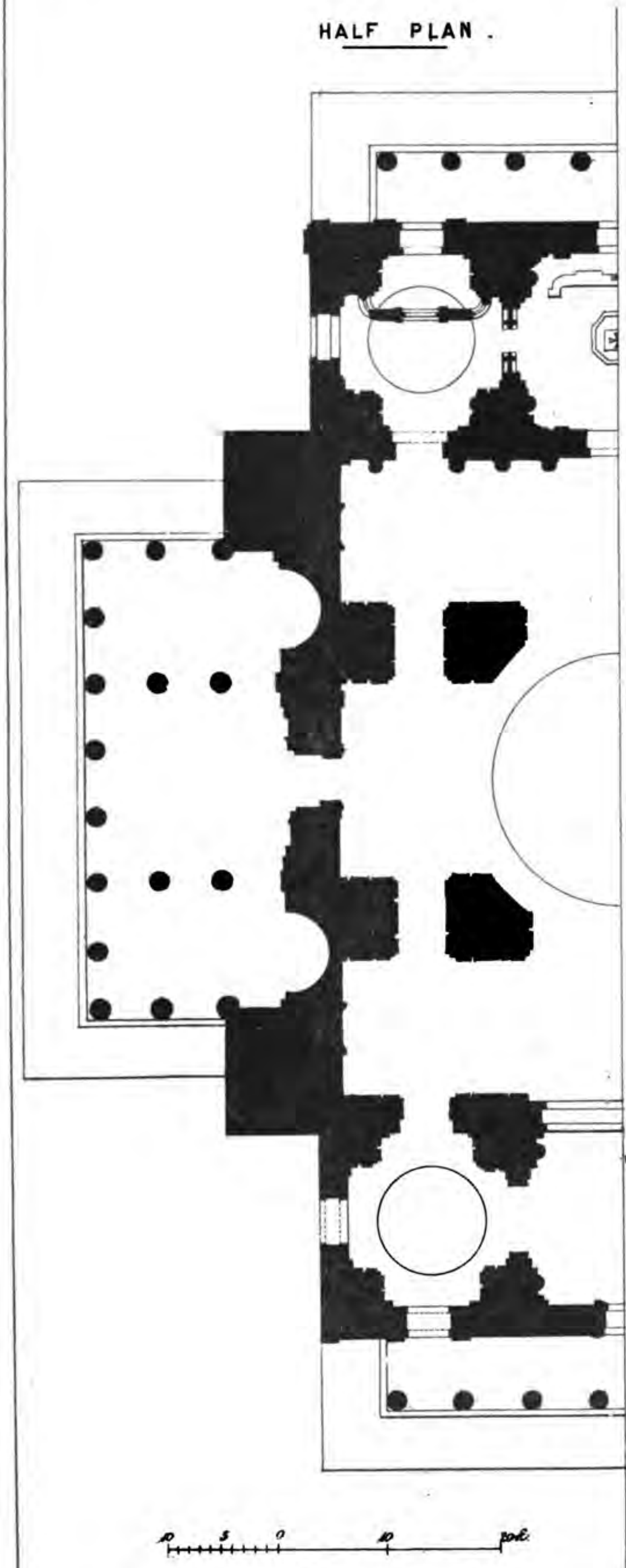
"Thus have we verified and evidently exceeded the inferences drawn from the experiments made in 1846 at M. Phillippe's, and, consequently, confirmed the favourable conclusions in consideration of which the Council proposed a more decisive trial, to ascertain whether the use of ether doubles the power without adding to the consumption of fuel.

"Extract made from the diagrams of the index, taken from observation of the arm of the lever, placed so as to measure the power of the two engines coupled together, the lever gave 80, 90, 105, and even 120 kilogrammes, at 40 and 46 strokes, the weight attached to the lever in the experiment being from 38 to 42 kilogrammes. The steam-engine, by itself, was unable to lift the weight attached to the lever, being from 38 to 42 kilogrammes: it stopped immediately upon tightening. The ether-engine, by itself, lifted it without difficulty, with a load of about 200 kilogrammes and more; that is to say, that a direct and continual injection of steam into the ether-vaporiser, produced upon the ether-engine alone the maximum of work given by the lever."

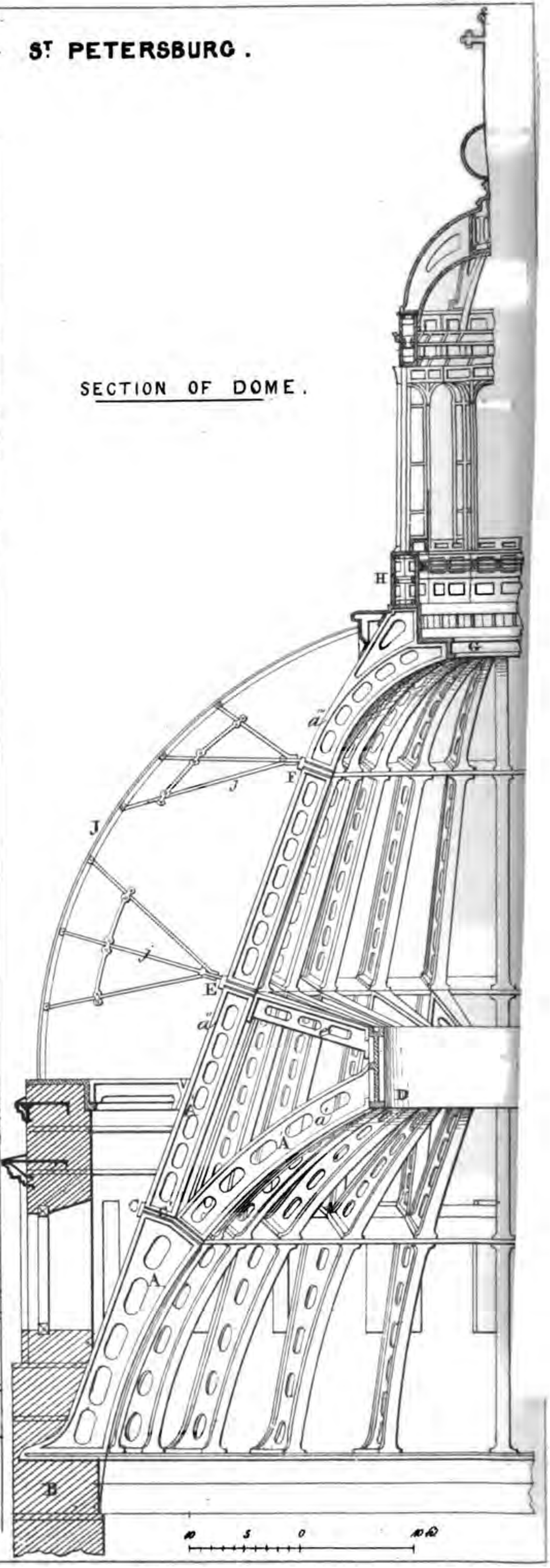
The inventor observes: "The Report omits to take notice of the vacuum, which in this engine gives a power of as much importance as the power of both vapours combined. An examination of the gauges affixed to the engine at Mr. Horne's, will explain my meaning. The pressure of steam on its entrance into the steam cylinder, as given by the indicator, was only 5 lb. per square inch (the piston making 46 strokes per minute); whilst the power of the vacuum, caused by the condensation of the steam, and acting in conjunction with it, upon the piston in the steam cylinder, as given by the indicator, was double, viz., 10 lb. per square inch: total power exerted in steam cylinder, 15 lb. per square inch.—In the other or perchloride cylinder, the expansion of the vapour was equal to a power of 21 lb. per square inch, and the vacuum of 8 lb. only: together, 29 lb.; or an average pressure in the two cylinders combined of 22 lb. per square inch, without an expenditure of more fuel than is necessary to produce a power of steam of 5 lb. per square inch."

S^T ISAACS' CATHEDRAL — S^T PETERSBURG.

HALF PLAN.



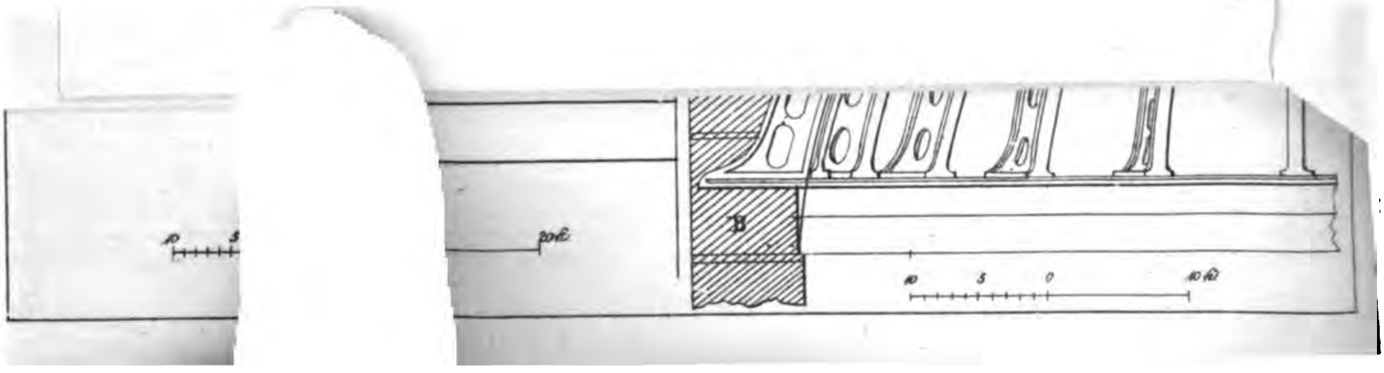
SECTION OF DOME.



e ends of the transepts. There were three inconostases of e class described by Herr Hallman, in his able paper on the Greco-Russian Church, contained in the second part of the "Transactions of the Institute," The plan, therefore, is simple and majestic—its parts well defined and presenting a great variety of effects. The perspective view also offers a busy and picturesque aspect. The lofty spire and the central dome, surrounded by its four minor turrets, has an effective and distinct

churches we should expect that the west end would form the principal entrance, and consequently would receive the greater degree of embellishment. But in this instance there are two noble porticoes at the ends of the north and south transepts; octastyle, like those at the east and west end, but having a depth of three intercolumniations, instead of one, with deeply-recessed large niches, the whole composition being in imitation of that at the Pantheon of Rome in every respect. Apparently, this greater

Plate 3.



THE CHURCH OF ST. ISAAC AT ST. PETERSBURG.

ERECTED BY THE CHEVALIER DE MONTFERRAND.

(With an Engraving, Plate II.)

Description of the Church of St. Isaac at St. Petersburg. By T. L. Donaldson, Esq.—(Paper read at the Royal Institute of British Architects.)

One of the most important features of this Institute is the noble body of distinguished professors of our art, who compose the list of honorary and corresponding members. It forms the immediate link of connection between the professional men of this and foreign lands. We have thus the privilege of knowing the imposing edifices which arise in the principal cities of the continent, and are stimulated by their example, instructed by their genius. If in point of some facilities in matters of construction, we have the advantage of them, they, on the other hand, have more frequently the opportunities of bringing into co-operation the sister arts, and by the abundance of the means placed at their disposal, can more profusely adorn their edifices by the production of the pencil and the chisel, and by an abundance of rare and exquisite materials, such as granite, marble, bronze, and precious stones, can give that splendour of enrichment, in vain to be looked for in our modern buildings, until the present completion of the House of Lords, by our distinguished member, Charles Barry.

I have had occasion in a previous session to call your attention to the stupendous column of Alexander, erected by the present Emperor of Russia, to the memory of his predecessor and beloved brother, after the designs of the Chevalier de Montferrand. In that work we particularly admired the monolithic shaft of granite, and the mechanical means employed in the elevation of the huge block. The chevalier, our honorary and corresponding member, has since favoured us by sending to the library a superb volume, illustrative of the magnificent church of St. Isaac, just completed: a monument of such leading consequence in every respect, and holding so important a rank in the cathedral churches of Europe, that it well deserves a passing notice, as introducing us to a peculiar combination of plan, and an application of granite and iron, and other ingenious processes, on so large a scale, and in some points of so novel a nature, as to be very instructive and interesting.

The origin of the church of St. Isaac dates from the foundation of the city of St. Petersburg; for Peter the Great conceived the idea of erecting a place of worship under the invocation of this saint; but he was not able to do more than construct a provisional church of wood in the Naval Yard, which was shortly after burned. The Czar then laid the foundation, in 1717, of the second church of St. Isaac, not far from the Neva, on the site of the present palace of the Senate.

This church was also partly burned by fire in 1735, and the quarter of St. Isaac becoming more populous, and a place of greater resort, the Empress Catherine directed the erection of a new church in honour of this saint, in that part of the city, and the architect Rinaldi prepared the designs, and it was commenced in 1768. It was intended to build this church entirely of marble, but the death of the Czarina took place when it had only been carried up as high as the entablature, and the Emperor Paul I., anxious to clear away the immediate vicinity of the church, in order to render the site less obstructed, and the original plan more complete, directed the architect Brenna to finish it provisionally; in the mean time omitting or diminishing some of the principal features, until its proper completion, when a development more commensurate with the ideas of the emperor, the church, and the people, could be carried into effect.

The plan of this church was strictly in conformity with the tradition and usages of the Greek church, the national rite of the Russian empire. It consisted of a Greek cross, of four equal arms, having apsidal ends, the intersection or crux of the arms being surmounted by a dome with four abutting chapels at the angles, also surmounted by internal domes and exterior steeples. There was a projecting tower at the west end advancing considerably in front of the mass of the church, with a lofty steeple and entrance doorway; and there were doorways at the north and south at the ends of the transepts. There were three inconostases of the class described by Herr Hallman, in his able paper on the Greco-Russian Church, contained in the second part of the "Transactions of the Institute." The plan, therefore, is simple and majestic—its parts well defined and presenting a great variety of effects. The perspective view also offers a busy and picturesque aspect. The lofty spire and the central dome, surrounded by its four minor turrets, has an effective and distinct character, devoid of monotony, although perhaps not very pure in detail, or severe in its composition as a whole. The outside dimension of the square mass of the church was 173 feet. Its greatest width from outside to outside of the apsidal ends of the transept was 222 feet. Its extreme external length from the front of the tower to the exterior of the eastern apsis 280 feet; consequently it was an edifice of no mean dimensions.

The magnificent ideas of the emperor, who desired to have a temple commensurate with the vast empire over which his rule extended, led him to submit to public competition the project for the new fabric; but none of the plans submitted seemed calculated to meet the public expectations.

Alexander the First then directed the Chevalier de Montferrand to prepare designs, with the express command, to preserve as much as possible the old church, particularly the space occupied by the three inconostases, or altar screens, already consecrated. Many projects were consequently submitted to the Czar, who adopted one, which seemed best adapted to the special purpose of its destination, and combining best with the buildings by which it was more immediately surrounded.

In order to carry the works into effect, the architect immediately proceeded to clear the locality and to erect spacious workshops, offices for the clerks, habitations for certain of the police and officials, barracks for a military guard, a steam-engine, and other indispensable contrivances.

The foundations were immediately excavated to the depth of above 33 feet below the surface of the ground. Fir piles were then driven throughout the whole extent, 12 inches in diameter and 21 feet in length, their distance apart being equal to their diameter. The earth around the heads of the piles was cleared to the depth of 14 inches, and charcoal driven in to fill up the vacuity, and the whole surface presented 10,762 piles.

Upon these were placed two courses of granite, composed of large blocks. The points of support, and particularly the foundations of the four piers of the dome, were also carried up in solid granite, and the rest filled up with ordinary construction, but forming a regular mass of compact masonry throughout the whole surface of the monument.

While these works were proceeding, the architect was directed to proceed to Finland, to examine the quarries whence were to be extracted the forty-eight monolithic blocks for the shafts of the columns of the portico. These quarries are situated in two small islands on the shores of the Gulf of Finland, between Vibourg and Fredericsham. These shafts in the rough were 7 feet in diameter and 56 feet long. They were embarked two on a vessel, and then transported by the Neva to St. Petersburg, and there finished off. These columns are certainly the largest ever employed for such a purpose. Those of the Pantheon at Rome are only between 46 and 47 feet long, and they exceed in size any others of antiquity now remaining. The peristyle of the dome has 24 columns, 42 feet high. Those noble columns, which many of us know, in the Baths of Diocletian, and those in the Baths of Caracalla, are only 38 feet high.

Again, there are 32 columns in the steeples of this church, also monoliths; they are 30 feet high—thus presenting a series of 104 monolithic columns in granite; in number and size, and costliness of material, excelling every other monument of ancient or modern times.

We will now proceed to consider the plan of the building, which presents the elementary type of the Greek cross. (The engraving, Plate II., exhibits one half of the plan, the south side of the cathedral, the other half being precisely similar.) This, however, is hardly marked with such distinctness as in the older church, there being several supplementary chapels and vestibules, which give somewhat of complexity to the arrangement. In the centre is the intersection of the four equal arms of the cross, surmounted by the dome; and again at the extreme angles of the parallelogram are four square divisions, surmounted by the four steeples. The church is placed due east and west—the altar to the east, with its several iconostases, and the principal entrance at the west, with its three doorways under an octastyle portico, projecting only one intercolumniation from the body of the building. The east end has a similar portico. In the ordinary arrangement of churches we should expect that the west end would form the principal entrance, and consequently would receive the greater degree of embellishment. But in this instance there are two noble porticoes at the ends of the north and south transepts; octastyle, like those at the east and west end, but having a depth of three intercolumniations, instead of one, with deeply-recessed large niches, the whole composition being in imitation of that at the Pantheon of Rome in every respect. Apparently, this greater magnificence at these points arises from local considerations, as facing more important approaches and more imposing public edifices. The bases of the columns of these porticoes, as also the capitals, are of bronze; the shafts 6 ft. 6 in. in diameter, 11 feet apart, and 45 ft. 6 in. high, giving a total height to the columns, including the base and the capital, of 56 ft. 6 in. The entablature is 14 ft. 6 in. high: together 71 feet. Each portico is surmounted by a pediment, crowned by statues; and the summit and acroteria, and the tympanum, are enriched with bronze groups. This order runs round the whole exterior of the church, and has above it a double attic, equal in height to half that of the entire principal order—an enormous disproportion, which renders the building top-heavy, and tends to detract from the vastness of the order beneath. It is most likely that the architect may have adopted this lofty attic to hide the roof; but the expedient has been more destructive to the effect of the building than the apprehended unsightliness of the roof.

We will now enter the church under the western portico, and immediately we are admitted into a vestibule, similar to the narthex of the ancient Christian temple, with smaller vestibules to the right and left, which are surmounted by the steeples already alluded to. There is a centre nave, 43 feet wide, 175 ft. 6 in. long, up to the iconostasis, and presenting a total length, from the inside of the eastern to the inside of the western wall, of about 278 feet. The greatest width inside between the walls is 153 feet.

The grand iconostasis, of white marble, rises up and forms the altar-screen, or image-bearer, in front of the large piers which terminate the eastern arm of the cross. It is 150 feet wide and 70 feet high.

Three steps lead up to the level of the altar platform. There are three lofty circular-headed doorways, about 14 feet wide by 34 feet high. The principal order is 46 feet high, the eight Corinthian columns 37 ft. 6 in. high, the shafts and those of the pilasters are fluted, and consist of exquisitely inlaid malachite from the province of Perm, discovered in 1831 in a copper mine of M. Demidof, the largest seam ever known, being 17 ft. 6 in. long, 8 ft. 2 in. wide, and 4 ft. 6 in. high; the weight of which mass has been calculated at 120,000 lb., or 50 tons. The bases and capitals are of bronze gilt—I should state that there is a cylinder of cast-iron to each column, forming a core, covered by a brass cylinder, to which the malachite is attached, the pieces being fitted with such exquisite skill that the columns and pilasters appear to be of one enormous block. The whole iconostasis has incrustations of porphyry, jasper, malachite, and other precious stones of the country. An attic 20 feet high rises above the order, which in the centre is again surmounted by a supplementary attic, flanked by two angels, and forming the pedestal upon which is raised the cross, with a group of angels at the base in the attitude of prayer, grief, and devotion. Groups representing the resurrection of our Saviour, and the ascent of the Virgin Mary, flank the circular-headed aperture of the central doorway. There are three tiers of pictures of saints, the Virgin, our Saviour, and the Almighty, who occupy the central compartment, and other sacred personages the side divisions, all painted on a gold ground, clad in rich vestments, and bedecked with jewels. In conformity with the canons of the Greek church, there are no other figures in relief than the angels. The door which closes the centre aperture is of silver, 34 feet high; the side doors are of marble. A profusion of lamps, all of massive silver, are pendant from the ceiling, hanging in front of the pictures.

Behind the iconostasis are three sanctuaries, the central one with the high altar, which is surmounted by a baldachin, or canopy, supported by eight marble columns. Each of the side chapels has its own iconostasis and altar, dedicated respectively to St. Alexander Newsky and St. Catherine. These secondary iconostases are 40 feet wide each, and above 25 feet high, but a central attic and surmounting group of the Ascension increase the total height of the loftiest part to 40 feet. They are of white marble, designed in the cinque-cento style, and elaborately ornamented, the panels being filled with gorgeous pictures of saints on a gold ground. But, in truth, all these paintings, although executed with consummate art, are but temporary, as they are ultimately to be taken out and replaced with resplendent mosaics. In fact, this group of three sanctuaries, with their iconostases, altars, and side door-screens, dividing the central altar-place from the side chapels, composed of the most exquisite marble, profusely enriched with sculptures, paintings, and bronze gilt, make a dazzling group, of which we can form no adequate conception, even if we can in imagination realise the restoration of the sanctuary of the most ornate of our principal cathedrals, carved and painted throughout —emblazoned in all the pomp of the most profuse polychromy, and abounding with statues and groups of the Saviour, the Virgin, the Patriarchs, the Prophets, the Apostles, Saints, and Martyrs of the religious calendar of the middle ages.

The general decoration of the interior of the church consists—first, of a low stylobate or dado, nearly 5 feet high, above which is a Corinthian order of columns and pilasters, 42 feet high; and this is again surmounted by a lofty attic, with pilasters and cornice, 21 feet high. The loftiness of the attic, being half that of the principal order, detracts materially from the importance of the order; and, in fact, there seems no necessity for dividing the height into two, for if the outer order of the porticoes had been continued inside, the effect would have been nobler, and the expectations of the beholder, excited by the proportions and scale of the outer order, would have been realised also within the church. From the top of the attic spring the vaultings of the ceilings of the church, which are sumptuously enriched. The cornice of the attic is not of sufficient importance to act as the impost of the vaultings. The intersection or crux of the arms of the cross is surmounted by the dome, 96 feet in diameter, and 196 feet high from the pavement to the cupola of the lantern, and 332 feet to the top of the cross. Immediately over the pendentives formed by the intersection of the vaultings, and the naves and transepts, is a lofty stylobate, 27 feet high, in the periphery of which are twelve angels, 19 feet high, supporting consoles.

The wall of the drum of the cupola is pierced by twelve circular-headed windows, and the order, 46 feet high, is Corinthian, like that of St. Peter's and our own St. Paul's, and most other similar cathedrals. The pilasters are fluted. The dome rises to a height of 40 feet above the entablature of the order of the drum. It is not divided into compartments, but forms a vast plain surface, decorated with a picture of the celestial glorification of the Virgin Mary. In the centre of the dome is an aperture 21 feet in diameter, opening into an upper dome, formed by the intermediate cone, and on the surface of this is also a painting of the glorification of the Redeemer. The whole surface of the walls of the interior of the church and vaultings, with the columns, pilasters, and dressings, are all cased with white and various coloured marbles, from Finland and Italy; the bases and caps are of bronze gilt, in *or-molu*. For the purpose of procuring a white marble, superior even to that of Carrara, a Tuscan company undertook to open a new quarry at Seravezza. Bridges were constructed over torrents and ravines, roads were formed on the sides of perpendicular rocks, and habitations and workshops were erected for the workmen, in order to provide this choicer material. The marbles from Finland were red, violet, black, and mixed, and were used in the mosaic pavement, in the construction of the basement, and in the four smaller cupolas to the steeples, at the angles of the church. The Chevalier de Montferrand has paid great attention to the decoration of the vaultings of the interior, which are distributed in large divisions. Forty colossal figures, in high relief, of galvanised bronze, and in the proportion of 21 feet high, form the chief features of this decoration. They represent the prophets, patriarchs, and angels, with their various attributes. Some stand on corbels; others are seated within niches.

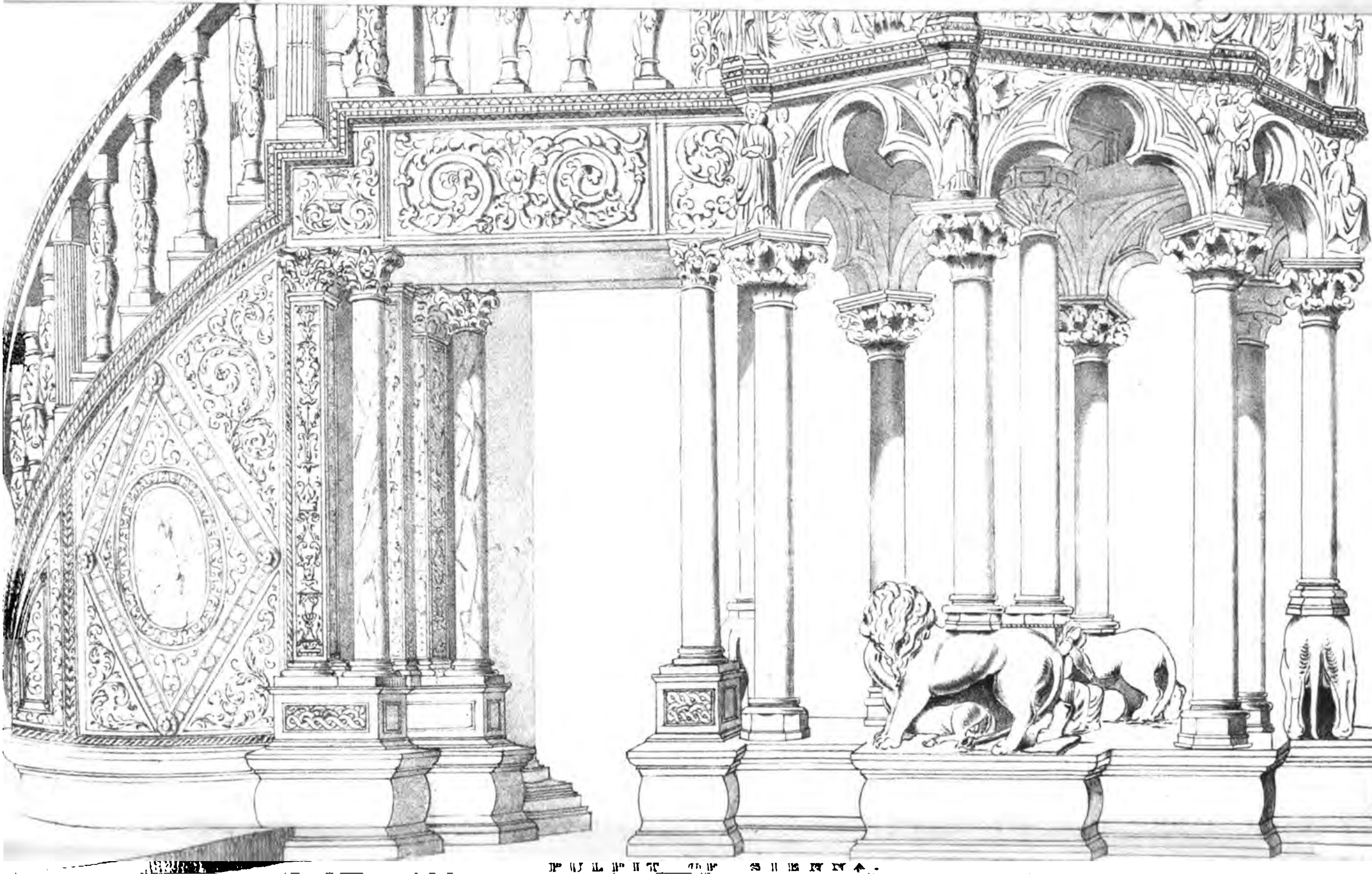
Before continuing the notice of the building, perhaps I may be permitted to call attention to the enormous application of the electrotype or galvano-plastic process in the sculpture of this cathedral by the architect. After having made very important experiments, he was authorised to adopt this mode in the execution of the metallic sculptures and carvings for the following reasons:—

1. The identical reproduction of the sculpture without chiselling.
2. The lightness of the pieces, which enabled the architect to introduce sculptures of higher relief than any hitherto known, and to fix the pieces suspended from the vaultings, without fear of accident, or of their being detached.
3. The great saving of expense between these castings and in bronze.

The gilding also was effected by the same process, and presented equal advantages.

The seven doors of the cathedral will be of bronze and electrotype, the framework being of the former, and the sculptural parts of the latter. Three of these doors are 30 feet high, and 14 feet wide; the four others 17 ft. 8 in. wide. They contain fifty-one bas-reliefs, sixty-three statues, and eighty-four alto-relievo busts, of religious subjects and characters.

There is so remarkable a departure in the construction of the dome from the systems hitherto adopted, that I shall be perhaps pardoned in trespassing further on your attention by describing, with the aid of the engraving, the whole assemblage of this important feature.



PULPIT OF SIENNA.

In alluding to the cupolas previously erected, the chevalier pays a just tribute to the genius of our illustrious Wren, and recognises St. Paul's "as the only existing dome presenting an irreproachable solidity." He, therefore, adopted the principle of Sir Christopher, carrying it out in a combination of wrought and cast iron, and hollow pots.

The walls of the drum of the dome are carried up in solid construction of brick, with tiers of stone bond, and are above 8 feet thick. On the level of the top of the cornice of the circular colonnade, which girds the drum, there is a series of twenty-four cast-iron ribs A, the feet of which rest on a cast-iron plate B, 7 feet wide, which runs quite round the circumference. The lowest division of each rib rises to a height of about 23 feet; in its narrowest part is 3 ft. 4 in. wide, in its broadest 5 feet, with upper and lower ribs, and the central part lightened by large apertures. At their head all the ribs are attached to a horizontal plate or curb, C, 6 ft. 3 in. wide, which follows the periphery of the dome. At this height the rib is divided into two *a*, *a'*, the one part *a* about 2 ft. 6 in. deep, following the sweep of the inner dome for a height of 20 feet; at its summit bolted to a cast-iron perforated cylinder D, 21 feet in diameter, and 7 feet high: this forms the central aperture at the summit of the inner dome. The other part *a'*, follows the line of an intermediate cone, with a catenary outline, and similar to the one in our St. Paul's: it is also 21 feet long, and 2 ft. 6 in. deep, and perforated to render it lighter. At this height the heads of the ribs are again secured to another horizontal plate or curb E, which forms a complete circle, and is 3 feet wide; and this curb and the ribs are tied to the cylindrical opening of the inner dome, already mentioned, by radiating beams, *e*, 2 ft. 3 in. deep. The conical ribs have then another length of 21 feet, *a''*, and their heads are again connected by another horizontal plate, F, from which spring the circular ribs, *a'''*, about 16 feet long, forming a dome to the intermediate cone, and their heads also bolted to a cylinder G, 8 ft. 6 in. in diameter, and 18 inches high. But the upper portion of the ribs diverge at top, so as to form a base for the octagonal cupolino, H, which consists of a series of cast-iron story-posts, ribs, and bracketings, inclusive of the dome of the cupolino, with its ball and cross at the apex, which last are of brass gilt. The filling-in between the ribs consists of pots, the surfaces of which were subsequently rendered with plaster, and painted with sacred subjects. The sphere of the outermost or third dome, J, consists of a series of wrought-iron T ribs tied to the conical dome by rods, *j*. The external face of this outer dome is divided by twenty-four bold ribs, and is covered with bronze, gilt in three thicknesses of leaves of ducat gold. The three principal gilders of St. Petersburg were charged with the inspection of the execution of this portion of the work, and rejected every leaf that had the slightest spot or blemish.

The whole entablature and flat, and the balustrade over the peristyle of the drum of the cupola, likewise consist of cast and wrought iron framing, faced with plates of copper, to form the profiles and mouldings. The twenty-four pedestals of this balustrade carry winged angels of bronze, above 9 feet high, each of a single casting.

The quantity of metal employed in the dome is as follows:—

Ducat gold	..		247 lb.
Copper	52¼	tons.	
Brass	321½	tons.	
Wrought-iron	524½	tons.	
Cast-iron	1068	tons.	
Total ..	1966¼	tons	247 lb.

The foresight of the architect has provided the following precautions against lightning,—much the more liable, as the summit of each dome is in metal: at the top of the crosses of the bell towers and of the cupolino of the central dome are rods of platina, terminating in a point: each dome at its springing has isolated iron conductors, which go down to the roofs; and in the direction of the cast-iron rain-water pipes are continued in the interior of the walls down to wells in the basement, the overflow of which discharges into the town sewers.

In justification of the system here employed let the architect speak for himself:—"We think," says De Montferrand, "the mode we have adopted superior to that of any other cupola. For what can be more absurd than those vaultings raised 250 or 300 feet in the air—whose frightful weight, unceasingly in action, tends to disunite the points of support which uphold them. Our new system offers a stable combination, which allows of no disunion—which has no thrust, and which reduces to a tenth the weight of any previous combination. In our plan, the iron and bronze entablature of the peristyle of the drum is not a mere architectural embellishment: it is a solid girdle, which embraces firmly the dome, so as to give it a great stability; and can the superiority of this system be contested, when it is considered, that here is employed the material which can alone, with prudent care, brave the effects of a rigorous climate?"

The arches and vaults of the nave and transepts and the soffits of the porticoes are carried out in like manner by means of cast-iron girders, to which are attached the marble facings and decorative embellishments.

The roofing is wholly of iron, covered with copper. There are thirty-four small columns of cast-iron, resting on the walls and vaultings of the ceiling. These are tied together by a series of inverted queen trusses of wrought and cast-iron mixed, about 6 feet apart, with wrought-iron lathing to receive the copper. The whole presents a very light effect, and is very simple in its combination; and although the roof rises about 9 feet above the level of the attic outside, yet it is not seen unless by those at a very great distance from the building.

In determining the thickness of the drum of the cupola, M. de Montferrand has adopted the principle laid down by Fontana, of making the thickness of this cylindrical wall equal one-tenth of the internal diameter; although Rondelet and others allow a much less thickness. Notwithstanding, a substantial base for this great thickness of wall and the projecting architectural embellishments of the dome, is afforded by the pendentives, which rise from the four great piers of the dome, and form the circle for the cylinder of the drum.

The raising of the monolithic shafts of the twenty-four columns of the exterior peristyle of the dome,—each of which weighed near 66 tons,—to the height of 150 feet, was an operation requiring considerable skill. Each shaft was surrounded by a stout casing, to which were attached strong cables. It was then placed on an immense truck, calculated for the size of the vast block, and drawn by capstans upon an easy incline to a platform, which was on a level with the tops of the columns of the interior order, 42 feet high. Upon this platform was a moveable incline, 92 feet high, but with a very sharp rise, and up this the monolith was again drawn by capstans. At the summit was a large platform, 180 feet square, upon which was a moveable wooden framework, answering the purpose of a crane, with blocks and falls. There were twelve capstans around this framework. The monolith being dragged up the incline, reached the summit, and, by its own weight tilting over, reached the framework; it was then by it raised to a vertical position, and gradually lowered on a granite die prepared to receive it, and which was cased with a bronze base.

As soon as one monolith was in its place, the moveable incline and the moveable platform and frame were all wheeled round, ready to raise the next column; and so on the operation was repeated until the whole series were securely fixed in their respective places. It only required two hours to raise one of the shafts from the platform on a level with the capitals of the inner order, and to fix it on its base. Three hundred men performed this operation:* the most perfect order and silence were maintained throughout, and the different movements directed by the sound of a bell. A silver rouble was placed on the base of each column, in a hole sunk for the purpose.

The first column was raised on the 17th of November, 1837, just eleven years ago from this period; nor was the operation commenced without prayers to Almighty God to bless the undertaking with success. In two months the twenty-four columns were completely fixed, and, be it remembered, in the very depth of a Russian winter.

The skeleton of the entablature of the peristyle of the dome is of cast and wrought-iron, resting on the columns, and affixed to them by wrought-iron pins, which are let a considerable depth into the shafts; and the framework is also let into the cylindrical wall of the dome, securely affixed to three templates. The cornice, with its modillions and mouldings, rest on cast-iron corbels; the caissons and rosettes of the inner soffit also rest on cast-iron girders. The balustrading above is similarly framed, and the pedestals support bronze figures of angels, already mentioned, holding their attributes, each 9 feet high, and of only a single casting, weighing 1¾ tons. The balusters are also of bronze.

I may perhaps be permitted to observe that the bronze bases, capitals, figures, and other decorative details of this material on the outside are neither gilt nor painted; consequently, the dark tone of these parts has a heavy appearance, and ill accords with their purpose and the stonework of the outer facing.

In the presence of such an assembly, so competent to judge of the merits of this important monument of our art, it would ill become me to offer any remarks, other than those which I have already made, upon the most striking points in regard to taste and skill, which distinguish this production of our honorary member.

He has chosen the most appropriate materials, and has with considerable skill applied to his construction the improved system which cast-iron presents. I have not stopped to consider whether he has adopted all the expedients which we should consider necessary for counteracting the expansion and contraction to be expected in ironwork; particularly as regards the movement which might be expected at the feet of the ribs of the dome, and which possibly we might have regulated by rollers, and by allowing space for the development to be expected in a warmer temperature. The interval of ten years must have proved the efficacy of his provisions, and I should ill requite the courtesy of our generous donor were I to analyse with the severity of a critical eye the proportions and details of this remarkable monument. The unsparing nature of the materials employed prove the pious liberality of the emperor and the nation. The careful skill with which the architect has fulfilled his part, and the deep feeling for decorative art with which he has embellished the cathedral of the Russian capital, and the brief space of time in which he has erected the lofty pile, must ever render the church of St. Isaac one of the most striking edifices of the nineteenth century.

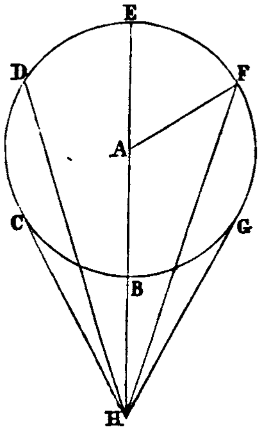
GENERAL SCALE FOR MEASURING EARTHWORK.

Sir—Enclosed herewith I send you a printed description of a new method of measuring earthwork, thinking that you might insert it as a communication in your valuable *Journal*, for the benefit of such of your subscribers to whom I have not the opportunity of remitting this circular, which explains a simple and novel application of a scale to earthwork measurement. As the circular so fully explains the use of the scale, it is not necessary for me to mention anything concerning its practical use; but as the mathematical principle is not so obvious as students of these kind of problems may desire, I beg to supply this demonstration for their benefit. I was led to perceive this principle, as I have applied it, quite accidentally while investigating a totally different problem—viz., the geometrical extraction of the cube root, of which I have obtained a very simple and approximate solution. The principle on which the construction of the scale depends, is as follows:—

Let B D F be a circle; A, its centre; H, a point without the circle in the diameter B E produced; and let each semicircle be divided into n number of parts at C, D, F, G, &c.: then,

$$\overline{AB}^n + \overline{AH}^n = BH \times HF \times HD;$$

or equal to the continual product of the lines drawn between H and alternate points of division of the circle.



The diagram shows the semicircle divided into *three* equal parts; and if $AH = H$, $AB = h$, $n = 3$, the above equation becomes

$$H^3 + h^3 = HF^2 \times BH, \text{ because } HF = HD.$$

$$\text{Also, } BH = AH - AB = H - h;$$

$$\therefore HF^2 = \frac{H^3 + h^3}{H - h} = H^2 + Hh + h^2.$$

But on referring to the 176th page, line 11, of my work on the "Prismoidal Formula," it will be seen that this expression for HF^2 is identical with the variable part of the second term of the general rule for the contents of a prismoid. Hence we derive the application of this problem to the computation of earthwork.

If you inspect the diagram at the head of my circular, the correspondence is evident: the point A corresponds with the gradient or formation line; A E is the height of cutting at that point $= h$; A H is the last height plotted below the gradient $= H$; and H F is the diagonal along which the scale is applied to measure the slopes. For those who desire an authority without the trouble of investigation, for the foregoing diagram, a reference to "Mathematics for Practical Men" (Weale, 1848), p. 108, will suffice.

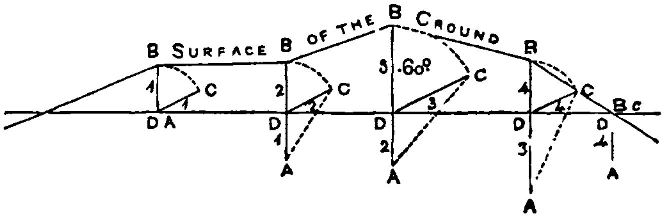
I have only another observation to make concerning the convenience of this scale. It is engraved for a plot of 20 feet vertical = 1 inch: but if the plot is otherwise, then, after the measurements have been taken by the scale, it is necessary to multiply or divide the results by the proper ratio due to the difference of plotting. Thus, suppose the plot were 40 feet to 1 inch; then all measurements for the base or middle are too little by 40 : 20, or 2 to 1; and too little for the slopes or sides by $\sqrt{40} : \sqrt{20}$, or $\sqrt{2}$ to 1. If the plot were 10 feet = 1 inch, then all the measurements are too great—for the base, as 1 to 2; for the slopes, as 1 to $\sqrt{2}$.

Apologising for occupying your time thus, though with a view to benefit others,

I remain, Sir,
Yours truly,
J. B. Huntington.

Wanstead, Essex,
December, 13*th*, 1848.

The following is a copy of the circular referred to by Mr. Huntington:—



Let the above diagram represent a section of a railway plotted in the usual manner, with a vertical scale of 20 feet to 1 inch. Divide the section into prismoids in the ordinary manner, by perpendiculars (B D) throughout. The present mode of measuring earthwork is to measure the several heights, 1 B D, 2 B D, 3 B D, 4 B D, &c., and then to compute the mean areas by referring to tables prepared for the purpose by Macneil, Bidder, and others, whose methods have been explained in the appendix to the Second Edition of "Huntington's Tables." In measuring with a scale divided into feet, it unavoidably happens, in a large majority of cases, that the heights B D do not measure exactly integral feet, but some fraction or decimal part of a foot, more or less; that is, the plotted height of the section rarely coincides with the divisions of a scale. It becomes generally necessary in using Tables to omit these fractions, and to compute the quantity due to the nearest number of integral feet found in the table; so that by allowing the measurement to be sometimes more and sometimes less than the truth, a compensation is provided, and a tolerably accurate result is obtained. But where cuttings or embankments are very great, it will be found that the number of cubic yards computed by the above method will vary by a large per centage from the true amount, because the allowance for compensation is always discretional with the measurer, whose judgment must be constantly exercised with a doubtful prospect before him, as to whether the fractional measurement should become nearest the foot above or below.

In order to avoid this chance—indeed, I might almost say, certainty of error—I considered whether it were not possible to construct a scale so as to determine the cubic quantity, by making the degrees of the scale *exactly coincide* with the plotted heights; there would then be no necessity to give or take; and if I could divide the scale so minutely that, with the further assistance of sub-division by the eye, the graduations should become less than any fraction of a foot, for which tabular numbers are prepared, I might fairly assume, that the coincident quantity thus read from the scale, must be far more accurate than by the methods usually adopted. In 1839, I first made some scales on this principle for the use of the Eastern Counties Railway, adapting them to the particular base and slopes of that railway. I have described them, with a cut, in my work on "Earthwork," &c. Since then, having been asked whether I could make a *general scale*, to effect the same purpose, applicable to *all bases and slopes*, and extending to *very great cuttings* and *embankments* of 150 feet vertical section; I again turned my attention to the subject, and discovered a very simple means of successfully performing the operation; and having for some time submitted the method to the test of private use, which is quite satisfactory, I now offer its advantages to the public. The scale is made, of the usual materials and length of 12 inches, so as to fit into boxes or sets of scales now generally employed, thereby ensuring its portability and general utility. As most working sections are plotted to a scale of 20 feet to 1 inch, I have constructed the graduations to this standard.

The application of the scale is as follows, all dimensions being in feet:—

Having divided the section, as before described, in the usual manner, produce the perpendiculars B D beyond the gradient to A, and through D draw the lines D C, so that the angle B D C is *always 60 degrees*. This is very easily done, as every draughtsman is provided with such an angle. Then with the compasses make 1 D C, 1 A D = 1 D B; 2 D C, 2 A D = 2 D B; and so on throughout. The section is then ready for measurement.

To find the Mean Area of the Sides.—With the scale marked A C, measure across from A to C, and note the graduation from O of the scale. This measurement, multiplied by the slope, is the mean area, or the cubic yards, due to 1 foot of length.

To find the Mean Area of the Middle.—Apply the scale marked A B to the distance A B, and note the graduations from O of the scale. This measurement, multiplied by the base (in feet), is the mean area, or the cubic yards, due to 1 foot of length.

The sum of these two measurements multiplied by the length in feet will give the cubic yards contained in the prismoid.

The process above detailed, when put into a formula, appears thus—

$$[(AB \times \text{base} + AC \times \text{slope}) = \text{mean area}] \times \text{length} = \text{cubic yds.}$$

From the above statement it appears, that there are two measurements of this scale, set against two measurements of the heights, and their respective tabular numbers; the remaining process being the same by both methods: thus showing, that besides the greater accuracy due to the coincident measurements of quantity, a saving of time is effected by not having to refer to tables.

Having thus described the use of this general scale, I beg to refer to the particular scale already herein noticed, and fully described in my work, page 210. This is constructed on the same principle of coincident measurements; and is adapted for the use of any railway, by simply altering the graduations of the part called "sectional areas," which can be easily done by means of the rule given in the volume.

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, and inserted them in column 6, 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. The arrangement of the columns used for this scale is as follows:—

$$[(\text{Col. } 1 + \text{col. } 2 =) \text{ col. } 3 - \text{col. } 4 =] \text{ col. } 5 \times \text{col. } 6 = \text{col. } 7 =$$
cubic yards in the prismoid.

ADD TOGETHER		SUM	DEDUCT	DIFF.	LENGTH	CUBIC YARDS
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7

The scales above described can be had by applying to Mr. Elliot, 268, High Holborn.

CAST AND WROUGHT IRON BRIDGES.

On the Strength of Materials as applicable to the construction of Cast or Wrought Iron Bridges. Part III.—"*On the Transverse or Cross Strain.*"* By George Buchanan, Esq., F.R.S.E., President R.S.S.A.—(From a paper read at the Royal Scottish Society of Arts.)

The President stated that he proposed now to complete the third branch of the subject—namely, the TRANSVERSE STRENGTH OF MATERIALS, but would first advert to one or two points connected with the preceding expositions, namely:—

First, the Conway Tubular Bridge, in regard to which it was gratifying to observe, that it had now been in operation for upwards of three months, the regular traffic of the line going on, and trains passing and re-passing daily, everything connected with it proceeding in the most satisfactory manner, and this truly wonderful design crowned with complete success. He then exhibited a drawing of the great Britannia Bridge, now in progress of execution across the Straits of Menai. This was exactly on the same principle as the Conway Bridge, but on a still more magnificent scale, the Straits here being so much wider, and the bridge, in order to keep the navigation free from obstruction, being elevated 102 feet above the surface of the water at the highest equinoctial tides. The breadth across the Straits at high-water is about 1,160 feet; and, including the banks to the abutment piers of the bridge, 1,490 feet. This space is divided into four spans by a massive pier in the centre of the water-way, termed the Britannia Tower, 45½ feet thick, and two small piers or towers in the water at each side, 32 feet each, forming two spans in the centre, 460 feet in length each, and two half spans, one on each side, 230 feet.

Secondly, having been particularly requested by the Society, at the last meeting on this subject, to extend and complete his experiments on the tensile and compressive strengths of different stones, he would now state the result of these experiments. The mode of trying the direct *tensile strength* was formerly exhibited by appending weights to the substance till it was actually torn asunder. In this way the strength of the different stones, by careful and repeated experiments, was found at an average as follows, viz.:—

	Breaking weight.
Craigleith stone	453 lb.
Hailes	336
Redhall	326
Humble	283
Binnie	279

Several other specimens had been prepared of marble, whinstone, Caithness and Arbroath pavement, and the results on these would be afterwards communicated.

The *compressive strength* of these substances, or their power to resist crushing, being generally far beyond their tensile strength, could only be tried conveniently by mechanical power, and he showed the apparatus which had been used for the purpose, consisting of a combination of two levers, giving an increase of power of 30 to 1. The specimens, consisting of nearly exact cubic inches of the material, being placed near the centre of motion, and the upper lever brought down with a plate of metal to fall exactly on the stone, the weights were applied at the extreme end of the lower lever until the stone gave way. On trying, at the meeting, with this apparatus a piece of Hailes stone, it bore 3,540 lb., and then gave way with a violent crash. A specimen of Craigleith stone was next tried, the side of the cube being about one-eighth part more than a square inch. This carried upwards of 6,500 lb., when the sides began to skirt off, and with 6,810 lb. it suddenly gave way, and was crushed to powder. In all these experiments it was observed that when any part of the stone remained entire, it exhibited the same appearance noticed by Hodgkinson in the fracture of cast-iron; pieces breaking off at the sides at certain angles, and leaving a nucleus of a conical shape. Specimens of these were preserved, and may be shown at another meeting. By experiments of this kind, carefully made and repeated, he had found the *compressive strength* of the different stones as follows:—

Craigleith, gave way to a pressure of	4,900 lb.
Humble	3,740
Hailes	3,530
Redhall	3,320
Binnie	2,820

In regard now to the *transverse strain*, this, as formerly explained, is of a compound nature, both the tensile and compressive forces being brought into play. A beam supported at the one

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* For the two previous portions of this paper, see "Journal," vol. xi., p. 125, and 153.

extremity, and loaded at the other, becomes a lever, at the extreme end of which acts the weight tending to bend and break the material, by turning it round the point of support; while the power of resistance, residing in the section of fracture at the support, acts in the middle of that section, and at a distance from the centre of motion equal only to half the depth of the beam. The same is the case with a beam supported at the two extremities and loaded in the middle; the beam, in that case, dividing itself in the centre into two levers, and half the weight acting at the extremity of each; while the strength of the beam acts, as before, in the centre of resistance, which is in the middle section of the beam. The notion of the beam turning round the point of support and distending or stretching all the particles in the section of fracture, which was that of Galileo, is not correct; the centre of rotation is in a point somewhere near the middle of the beam, and all the particles below this point are distended, while all the particles above this point are compressed or crushed together, while in the centre they are neither compressed nor distended, and hence this point has been termed the neutral axis. Much discussion has arisen regarding the exact position of this neutral axis—the limit between the tensile and compressive forces —a nice question, and one of abstruse and difficult investigation; and the probability is, after all, that it is not a fixed point, but is liable to vary with the nature and intensity of the strains. Be that as it may, it fortunately happens that the practical result as to the strength of the beam is almost exactly the same, whether the axis be supposed, with Galileo, at the point of support, or, with succeeding philosophers, at a point near the centre. In every case the strength depends, as formerly explained, on the length and depth of the beam, combined with its area at the section of fracture; and by these three elements the strength can be calculated in every case, provided we ascertain by experiment the actual strength of a beam or beams of given dimensions. Numerous experiments have been made with this view, and particularly on cast-iron, by Messrs. Hodgkinson and Fairbairn, and other observers. These were made on beams of various dimensions as to length, breadth, and thickness, but the calculation is simplified if we reduce them all to a unit or standard of 1 cubic inch; taking, for example, a bar 1 inch square, resting on supports 1 inch apart and loaded in the middle, and the average result of all the different experiments is, that such a bar of cast-iron would bear a weight of 24,400 lb., or very nearly 11 tons. The strongest specimen was of No. 3, cold blast, which gave 31,212 lb., or nearly 14 tons; and the weakest being one of No. 2, hot blast, gave only 19,278 lb., or better than 8½ tons. The difference as to strength between the hot and cold blast appears to be trifling. The following are the strengths of some of the irons, given by Mr. Hodgkinson:—

Carron, No. 8, hot blast	..	..	12 7 tons.
Do., do., cold blast	..	..	10·9
Do., No. 2, hot blast	..	..	11·1
Do., do., cold blast	..	..	11·5
Low Moor, No. 2, cold blast	..	..	11·4
Muirkirk, No. 1, hot blast	..	..	10·1
Buffery, No. 1, hot blast	..	..	10·6

Every other beam, then, will bear in this average proportion of 11 tons, in respect of the three elements above mentioned—namely, 1st, the section of fracture; 2nd, the depth of the beam; and, 3rd, the length or distance between the supports; and the rule is, to multiply this average unit of strength of 11 tons, 1st, by the section of fracture; 2nd, by the depth; and, 3rdly, divide the product by the length. This is an universal rule, and one of most extensive application, and is here given in a somewhat simpler form than is generally found in elementary works. He then showed the effect, by experiment, on a cast-iron beam, one inch square, supported at the extremities at two feet apart, and loaded in the middle till it broke. By the above calculation of 11 tons for the unit, the strength would be 1,068 lb.; and it first deflected greatly, and then broke, all of a sudden, with a weight of 1,140 lb.; and as the exact area of the bar is about 1-10th more than an inch, this gives a unit of strength very nearly that of the average above mentioned. This specimen of iron was from Broughton Foundry, and he understood was of Summerlee iron, No. 2.

Form of the beam.—The simple rectangular beam is not the one best fitted for strength in proportion to the weight of the material employed. In the first place, the centre being the weak point, the mass at the ends may be reduced and accumulated in the centre, giving the beam a curved shape on the upper or under or on both sides; and this is the form generally adopted in large beams or girders. The ends may be safely reduced to half or two-thirds of the depth in the middle; and for a load uniformly distributed over the beam, the surface should be formed to an elliptic curve, and for a load at the centre, to a parabolic curve. But, 2ndly, the cross section of the beam, instead of being rectangular, can be modified with great advantage by removing the material from the central parts, and accumulating it, in the form of projections or flanges either at the top or bottom, or both. If the flange be at the top, the cross section or the figure of the beam looking endways is that of the letter T; and if the flange be at the top and bottom, the figure is that of the letter I, with the head and tail extended. Originally the T form with the head or flange downmost was adopted in large manufactories or buildings for carrying brick arches, chiefly for the convenience of obtaining a bearing from which the arches on each side might be sprung. Afterwards the I or double T form was recommended, on no less an authority than Tredgold. But the knowledge and consideration of the property of cast-iron, already described, in possessing a compressive strength much superior to the tensile, has given an entirely new view to the subject, and led to very important practical results. This is a discovery due to Mr. Hodgkinson, and the experiments and investigations which he has undertaken, in conjunction with Mr. Fairbairn, have rendered most essential service in this branch of practical mechanics. The upper part of the beam being compressed by the application of a weight, and the under part distended, and the tensile resistance being three or four times less than the compressive, it is evident that the material of the beam ought to be accumulated much more at the bottom than at the top; and in order to ascertain practically how far this principle might be carried, Mr. Hodgkinson made a variety of trials of different forms, beginning with the flanges equal at top and bottom, or the letter I form, then increasing the bottom flange by ten or twelve different steps, till he found at last the greatest strength was attained when the bottom flange (as in this figure ⊥) was six times greater than the top; and some very curious results arose from these investigations. The strength of the beams, formed according to these views, is easily calculated on the principle already explained; for, whatever be the form, it will be found that the strength is still very nearly proportional to the three elements—length, depth, and section of fracture; but the unit of strength or standard for each beam is different. For rectangular beams of cast-iron, this unit, as explained, is at an average 11 tons. For the equal flange beam, which was formerly considered a model, the unit is no greater, but rather, if anything, less; but when the bottom flange is increased beyond the top in the ratio of 4½ to 1, the unit of strength of every inch of the beam is increased to fifteen tons; and when the bottom flange is farther increased in the ratio of 6 to 1, the strength is increased to nineteen tons. He then showed by experiment the strength of a cast-iron beam 2 feet by 2 inches deep, bottom flange five times greater than the top, and area of fracture 1 inch. If rectangular, it should have broke with 2,280 lb., but it carried 3,750 lb., and then gave way, showing an increase of strength equal to 4,170 lb. gained by this form of the section. Since these experiments of Mr. Hodgkinson, others have been lately made by Bramah and others, particularly those under the sanction of government, in reference to the fall of the cotton-mill at Oldham, by Sir Henry de la Beche and Mr. Thomas Cubitt. These are important, as being made on a larger scale than the others. They entirely confirm the views and results of Hodgkinson, but the beams experimented on not being of the same forms, do not give the same degree of strength. On the whole, therefore, the results given above may be relied on; but the strains for perfect security ought on no account to be carried beyond one-fourth or one-third of the breaking weight.

Now, that the nature of the transverse strain has been so thoroughly investigated, an important consideration arises,—how far improvements may not still be made by the introduction of malleable iron in conjunction with cast-iron, so as to form beams of a compound nature, having all the parts liable to compression of cast-iron, and all the parts liable to tension of malleable iron. This has already been adopted, in some cases with success, by the introduction of what are called tension-rods of malleable iron; but it is extremely doubtful if the best combination of the two metals has yet been ascertained. The great point is to keep the two metals clearly and distinctly to their different offices of resisting compression and tension, and unless this be done there is difficulty and risk of bringing the one or other of them into action; and neither of them, in such cases, sustaining its proper share of the load or pressure, the most serious consequences may result from the combination. Owing to this, the use of tension-rods has been rather condemned by engineers, and not without reason; but Mr. Buchanan thought the objections were not so much to the use of the tension-rods, as to the injudicious manner in which they have been or may be applied. No general rule, he said, could be laid down, but one principle should never be lost sight of—that the strongest form is the simple one of the roof: the two rafters butting against each other at the top producing a simple compressive strain through their length, and at the bottom a horizontal thrust on the extremities of the tie or tension-rod, producing simple distention. Forms might require to be modified by circumstances, but to this they ought all to tend, as to a centre involving the most perfect distribution of the forces. He then gave several illustrations of the mode of applying these ties, pointing out where they would be of essential service, and where they were objectionable and inefficient.

In many cases of railway bridges, the space between the level of the railway on the one hand, and sometimes a road, sometimes a stream, or navigable river, on the other, is so confined, that even with tension-rods well applied, or massive girders, the span is so great as to occasion too enormous a strain to be safe or expedient; it is much better in such cases, rather than attempt to span the opening with too limited a depth of beam or girder, to acquire height by setting the girders on the outside of the railway, where an unlimited height can be obtained for arching, or framework of timber or iron; and this leads to the consideration of a remarkable species of bridge much used in crossing the vast openings of the American rivers, both for common roads and railways. It is termed the *Frame Bridge* or *Lattice Bridge*. These bridges have been most extensively applied, and with complete success, and, by successive improvements, have now been brought to great perfection; and as they possess some remarkable properties, and form an excellent illustration of the principle of dividing the tensile and compressive strain into distinct members of the bridge, he thought it might not be uninteresting to the Society, to give a short explanation of them here. A very interesting account of these bridges, one of which, over the Susquehannah at Columbia, of twenty-nine arches, each of 200 feet space, is about a mile and a quarter in length, will be found in Mr. Stevenson's excellent work on the "Civil Engineering of North America," and through two engineering friends he had been favoured with farther information and drawings, which were exhibited.[*] The great principle of the frame bridge he then illustrated by reference to a small model. It is nothing but a simple modification of the principle of the roof; two rafters meeting in the centre of the bridge, and resting at their extremities on a tie-beam; from this centre the tie-beam is extended longitudinally on each side, and running horizontally to the opposite abutments; and along with it, at regular intervals, a series of rafters, running parallel with each other and parallel with the centre one, are extended the whole length of the bridge; the feet of these rafters rest on the tie-beam; the tops of them cannot meet, but are connected by an upper longitudinal beam running horizontally. On this the rafters are all abutted and act exactly as if each pair had met in the centre, only that the intermediate connecting beam is subjected to a compressive strain, arising from these rafters all pushing on towards the centre, in the same manner as the lower beam is subjected to a tensile strain from all the feet of the rafters pushing off from the centre. The upper beam is termed the top chord, the lower beam the bottom chord, and the rafters are called the braces; and one member more is only wanted to make the structure complete—namely, a beam or tie standing vertically, to connect the top of the one rafter with the foot of the next adjacent, towards the centre; and in this manner every part of the frame is supported, and there being no cross strains whatever, it is truly astonishing how much such a structure will bear. The last-mentioned beam, from being subject to the tensile strain, is termed the tie, and a great improvement has been effected by the introduction of malleable iron rods in place of timber; by means of this, and of screws and nuts, the whole structure can be brought to a perfect degree of tension, so that every joint and member may bear its due share of the load; and in the case of shrinkage of the timber, or other derangement, the equilibrium and perfect form of the structure can easily be restored and maintained. By screwing up the ties in this manner, the bridge tends to assume an arched form, rising with a camber in the middle; to prevent this, another member has been introduced, termed the counter-brace, which is a beam of timber, extending from the top of one rafter to the bottom of the next adjacent, from the centre towards the extremities of the bridge. This counter-brace crosses the braces and resists any change of form which the screwing-up of the rods would bring on; and there is this remarkable advantage obtained, that the action of these counter-braces, thus screwed-up to a certain degree of tension, prevents the weight of the passing loads from having any effect in straining or deflecting the bridge. Instead of any additional strain on any part, these loads rather relieve the counter-braces from the tension to which they are subjected. No deflection or change of form can occur, except what may arise from the mere compression or distention of the parts, and these being all strained endways, and there being no cross or oblique action, this effect is absolutely nothing; and the form of the structure and strains on it become in a great measure, if not entirely, independent of the fluctuating traffic. The bridge is already strained to the utmost extent of any passing load, and cannot be affected by it; whence arises a principle of stability and safety, well worthy of consideration, particularly in the case of railways. The strength and stiffness of the small model was then shown, and the enormous load which it carried; and the whole of this interesting subject was concluded by the exhibition of a much larger model of one of the American bridges. Bridges of so great a span as 200 feet are common enough in that country, and the model represented one of these. It was exactly 1-10th of the dimensions, being 20 feet long, and the frames on each side 2 feet deep, consisting of the top and bottom chord, 1 inch by 2½ inches; the braces in pairs ¾ of an inch square; the tie-rods in pairs ¼-inch diameter; and the counter-braces each single, ¾-inch square. One of these frames was placed at each side of the bridge, connected at the bottom by cross beams on which was laid the planking of the roadway. The whole weight of the bridge was only 113 lb., and although 20 feet span and of such slender materials, it carried six persons, equal to at least 7 or 8 cwt., standing on the centre, without deflecting more than ¼ of an inch.

Another advantage he also mentioned of these bridges was the simplicity of construction; the braces and counter-braces were all cut exactly to the same length and square on the ends; no morticing or jointing of any kind, but resting simply on blocks attached to the top and bottom chords, through which blocks were also passed the tie-rods. Nothing could be simpler, and the whole bridge could be taken down, removed to another site, and there put up with facility. It is easy to see also, that as the malleable iron ties have been substituted for the upright timbers, so may it be for the bottom chord; and the braces and counter-braces could be made of cast-iron in the form of hollow square tubes, which would altogether form an extremely simple and strong girder or bridge. One remark, however, he must make regarding all these bridges or girders of a rectangular form—namely, that though they may be practically convenient in many respects, they are all attended with a sacrifice of material, in so far as they deviate from the principle of the arch. The top chord might be in the form of an arch, starting from the level of the roadway at the abutments, and rising to the original height at the centre. In this way much material would be saved, while the strain on the chord would be greatly less, owing to the curvature; and this form is often used in America, but not combined with the principle of the braces and counter-braces as it might be. The same remark applies also to the iron tubular bridges, which possess advantages in simplicity and great steadiness, but no doubt the material at the ends is redundant, and the strain in the centre beyond what would occur in the case of the arch. He now begged to conclude these expositions, which had been extended to much greater length than he had anticipated.

After the reading of the paper, Professor **Forbes** observed, that in regard to these American bridges, which appeared to possess peculiar properties, he would put a question or two which Mr. Buchanan might probably answer—namely, how far they did not resemble in principle the iron tubular bridges of Mr. Stephenson. The frame-work in the model of the American bridge at the sides was no doubt open, but he observed from the drawing that there were double the number of frames as there were in the model, and he understood that the sides were often formed by numerous little lozenges, or lattice-work, forming nearly a continuous web, and he should like to know whether the sides of the tubular bridge, with the angle-irons to strengthen them, did not much resemble this web of lattice-work. In regard to the top and bottom also, it appeared from the model that those also were united by diagonal beams or frames, forming a sort of enclosure at top and bottom, and as the side frames were twenty feet in height, this left ample head-room for passengers and carriages.

Mr. **Buchanan** could not help expressing how much he felt gratified by the countenance and approval of such high authority as Professor Forbes. In regard to the American bridges, the resemblance in principle to the tubular bridges had struck himself forcibly in considering these structures. The top and bottom

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[*] For one of these drawings he was indebted to his old friend and assistant, Mr. Laurie, now engineer on some of the American railways; and for the other, along with interesting views as to the principles of construction, to Mr. Lawson, a friend and engineer, lately returned to Britain.

chords of the former, answered to the cellular tubes in the roof and floor of the latter, and the frames on each side to the iron plates, forming the sides of the main tube, with their numerous angle-iron pieces, which were laid on the continuous ground of the plates to give stiffness to the sides. The frames of the American bridges were also connected at the bottom by cross frames and timber planking; and at the top, he believed, they were also, in some cases, connected in a similar manner, and covered in by a roof, for protection against the weather; so as, on the whole, to form, as it were, a complete rectangular tube in skeleton. Still, however, the tubular bridge was, in many respects, a very different structure; and the design of a bridge, of one vast malleable iron tube, was an idea at once happy and original, and was, he considered, due entirely to Mr. Stephenson.

Mr. Buchanan having explained, in regard to the tensile strength of malleable iron, stated at 27 tons for the breaking weight, that this was from the old experiments of Telford, Brown, and Rennie, Professor Forbes said he understood from Mr. Stephenson that he considered this result too high. Mr. Buchanan stated that he was not aware of this, but he knew Mr. Stephenson had taken the safe load of malleable iron of the Tyne bridge at 9 tons, which was rather larger than Mr. B. had been used to calculate, so that the final results were very nearly the same. He would, however, endeavour to obtain Mr. Stephenson's results accurately.

REVIEWS.

Rudimentary Architecture: the Orders and their Æsthetic Principles. By W. H. LEEDS, Esq. Weale, 1848.

We do not expect to obtain much credit for impartiality, in speaking of what comes from the pen of one whose name has, in one or two instances, appeared in our own *Journal*, as that of a contributor to it, and who is suspected by some to have written in it *incog.* to a considerable extent. Although this consideration does not and ought not to deter us from noticing a treatise whose subject is of immediate interest to our own readers, it will serve to render us guarded in our expressions, and at any rate prevent us from falling into the strain of common-place puff. Were we the first to notice this production of Mr. Leeds's, and to speak of it in the laudatory terms which some others have employed, our praise might be received with mistrust. But it has already been noticed with pointed commendation in more than one quarter, as treating the subject admirably. In an article on "Weale's Rudimentary Treatises," in the *Mechanics' Magazine*, the reviewer says: "The treatise on ARCHITECTURE is by one of the first architectural critics of the day (perhaps the very first), and has nothing to fear from the worst that rival critics or chastised pretenders can advance against it—which, assuredly, is saying a great deal, but not more than we conscientiously believe to be true. It is confined to 'the Orders' and their 'Æsthetic Principles'—of which modern term *Æsthetics*, there is a clever definition in a most useful 'Glossorial Index,' and which definition we here quote for the benefit of those —not a few—to whom the exact import of the phrase is still a mystery, &c. &c."—From what has been quoted, it is evident that meritorious as the treatise is, opposition to the views promulgated in it may be expected. Undoubtedly, such is the case: however they may be hailed by those who come quite fresh to any study, and make their first entrance into it, original and more rational views of it than what had hitherto prevailed, can never be greatly relished by those who discover—even if they will not confess as much—that they have been all along guided, or rather fettered, by very contracted and narrow-minded, if not absolutely erroneous, doctrines.

In another review of this treatise on the Orders, which we have met with, it is said: "Unambitious as is the form in which it appears, it is likely to effect an important and desirable change in the mode of architectural study and teaching—so far, at least, as the Orders are concerned, by explaining their *rationale* upon broad and liberal principles, and by getting rid of all those dull and pettifogging rules, the adherence to which has rendered architectural design little better than a system of blind copyism and mechanical routine. It is anything but a compilation manufactured for the market: on the contrary, it is the production of an experienced writer, and an original thinker."—Neither are those from whom we quote the only notices that have appeared, and all which we have as yet seen are commendatory. Still, it is very probable that others will either speak of this little treatise in a very different tone, or else pass over it in silence, as being too insignificant to challenge criticism. That it will produce the slightest effect upon those who are already confirmed in their opinions on the subject (having been trained up in the old routinier system), we do not at all suppose. They, of course, will continue as they have begun, trusting that their system will continue to retain its credit during "their time;' and then—*après nous le deluge!* It is only the rising generation of architects who will adopt Mr. Leeds's heresies—for heresies they undoubtedly are at present, though in time they may come to be considered orthodoxy. A good deal of architectural heterodoxy, we may remark, is just now abroad: for Mr. Fergusson is to the full as great, or even a greater, heretic than Mr. Leeds.

With respect to the publication before us, what, it will be asked, is the particular doctrine or theory in regard to the Orders, which it enunciates? In the first place, then, although a mere trifle, if considered as a book, this treatise is evidently the result of much and unprejudiced thinking on the subject; and not its least merit is the sincerity of purpose shown in regard to communicating instruction, by completely clearing away all that mystery and mystification with which the study has hitherto been more or less encumbered, and obscured, and made to appear—intentionally, perhaps, though not laudably so—too formidable, or at any rate far too repulsively dry, to be approached by any except those who apply to it professionally. Hitherto, architecture has been studied and taught only either merely historically or merely technically. Its nature and privileges as a Fine Art—in which character all ought to be able to sympathise with, and appreciate it—have, instead of being placed prominently forward, been nearly overlooked,—at the most, briefly and vaguely insisted upon in the abstract, but neither intelligently explained, nor dwelt upon with real feeling.

We do not pretend to say that Mr. Leeds's treatise fully supplies the desideratum, because, being strictly confined to the Orders, it elucidates only *their* "æsthetic principles;" and notwithstanding that they are the basis of what may be called the general modern European style of the art, that style includes many other elements of composition. As much as is professed to be taught, is taught ably and rationally; so as clearly to explain, in the first place, the natural constitution of the Orders as all belonging to one general system, and then considering them as divided into three leading classes, each of which includes several varieties,—some of them differing very widely from each other, yet all having something in common which at once marks them as belonging to that particular class or *Order*, in contradistinction from either of the other two. This theory—according to which the generic character of each class may be modified *ad infinitum*—affords the architect a degree of artistic freedom hitherto denied him. Whether such freedom will be welcomed by those who have been reared up in slavery to arbitrary mechanical rules, may be doubted; therefore, it is only to the rising generation of the profession that we can reasonably look for the adoption of more liberal and artistic principles. If such principles—those advocated in Mr. Leeds's treatise—can be shown to be erroneous, their adoption is of course to be deprecated. Yet, before they are rejected, let them be impugned, and fairly convicted of error. Otherwise, although intended to be expressive of contempt, silence may be misconstrued; and instead of its being supposed that the opinions brought forward by the author of the present treatise remain unopposed because not worthy of being replied to, it may be fancied that they are not answered because they are found unanswerable.

"Are our architects artists?" is the question put by another of those who have spoken of Mr. Leeds's treatise.* Highly as he commends the views entertained, the reviewer is of opinion that they are too much in advance of the present practice. "Have not," he asks, "all the monstrosities of modern times originated in attempting to avoid mere routine, and attain the merit of originality? And whilst we would rejoice in seeing architectural genius developing itself in forms of beauty hitherto unappropriated, is there no danger of Mr. Leeds's advice being acted upon too literally?—There is." Yes, undoubtedly there is; but to what does the objection amount? Is only maintaining that because liberty may be abused and converted by some into lawless license, we ought to renounce freedom, as being fraught with danger? Therefore, lest some should go astray, all architects are to be clogged, and compelled to plod along in the path of routine already traced out for them. The reviewer's objection would have been a decisive and unanswerable one, could he have shown that the ill consequences to the art now apprehended have invariably taken place whenever architects have been left free—as was the case in former times, both classical and mediæval—to design their own detail,

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* The Edinburgh News, of Dec. 16th, 1848.

and exercise some invention—in a word, were not bound down to precedent. We do not find that the freedom then enjoyed was abused to any alarming extent, or productive of many monstrosities—unless contemporaries regarded as monstrosities what we now admire as the productions of happy and fertile imaginations.

Before rejecting as dangerous the freedom claimed for architects by Mr. Leeds, we ought to be convinced that the system now followed effectually guards us against monstrosities, and invariably ensures to us edifices that are "to the credit of our national taste." And until that can be fairly proved, we must claim liberty—the liberty of doubting, if not actually denying it. If we do not get monstrosities, we get dulness and mediocrity,—correct and respectable, but mediocrity and dulness still. We do not hiss, indeed, but we *yawn*,—and hissing is much the livelier employment of the two. The National Gallery, for instance, is the butt of newspaper criticism, and enables it to show its sprightliness; whereas the poor British Museum lulls both newspaper criticism and critics fast asleep.

To return to the reviewer and the reviewed, Mr. Leeds's advice is to be interpreted *cum grano salis*. By no means does it follow from what he urges, that all are bound to strive to display originality. All, as we conceive, he means is, that those who feel themselves capable of doing so, should not be deterred either by fear or by paltry *mauvaise honte*, from doing so. Something is, of course, ventured; but the courage which dares not to venture anything, or to come forward unless assured beforehand of success, is not, in our opinion at least, many removes from cowardice. We do not at all imagine that there are many—at any rate, not at present, who could successfully put into practice what Mr. Leeds recommends. Yet, there are surely—perhaps it would be nearer the mark to say, instead of "surely," *uncertainly*—some, capable of availing themselves of the liberty held out to them. If no others, we have our Barrys and our Cockerells, who, it may be presumed, are *artists*, and as such, trustworthy. Those who do not feel the requisite impulse and confidence within themselves, may be left to go on as heretofore, confiding in rules and adhering to routine.

It is not only a stale, but an unfair trick, to bring forward instances of notoriously extravagant caprices as argument for restraining an entire profession from any exercise of inventive faculty, lest they should fall into similar excesses. Just as fair would it be to condemn rules altogether, as useless, or worse than useless, by referring to the numerous tasteless, insipid, and prosaic designs that have been manufactured acccording to rule, and may so far be unimpeachable,—very respectable, but utterly worthless.

Besides, no one can mistake Mr. Leeds's meaning so egregiously as to imagine that he advises architects to put forth rashly whatever crude fancies may occur to them. On the contrary, he strongly inculcates the necessity of æsthetic study. In architectural design, decided innovations are not to be adopted lightly, being left to take their chance for success or failure. It is for the authors of them to study them thoroughly and mature them, before they put them forth to the world,—to consider and re-consider them again and again. And if, after such consideration and contemplation of his idea in drawing or model, the architect is satisfied in his own mind that he has accomplished his purpose, and can account rationally for what he has done, hardly will he have perpetrated a *monstrosity*. After all, too, it is better to have to endure some monstrosities, than to be condemned to endure universal mediocrity, and the wearisome repetition of the same stale ideas.

The present generation of architects, trained-up as they have been to depend entirely upon rules and precedent, may not be capable of profiting by the more liberal views now promulgated. They are to be pitied rather more than to be reproached. But let us hope that their successors will be trained-up better—so trained-up that there will be no occasion for the invidious question: "Are our architects artists?"

The Popular Atlas; with Geographical and Statistical Descriptions. London: Wyld, 1849.

This work, which has been in progress of publication for the last two years, is now completed. It is an atlas of large maps, with statistical letter-press by Mr. Wyld, M.P., and Mr. Hyde Clarke, being the only work of the kind. It is not so complete as it might have been; but still it is more so than any other, and is the latest work of reference on the subjects to which it relates. Although it is necessarily a compilation, there is much originality in it, and it suppplies in the cheapest form which has yet been attempted what has been hitherto scattered in many books. It gives a very full view of the English empire and colonies. Under the title of Ancient Britain, is a new theory of what have been called Druidic monuments, in the suggestion that they are of Iberian origin. The ethnological characteristics of the English are more fully investigated than has yet been done, and a new light is thrown on the history of the Anglo-Saxon and other Germanic races. The Anglo-Saxons, here called English and Suevians, are traced in several of their connections, and a novel branch of history is laid open by the identification of a Suevian race, which, under the names of Varini, Warings, Rugians, and Russians, took part in the invasion and peopling of Britain and Slavonia. Since the identification of the Medes, Alans, and Ossetinians, no fact of equal importance in ethnology has been attempted to be established. For the detail of geographical, political, and commercial statistics, the Popular Atlas may be advantageously consulted, and will not be soon superseded, while it gives for three pounds a work what has hitherto cost twelve or fifteen. It seems to be a fashion now for M.P.'s to produce such books, as before they did pamphlets, and we have Mr. Macgregor, Mr. Wilson, and Mr. Wyld, starting in this new line. We hope the production of bigger books on political subjects will be accompanied by better information. It is certainly a proof of progress in political studies, as much as is the class of historians, represented by Lord Mahon, Mr. Macaulay, and Lord John Russell, and seems as if it would now be required that statesmen should know something of their business. We thought it something formerly if parliament was illustrated by poets and novelists.

THE PHILOSOPHY OF NATURE AND ART.

An Historical Inquiry into the True Principles of Beauty in Art, more especially with reference to Architecture By JAMES FERGUSSON, Esq., Architect; Author of "An Essay on the Ancient Topography of Jerusalem," "Picturesque Illustrations of Ancient Architecture in Hindostan, &c." Part the First. London: Longmans, 1849.

The writer of this book has set forth fully the great difficulties he has had to struggle with in drawing it up, and has owned in how much he is wanting for its rightful execution. There are evils which still more beset the reviewer, for while the reader looks for a close examination, sound criticism, and a decided judgment, the reviewer finds that much time is required, much knowledge, and deep and careful thinking, before he can fairly begin his task. He is led over a wide field of learning; he must strengthen his remembrance as to much which has faded from his mind; he must bring back again many things which he had altogether forgotten; he must learn much that is new. This must be always hard work; but much more so when time is not given, for the reader looks for an early notice of such a work. With most books this may be readily done; indeed, it is enough to see them, without reading, to know what to say of them; they are knocked up for the market, made for a speedy sale, and their freshness is all that needs to be asked about. But when a man spends a score, or two score years—a life, indeed, in making his book; when he brings to it not handiwork, but thought—how, in a few hours, or few days, is his book to be grappled with, its strength to be felt, and its weaknesses to be found out and set forth? Such a book, nevertheless, is that now before us, which has taken years in its accomplishment, and for which the writer has gone through the whole round of knowledge.

Our readers will like to know who the writer is, and happily we can tell them, from his own words. They look, perhaps, for a member of the Institute, with a fair share of wealth, who has gone through his pupilage, posted to Rome, steamed to Athens, sent in a competition design for a poor school, and built a Tuscan cotton-mill, and an Elizabethan workhouse. This does not seem to be so: and though Mr. Fergusson calls himself an architect, we do not know that he ever put up a building. For the work he has undertaken few men, he says, have, either from education or the professional pursuits of their life, been less prepared. From boyhood he was destined to the desk. From school he passed to the counting-house. In early life he was kept so closely to the desk as to have no time for society; and having likewise no taste for the common amusements of his fellow-clerks, he unbent his mind by reading. Like most young Scotchmen, the science that charmed him most was metaphysics; but he read likewise much on chemistry and geology—tried hard to understand crystalography, and puzzled himself with problems of mechanics and astronomy. "In short," he says, "I bought any book on science my limited means would allow, and more with reference to the price than the contents."

The effect of scrambling reading was confusion of views. This Mr. Fergusson soon found out, and he set himself to order and arrange his stores of knowledge. This led him to his first sketch of the classification of the arts and sciences.

From the counting-house his way took him to an indigo factory in the East; of all places in the world the one he thinks least suited for a cultivation of any knowledge of the fine arts. He then became an acting and active partner in a large mercantile establishment, from the trammels of which, in spite of every endeavour, he has never been able to free himself; and during the time this book was in hand, he wrote more about the state of the money-market, indigo, sugar, silk, and such like articles, than he did regarding architecture, painting, or sculpture. The last eighteen months Mr. Fergusson complains of as times of anxiety and distress to every one connected with mercantile pursuits, and more especially to those connected with the East, and as having drawn himself into its whirlpool.

His mercantile pursuits, he laments, have shut him out from the best class of intellectual or artistic society for years; and even his writings have not given him that introduction which might have been of use. Thus he has been cut off from counsel and advice in a task of no mean weight; and he has not had all that help from books which he would so much have wished. He has, nevertheless, made the most of his time and means, and has spent as much of his time latterly in the study of his subject as most men have been able to do; and to this we can bear witness from the fruits.

He has, moreover, had the good fortune to spend the best years of his life in the East; and in travelling he always travelled alone, with only one end in view. Thus he has seen much of art, and has had plenty of time to think over what he saw. For months together he lived among buildings and the works of art they contained, and looked on them long and steadfastly; following, even to the chisel-marks, the thought and bent of the artist and the workman. Whatever schoolmen may think, this is no mean training in art; and such a man is more truly an artist than nine-tenths of those who draw, carve, and build.

Our readers will remember that Mr. Fergusson has written of late years, "Illustrations of the Rock-Cut Temples of India," "An Essay on the Ancient Topography of Jerusalem," and "Picturesque Illustrations of Antient Architecture in Hindostan." The work now before us is of higher bearing. The first part only is published; other two are to follow, and one is ready. This is to be on Eastern, Asiatic, Mahommedan, Byzantine, Gothic, and Mexican art. The third part is to hold what the writer calls "A History of the Monkey Styles of Modern Europe, from the time when men first began to copy instead of thinking, till the present time, when they have ceased to think, and can only copy." It will be seen that there is no wavering as to the overbearing evil of modern art. The two latter parts will be as thick as the first, which holds above five hundred large octavo pages, with many drawings.

None of the common writers or readers on art will be ready to believe, or pleased to hear, that the beginning of a book on architecture is a treatise on what Lord Bacon has named *Philosophia Prima*. Yet so it is; and there are few works of this day—not even those of Whewell, Herschel, and Brougham—of a higher philosophical bearing. Shall we go where Mr. Fergusson has thought it right to lead—shall we follow him round the wide fields of knowledge, afar from art—or shall we pen ourselves up in what is held to be strictly architectural? By doing the latter, we shall please the mass of our readers; by doing the former, we shall awaken the anger of many, and meet with the applause of but few. We shall do the latter; first, as we think Mr. Fergusson has set a noble example by writing a work to be read and be thought about, and therefore ought to be upheld; next, inasmuch as the *Journal* has heretofore done the same things that he has done, and said the same words, and, as we believe, has in some way strengthened and encouraged him in the task he has fulfilled. We believe Mr. Fergusson to be right, and ourselves to be right, and we ought not to lose this opportunity of enforcing the truth. If we are merely to be flatterers of the crowd, to tell our readers not what is true, but what is pleasing to them, we may as well at once cut off the architectural portions of our *Journal*, and leave them to the dry chroniclers of news, and the namby-pamby praise of publishers of tours and illustrated guide-books. There is something of more weight to be done in these days, than giving details of styles and orders. We have to bring art to life, and not to rest till this is done. We are upheld by the trust that the *Journal* has already done some good in unsettling wrong feelings, and awakening right ones; and this is a good ground for going on.

We may say further, that we have often shown that architecture and engineering have many common ties, and a wide bearing on each other—and in nothing more than in right training and education; and therefore, whenever anything of common interest comes before us, we are bound to lay it before our readers of both professions. We have too many readers who are not practising members of either profession. We shall therefore follow Mr. Fergusson throughout.

We must own we were never more struck than by the beginning of this work; and so unlike is it to what would be looked for in a book on art, and what we have always had from writers on art, that we read with the greatest distrust. The great body of them are so wanting in real learning, so narrow in their minds, and in their sight—so little of artists, and still less of philosophers, that we are too ready to think that no other kind of writers have ever given their time to high art. The world is to be forgiven for this; for those who call themselves artists have most of all forgotten that Aristotle, Plato, Cicero, Bacon, Burke, and Brougham, not to name many others of great name and great mind, have written more or less upon art and its principles. After all, this is what should not be forgotten, that art as much belongs to the kingdom of philosophy as anything which is more commonly allowed to be under its sway; and it is from having broken loose, that art alone has gone back, while everything else in these days has gone forward, till we speak with pride and joy of what has been seen and done in our days, with only one blot—that we have done nought in art.

Mr. Fergusson treats art as the offspring of mind—its physical expression or representation; bearing in its shape, as do the children of men, the impress of the youth or eld, the strength or weakness, the soberness or riot, which marked the parent at the time of birth. Art cannot be upheld by one man, or by a score, nor can it be made in a day; but the minds of nations, and the thoughts of years, can alone give it the breath of life. He brings it into immediate connection with the great social system, and treats it as under the same influences as any other human institution. The way in which Mr. Fergusson does this, and the system of philosophy to which it leads him, are in every way remarkable. They are another comment on the signs of the times, which so many now look upon with wonder. The struggle as to art is but a single fight on a wide battle-field, which, end as it may, will not sink the beam either way. One side may win, but many of its best men be slain by those whose flag has lost the day. Thus has it been before with art—nay, the freedom of others has been the contemporary and signal of its own downfall. In this day, everything shows one of those epochs in history which stand forth to all times for good or for evil. It is not alone that war is let loose, that kingdoms and commonwealths are unsettled, the bounds of the mighty taken away, and those of the weak set wider off; but the mind of man is everywhere, and in everything at work—driven on to some great and mighty end. If the wielders of political theories are emboldened by seeing their way to power, how much more are those who look forward to the application of the resources of science? It is a great thing to have driven the steam-horse or the steam-ship faster—to have stretched afar the tongue of the telegraph—and to have drawn with the beams of the sun: but these are no more than the handsel of the inventor; the first fruits, it is true, but the earnest of greater bearing. If speed has been got, it is only to show us that more may be done. If we have made lightning our messenger, why not our carrier; if we have brought the people of the wide Atlantic nearer, why not hand to hand, or rather, mouth to mouth? Steam is a servant with a ready and a mighty arm; but we know not yet that we have called forth the greatest genii of the hidden world. The lamp may have been rubbed, and the steam wreathed from the jar; we may have workers of wonders before us: but these are only among the lowliest of those doing the bidding of an Almighty Master. The seav of the ring is at our beck; and yet he is only one of a numberless fellowship. The field of knowledge is known to be wide; there are those gone forth to search it: and whatever may be brought back, so much are we on the stretch for something new, that nothing can raise our wonder.

Everything betokens a great action on mankind—greater than anything which has been before, inasmuch as the physical conditions of time and space no longer narrow the field to its former bounds. Europe may have been the field before; but now the wide world is open, and the blow stricken at Paris is felt in Polynesia or Hindostan. It is not that there is any settled way before us; it is that we are ill at ease as to those we are now in. Discontent as to the past, mistrust as to the future; a restless longing for something better, without shaping what it is, mark the politician, the economist, the socialist, and the religionist. This, too, is felt in the world of art. It has not sprung up with the

French Revolution, nor does it take its aim from this; it began before, and has long been working; and revolution and reaction are among its phenomena, not among its causes, nor is its shape taken from one side. The Puseyite, who leans towards Rome, and his foeman, who would rush further from it, are both under the same spell; the same yearning for higher motives, and for a better sphere of action, is the influence operating with each. The *Times* and the *Northern Star* may be opposing forces, but they result in impressing the same direction on the public mind; both agree that what now is, is wrong; both that something is to be done, though neither knows well what that is. Look at art: can we anywhere find satisfaction with the present, or anything but looking back to Greece or the middle ages, or looking on to a hereafter—misty and mis-shapen? There are plenty of preachers against us; but few show us what to do, or anything which if shown is worthy of adoption.

There was much the same seeming in the fifteenth century, the sixteenth, the seventeenth, and the eighteenth; but, as already said, never had the minds of men so wide a field whereon to strive together—never before was the whole world so moved—never before did the lot of so many millions tremble in the beam. The fall of the Roman empire may have been felt by the tribes who fed their flocks under the Great Wall of China—from the Pacific to the Atlantic—from the Icy Sea to the Mediterranean; hundreds of tribes may have shifted their homes, and whole nations may have been brought upon the stage of history: but this, the events of which exercised the greatest physical influence, will give no parallel to that which now looms before us—nay, has already set in, in mighty outlines. The great French Revolution did nothing like this will do, because that was narrower in its bearings.

Each, however, is a part of the same system of progress—each a sequence of those which went before—this, too, of the others; but each has its own likeness, as well as that of its fathers—each has had its own philosophy. That of the last century, as said by Mr. Fergusson, though beginning in the inductive philosophy of Bacon, was divided into two narrow schools. The sectarian party fought not for truth, but for the safety of what they thought to be the dogmas of their system. Hence, being often wrong, they were often beaten by their foemen. These, again, had set up a system, in which they not only threw over all the sectarian views of the others on religion, but left out religion altogether. They, too, did not fight for truth, but to set aside religion, and to uphold a system of morphology, in which the present was evolved, by a series of regular changes, from the rudest elements, without any interference of design. A scheme was made out for nature or creation, on what were supposed the simplest philosophical principles, and nature was never to be thought to wander from them. Each side was always winning, but the other never thought itself beaten.

With these two schools we have still to deal: but there is now a third, which is likely to exercise great influence, as particularly representing the phenomena of the epoch; more material in its bearing, narrower in its sympathies, less symmetrical in its composition—and yet of higher aim. Whewel, Herschel, Whately, Prichard, Babbage, and Brougham, may be looked upon as having led the way to what has resulted in this new form, but without agreement and without design; while as yet no great teacher has sprung up to give a name to the new section. Its teachings are most to be found in the press of England and the United States; and, therefore, they have already exercised a powerful but silent impression on the public. The newspaper writer of this century will perhaps fulfil the task of the encyclopædist of the last—and, assuredly, with much greater might. The *Times*, with no definite end, has perhaps, alone, already done more to revolutionize the nineteenth century than all the encyclopædists of France and Germany did for the eighteenth.

To those accustomed to rail at the nineteenth century, and particularly the systematic supporters of the morphological school, nothing will give wider scope than this philosophy, without agreement in its teachers or its teachings; no certainty of aim, or far-seeing object—nay, not the same object. It is patchwork, confessedly, to suit an emergency, made for its day, acknowledged to be perishable, and expected to be destroyed. Its great point of distinction does not seem to be open to these reproaches; but there is little else but what is. By making theology and religion an essential part of this philosophy, its votaries give a greater field for its support; for though they cannot satisfy the sectarian, who wishes his sect only, they enlist men of all forms of worship; and the zealous Protestant may as consistently enrol himself, as the Jew or the Mahommedan. The adoption of this principle is, in reality, the key to the apparent inconsistencies. The object of the inquirer is not to attribute a sectarian or morphological motive, but to seek for the evidences of design, and examine its tendencies, believing that nothing has been done without an object and an aim. Hence the apparent conservative tendency, so far as concerns what already exists—hence the revolutionary tendency, if we may so term it, as to the future. A man is to be found like Mr. Fergusson or the writers of the *Times*, denouncing social evils one moment, and the next appealing to the existence of the distinctions of rich and poor, high and low, as established facts. There is, nevertheless, nothing inconsistent in this or such a system, though by the morphologists it will be denied to be philosophical. Mr. Fergusson cannot avoid giving a note to attack Liberty, Equality, and Fraternity; and the *Times* has baffled many of its readers by following such a course for months. The morphologists believe that everything in nature is regular and systematic: the others, that this regularity and system are governed by laws much more complicated than those the narrow capacity of the morphologists has assigned.

It is but another development of this principle to find the strong agreement of the new school in Anglo-Saxonism. In the message of President Polk, in the leaders of the *Times* or the *Chronicle*, in the "True Principles of Beauty in Art" of Mr. Fergusson, and with Mr. Hyde Clarke, in the "Popular Atlas," Anglo-Saxonism is the key or cuckoo note. This is sure to bring down severe criticism, and to provoke no gentle feeling, for it savours most strongly of illiberality, as such matters have hitherto been understood. As certainly as morphologists have had their chief seat in France and Germany, so must the others be narrowed to England and the United States; for it is not likely that others will take up a system which argues an inferiority of nature and destiny in their races. It seems most decidedly "to give up to party what was meant for mankind." The ground upon which it is done is this: the English have, from a handful of men in a nook of Jutland, become a mighty people—the dwellers in the *orbis alter* of Britain, in North America, and in Australia, and the holders of the greatest kingdom. The design has been that they should do this, and they are doing it—*ergo*, they are to do this until some new law is put upon them.*

It must, however, be said for the Anglo-Saxonists or Englishists, that many hold out that other races can be brought up to their model of perfection. The *Times* is always inculcating this for the behoof of the Celts, though we are not sure but some of the others teach that it is the destiny of what they call the inferior races to die off before the superior influence of the others.

We cannot help remarking that this Englishism comes with singular significancy in the present day. A war of races has been proclaimed—the mighty Italian people, the great Teutsh or Germanic people, the Scandinavian hive, and Panslavonia have set up their flags: others are to follow. What is the destiny of Englishism?

Mr. Fergusson brings this dogma to bear to illustrate the prospects of art in England. He relies on the capacity of our people in the former time and in the present time, to attain distinction in the arts; if there were but the will to do so, or the right way be set about.

The new school having once brought morals and religion within the pale of philosophy, are for applying them everywhere; in politics, in art—nay, in mechanics. They wish to give earnestness to even the lowest walk of life. On every branch of science and of art, these views are brought to bear; and it is by the practical development of them that a scheme of philosophy is worked out, really different from those which have been before laid down. Adopting Plato, Aristotle, Bacon, and Newton, and yet often rejecting each; learning from Bentham, La Place, Cuvier, and Lyell, without agreeing with them; a new monument is being heaped up, for which the workmen labour with earnestness, such as has never before been surpassed, and for which each lays down his contribution without any regard to its ultimate shape.

The only acknowledged end is to do good to society—to carry out the progressive tendencies of the human race, which the morphologists likewise hold: but there is no acknowledged way of doing this. Mr. Fergusson, in reference to re-modelling art, says (p. 161), "It may be asked, if I propose to throw over all precedent, and to abandon at once all Grecian pillars and Gothic pinnacles, and all the classical and mediæval details which now make up the stock in trade of an architect, what would I propose to substitute in their place? The answer is a simple, though scarcely

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* Perhaps we ought to say Englishism, not Anglo-Saxonism, according to some of these writers. The "Popular Atlas," which is as much written under the new inspiration as the "True Principles of Beauty," gives a full development of Englishism in all its bearings, statistically and minologically, most of which is so far from the common statement of historical facts, that it must lead to much controversy.

a satisfactory one, as it is merely—'I do not know.' But if any one reflects a moment, he will see that it is impossible I or any one else could know, without, at least, the gift of prophecy; for the very essence of progress is its procession towards something we do not now see; and the essence of invention is, finding out what we do not know, and what could not before be known." This is honest; whether it is satisfactory, we leave others to judge.

Having now shown the relevance of Mr. Fergusson's book to the school of philosophy to which it relates, we shall proceed to examine it by itself; which we could hardly do to the satisfaction of our readers until we had made them sufficiently acquainted with the position and views of the author; for otherwise, we should be under the suspicion of criticising a detail, which is irrelevant to the scheme of our work or the wishes of our readers.

Mr. Fergusson begins by considering the progress of mankind, and the state of this country, so far as vice and virtue are concerned; and the constitution of society as affected thereby. He asserts that there is no physical nor mental equality between men, but that there is a perfect *natural* equality of all conditions of mankind, as far as the power of attaining happiness is concerned (p. 4.) He looks upon "all states of society, from the merest barbarism to the highest civilization, as having its advantages and disadvantages, its virtues and its vices, and that, in fact, there is no natural advantage possessed by one over the other; in all, vice does and must exist,—in all, virtue is attainable by those who seek it; there is no state in which it is not in man's power to improve his condition: none in which a neglect of what is right may not render his position intolerable." He regards evil as inevitable and necessary, but that there is a full power of improvement. This leads to the question, "What are we to do to extract all the possible good out of our present condition?" Mr. Fergusson's answer is, "Cultivate the sciences and the arts; no purer faith—no real and permanent good can be effected, except from an improvement in knowledge; no higher or more elevated tone can be given on the all-important subjects of morals or religion, except by imparting a higher degree of refinement, and a better appreciation of the purely beautiful to the public mind. This last is—or at least, should be—the true mission of art; and were art so cultivated and based on knowledge, we should have higher aims and nobler purposes than we now have, and we might be struggling forward towards the Divinity, instead of grovelling in error, as we are now doing."

In our present condition, the writer considers us as a mere money-making, power-accumulating people—undignified by higher pursuits. If we remain so, the fate of Rome must be our's. He points out the mass of idle wealth, seeking and finding its only gratification in frivolity or sensuality; and a still more powerful mass of want and misery festering at the base, and preying on the vitals of society. It is upon the healthy mass that he relies for redemption in the future.

The evil which Mr. Fergusson points out as the most prominent is, not that usually selected, but which ought to be. "What is most wanted, says he, is a better style of education for the upper classes. It is in them that the great danger to society exists, and from them the example must come, that will elevate the tone of society." This is most true, and so is what follows. "At present we have not an upper class capable of conceiving or creating, and consequently, no lower class trained merely to execute; but art rests half way on a class combining both attributes, and who practice it only for its money-value as a trade, thinking and executing themselves" (p. 9.)

The system of education given to the higher classes the writer considers particularly to blame; but we think he does not sufficiently weigh the influence of Greek and Latin grammar. They may form "a distasteful and treadmill system," but those very properties constitute their essential worth in education, as a convenient mode of training. Their use, however, is one thing, and their abuse another; and it would be as wrong to throw them aside, as it is now to take them up as a panacea. It is no less a mistake to teach the wrong things at the wrong time; in boyhood, strict technical training strengthens the mind, and nothing can be more fatal than overtaxing the imagination or the reason. In manhood, it is as great a waste to train the lower faculties and neglect the higher. While we would strongly uphold what are called the classics in the lower schools, so would we keep them down in the higher schools, and give the time now devoted to them to the mathametical and practical sciences; to natural history, the fine arts, literature, and political science. "Useful knowledge" might be brought into our universities with good, instead of being part of the cram of boys and girls' boarding-schools and mechanics' institutions.

In coming to the important subject of classification in his introduction, the writer alludes to the failure of Bacon in the classification which he has set forth in his treatise "De Augmento Scientiarum" (p. 17.) and we agree with him that it was not because science was not enough advanced, but because, though Bacon's great merit was his contempt for the philosophy of the Greeks, he could not throw off, in mental science as in physical science, the dominion of Aristotle. To late systems of classification attaches the evil, that they want to chain down creation to lines and squares and circles, which have no place there. To Whewell, Mr. Fergusson makes the objection of Hellenism, and he candidly proposes one of his own as an outline to be filled up.

The first step taken by Mr. Fergusson is the division into two great natural classes of sciences and of arts; the former being a knowledge of all that creation does without man's intervention; the latter, a knowledge of all those modifications which man works on nature's productions.

Mr. Fergusson, like most of his school, and as opposed to the morphologists and sectarians, has a great dislike to metaphysicians, and he says that the mistake of former classifiers has been classifying according to some metaphysical idea of how it is perceived and learned by man (p. 23.) He asserts that the fundamental idea of a science is its total independence of man, either directly or indirectly, and instances botany. "If man had never been, or were to-morrow blotted-out from creation, would not the forests remain, and the 'small flower lay its fairy gem beneath the shadow of the giant tree?' Would not every natural production of the vegetable kingdom, and every phenomenon, remain identically the same, whether man observed them or not? All that man can do is to observe and try to understand; but he cannot alter one jot or tittle."

If we superinduce a change in the natural appearance of plants, and increase the size of their roots or flowers, this belongs to the province of the arts—agriculture, horticulture, or floriculture.

This seems to us a good distinction, but Mr. Fergusson has not supported it so fully as he might have done. Had he done so rightly, he would have saved himself from representing the division of labour and progress as the emblems of mind in distinguishing man from other classes of organised beings (p. 64.) The great distinction is the subordinate creative power, or voluntary power of modifying the forms of creation. No other animal has this power or exercises it, and it is the true means of progress. The acknowledgment of this power at once establishes the justice of Mr. Fergusson's two great divisions—physics, or a knowledge of nature; anthropics, or a knowledge of nature as modified by man.

Before these, he places those sciences which are universal in their relation, and concern equally physics and anthropics. These he names Universal Sciences.

The Universal Sciences (A) are classified into Theology or a knowledge of God, and Somatology or a knowledge of the laws relating to bodies. Here is a singular defect; for our writer has given no proper place to his own sciences of Biology, Ontology, and Psychology, which may be named Pneumatology. His classification of Somatology is not carried out on his own principles. If termed Poemology, it then includes the whole range of creation.

Atoms or particles are considered as in *space*, under the relations of *number* and *form;* and in *time*, under those of *rest* and *motion* (p. 35.) Poemology includes, therefore, Universal Mathematics and Mechanics, in their relations of arithmetic and algebra; geometry and analysis; statics and dynamics. It may, however, be questioned, whether there is such a condition as rest in nature (p. 35); and what is called statics, really considers a *point* or *unit* in motion (p. 37); dynamics, continued motion. Arithmetic and geometry, when considered in relation to numbers and bodies in motion, or as here called in the condition of time, belong to a higher range of science than when limited to fixed numbers and forms. So far as numbers, rest, and motion, are concerned, these must apply to what we have called Pneumatology; the laws of which have been little investigated (p. 26.) The application of mathematics and mechanics to creation, constitutes the applied sciences under head (A), as optics, perspective, hydrostatics, hydrodynamics, electro-statics, and dynamics, &c.; some of which, Mr. Fergusson has arranged among the pure sciences. The forces exerted by vegetable or animal life, the combined influence of vital dynamics and physical dynamics, and the combination of these again with mental forces, call for a systematic study which they have not yet received. So long as our mathematics and mechanics are those of matter only, the highest branches of their applications remain untouched, and the political sciences must be arbitrary in their principles and details. That a great deal is to be safely done, is shown by the progress which has been made in vital statistics; but what is to be done, must be done inductively. Taking the operation of moral laws as an example, it is quite as competent to give the statistics of the evils which have followed on their infraction, as it is to chronicle the result of physical disease. We may sketch out general laws, but the men of the present age require the evidence of facts. Here we may point out that the movements or dynamics of phenomena or events of what Whewell calls *catastrophic* laws, have never been carefully considered. The doctrine of probabilities is an empiric mode of escaping the investigation of facts, and the foundation of a new science is to be laid by gathering together, recording and investigating, the phenomena known to us; the orbits and and forms of the planets and comets, their revolutions; the periods of earthquakes, volcanoes, meteors, electric storms, hurricanes, famines, plagues; the forms of crystallization; the aggregation of atoms; the catastrophes effecting human, animal, and vegetable life. Whatever has been done in this, has been by laying down so-called regular circles, ellipses, and lines, and by taking means which are not recognised in creation. Mr. Fergusson has shown (p. 32, 33, 69), that there must be a much higher arithmetic and geometry than that we now possess; and it is only by the belief that we cannot attain them, that we debar ourselves from their acquisition. If we examine the history of mathematics, we shall find its higher branches have all been consequent on the advancement of the sciences of observation. A discovery in astronomy, in optics, or in electro-magnetism, drives the mathematician to more advanced and a more elaborate system of explanation. Had Galileo and Kepler never observed, the need of a system of fluxions or a calculus could scarcely have been felt. Progress in the observations we have enumerated, may thus be the initiative to an advance in mathematics and mechanics, beyond that which Newton made on those who went before him. At present, facts are attempted to be explained by science as it is, or rather, was; not to induce the science as Newton did, so as to lead the way to further facts. So little, indeed, is the teaching of Bacon remembered, or the example of Newton understood, that the few attempts which have been made to follow in his path (as by Mr. Herapath, for instance), have been decried—not on their own merits, but as acts of heresy and treason against time-honoured doctrines. What has been taught before may be true; but that is no reason for not learning more. Mr. Fergusson says (p. 29) "In nothing is man's conceit more painfully apparent than in his dread lest he should know too much, and thus learn to despise the Deity; his fear, lest the very limited space and time he can grasp should equal or surpass infinity or eternity; or, that the small modicum of knowledge which, from his formation, he can ever hope to attain, should exceed omniscience."

In defining Somatology, Mr. Fergusson considers the arrangement of atoms, and states his belief that "all the observed phenomena might be represented by some such hypothetical assumption, as that all space is filled with definite atoms in a neutral state, and, consequently, inappreciable by us, either directly or indirectly; but that these, at the same time, may exist in two states, which, for want of better terms, may be called negative and positive states, or male and female (to borrow a somewhat distant analogy). These may combine with one another—not like with like, but with their opposites, in certain definite proportions. That these combined atoms or particles, again combined, accord-to the same law, form chemical atoms; and these last combined in certain proportions, which we know, form the sensible matter of this globe." "I cannot help thinking," says the writer, "there would be considerable advantage in representing our chemical philosophy according to this simple theory; and I know it can be done." So far as our investigations on the atomic proportions have gone, we are inclined to the latter opinion. This view of antagonist principles or forces has been often put forward; it will be found in the works of Mr. Rooke, of Akehead, and last, by Mr. Hyde Clarke, in the Popular Atlas, already named, under the head of Phenomena of the Universe, where it is extended by the assertion that this antagonism is exerted in every phenomenon and operation, preventing the repetition of the same movements or forms. "The paths of the planets are in irregular-shaped ellipses, because, according to physical laws, they cannot be circular, for in nature a circle or a right line is not found, nor is the same shape ever gone over again, which would be so if a perfect figure were formed. In nature, there is always a contest between the operations of centricity and eccentricity." It is this assumption of an individuality of creation in each object and operation of nature, which is a prevailing doctrine throughout Mr. Fergusson's introduction.

Mr. Hay has, we consider, done a great deal of good by his investigations on form; but we cannot by any means agree in his theories or his results in the limitation of forms. Mr. Joplin has done much more to our mind, by showing the infinite variety of curves which may be produced. Mr. Fergusson, in the definition of geometry, gives, we think, reasons against Mr. Hay, which the inspection of the great room of the Society of Arts will confirm. "We are in the habit of calling squares and circles, cubes and spheres, and such like simple figures, perfect forms, and fancying that they are more beautiful or more perfect than more complex ones; and, indeed, they are so to us, as they are the only ones we can comprehend. But the amorphous[*] mass of granite is quite as perfect in nature's eyes, and as complete and certain in all its forms and relations, as a lens of glass or billiard ball (assuming them to be what they pretend to be), and more so; but the latter are so simple in their outline that we can reason upon them. The other defies our powers; but were our analysis sufficiently perfect to enable us to master its complexity, we should arrive at a very different conclusion."

The Physical Sciences are included in Table 3 (p. 40 and 56) which is only a sketch, and requires to be filled up and corrected. Mr. Fergusson begins with the stars or Astronomy, and proceeds to Etherology or the imponderables of the Universe (Light, Heat, Electricity); Mineralogy, the substances of the globe (Air, Water, Minerals); Botany, and Zoology; but though he afterwards establishes man as a separate class, Anthropology does not take its proper place in his series.

Each of these great classes, the writer treats under the relations of space and time, as in class B. Thus, under *space* in Zoology, are ranged Chemistry, Anatomy, Physiology, Ontology, Zoography, and Geography; under *time*, Palæozoology, and History.

Chemistry becomes the doctrine of elements; Anatomy shows how these are put together; Physiology, how they work; Ontology treats of the special laws of instinct or mind in animals; Zoography is the description of individuals; Geography, their relation to the earth,—and we should suppose Mr. Fergusson means to the universe or Cosmography. Palæozoology treats of the changes which took place in animals before the period of man, or man's observation; History, those which have taken place within his observation. On Mr. Fergusson's principles, the laws of design relating to these classes of animals should be eliminated; but unless they are included under Physiology (p. 52) or Geography, we do not see that Mr. Fergusson has provided for them.

The following is a development of Mr. Fergusson's system of classification on his own principles, but which he has left incomplete, it will be seen how many of these sciences are at present uncultivated and undeveloped.

Physical Sciences. (B)

ASTRONOMY.	ETHEROLOGY.	MINERALOGY.
Chemistry	Chemistry	Chemistry
Somatology	Etherology	Chrystallography (?)
Cosmorgics	Etherorgics	Georgics (?)
———	———	———
———	———	———
Astrography	Etherography	Morphology
Cosmography	Cosmography	Cosmography
Cosmogony	Geology (?)	Geology
History	History	History
BOTANY.	**ZOOLOGY.**	**ANTHROPOLOGY.**
Chemistry	Chemistry	Chemistry
Anatomy	Anatomy	Anatomy
Physiology	Physiology	Physiology
———	Ontology	Ontology
———	———	Psychology
Phytography	Zoography	Ethnography
Cosmography	Cosmography	Cosmography
Palæophytography	Palæozoography	Palæoethnography
History	History	History

In reviewing the state of Astronomy, Mr. Fergusson points out that it is at present most limited; and it may be added, that on his principles it is to be much extended. The assumption of spheroidal forms and elliptical paths, acted upon by a simple and continuous force, may be convenient in a rudimentary state of science, but he requires the investigation, not of theoretical, but of exact forms and orbits, and of the laws of design; under which the impress of form and motion have been communicated. Hitherto, astronomy has been within the range of Somatological mathematics only; and Mr. Fergusson claims it for universal mathematics, in which the laws of mind shall be investigated as well as those of matter.

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[*] Mr. Fergusson means amorphous in the ordinary sense attached to "form."

Etherology establishes the connection between this globe and the universe. Light, we know not to be confined to the solar system; heat, we may presume not to be so; and electricity has most probably a universal range. Of these imponderables, we know very little. Mr. Fergusson is opposed to the view that all the imponderables are only different forms of one substance or power, except, of course, in the sense in which he has spoken of atoms; and he thinks that the contrary view is much more philosophical, and will lead to more satisfactory results. He holds that it does not follow, because electricity, magnetism, galvanism, light, colour, sound, heat, and actinism, perform certain functions in common, or are governed by similar laws, "that they are one, or one genus, more than it follows because all quadrupeds walk on four legs, that they are of the same genera and species. On the contrary, by carefully marking every distinction, and classing apart every form which is not in all things identical with any other, we are more likely to distinguish their true characters and true relations, than by slurring them over to produce a superficial similarity." We cannot but agree in this view.

Of the laws which influence the imponderables connected with the globe, scarcely a trace is known. The investigation of magnetic tides and waves forms but a spot in the wide field of study, which is open.

Mr. Fergusson contends that minerals are absolutely inert, and calls for the application of a physiology to them. He might have said more on this head, and the application of a physiology to astronomy and etherology. We take a bladder of air, a jar of water, or a bunch from a mineral vein, and we treat them as inert. We might as well draw the same conclusion from other specimens in our museums—from the joint of a reed, for instance, or the broken limb of an animal. The organization of the globe must be a consequence of the general law of design, and we trace evidences of it in the flow of the tides, the movements of the atmosphere, the waves and poles of magnetism, the electric currents of mineral veins, the outbursts of volcanoes, and the shocks of earthquakes. These are as strong evidences of the organization of the whole globe, as we can find in the organization of any plant or animal. Whether this organization was in a higher state formerly is another question, as is what are its laws of movement. They may vary as those of the organization of an animal. Neither is the organization of the solar system, when properly viewed, less efficient. Numerous large and small planets, comets, and meteors, in constant motion, constitute an aggregate of movements and forces as various as those of the animal kingdom.

The views we have here expressed will be a sufficient comment on Mr. Fergusson's next subjects of Botany and Zoology, and they will apply with full force to the consideration of Ontology.

(To be continued.)

The Young Surveyor's Preceptor. By John Reid, Surveyor. London: J. Basevi, 1849.

This, a volume which we have much pleasure in announcing, is really a practicable work, and is what its title states, "a clear and comprehensive analysis of the art of architectural mensuration." The author takes each trade separately: he first gives the specification of the works to be done, and then offers some remarks for the guidance of the student in taking dimensions, which are very similar to those given for many years in "Laxton's Builders' Price Book;" but in Mr. Reid's book they are given in a collected form, and are more extended. After these instructions, he states the dimensions, as taken by the most experienced surveyors; next, a copy of the abstract, and finally the bill of quantities, monied out; all of which are very plainly and accurately set forth, and in such a manner as to make the work clearly understood by any one who has had a little practice in a surveyor's or builder's office. The book contains the whole of the Dimensions, Abstracts, Bills of Quantities, monied out, and a set of twelve drawings of the plans, sections, elevations, and working details of a first-rate dwelling, in conformity with the Metropolitan Buildings Act.

At the conclusion of the work there is a glossary of technical terms used in each branch of the building business, which, however, is not so comprehensive as it ought to be; and to render a glossary complete, it ought to be accompanied with illustrations.

There is one observation in which we must differ from Mr. Reid—that is, in recommending the dimensions in all cases to be entered with the description in full. This appears to us quite unnecessary. Many of the abbreviations used by experienced surveyors are so comprehensive, that with a little explanation to the student, they could not be misunderstood; for instance, take the plasterer—instead of writing "Render, float, and set," or "Lath plaster, float, and set," any surveyor would understand the book if they were entered, R. F. S.; L. P. F. S.: and again, in the joiner—instead of writing "1½-inch deal four panel, bead flush and square door," it might be entered as "1½-dl. 4 P., B. F. & Sq. door."

In conclusion, we recommend Mr. Reid to publish the plans separately, for the use of students who wish to practice.

TO THE EDITOR OF THE "CIVIL ENGINEER AND ARCHITECT'S JOURNAL."

Sir—I beg you will accept my thanks for pointing out an error in the example at page 205 of my work on Mechanics. The blunder, however, is only in a single letter: if for TON you put TUN everywhere except in the last line, all is right—reckoning 216 gallons to the *tun*, which is the old measure.

There are two typographical errors in your paper that are not in the book. In the last line but one in the solution, for 778,584; 83·04, read 77858483·04. In the last line, for 463,180, 11·5367, read 46318011·5367.

If you will insert this in your next number, you will much oblige

Yours obediently,

James Hann.

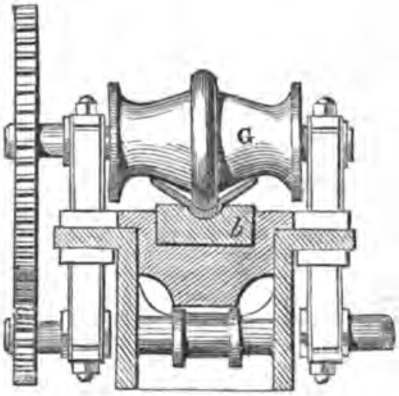
King's College,
December 16, 1848.

REGISTER OF NEW PATENTS.

MANUFACTURE OF TUBES.

William Taylor, of Birmingham, machinist, for "*an improved mode of turning up or bending flat plates of malleable metals or mixtures of metals by aid of machinery into the form of tubes.*"—Granted May 18; Enrolled November 18, 1848.

The plates of metal to be formed into tubes are to be first rolled of suitable length, breadth, and thickness; the plate being either feather-edged or not, according as the tubes are intended to be jointed. The diagram represents a transverse section of the machine, showing the mode by which the plate receives its first curvature. The plate of metal is laid flatways upon a long, narrow iron bed *b*, which has a semi-cylindrical concave groove formed in its upper surface, along the middle of its breadth, and extending all its length from end to end. The concavity of the groove is made to fit the exterior circumference of the intended tube. The grooved bed is made to slide successively in the framework in the direction of its length,—firstly, under a revolving convex roller, G, which presses down the middle part of the width of the plate into part of the depth of the concave groove, and thereby causes the edges to turn up into angular directions, and the plate to assume the form of a shallow trough or concave gutter; secondly, under another convex roller, which presses down completely the plate into the groove, and gives it the form of a deep trough or gutter, with semi-cylindrical bottom and nearly upright sides. On passing from beneath this roller, the plate slides over the bulb of a fixed mandril, and, at the same time, between a pair of rollers, the circumferences of which nearly meet, and have axes inclined from vertical positions in contrary directions to one another. The edges of these rollers are conical, but concave to a quadrant of a circle of the same size as that of the groove in the bed, so as to



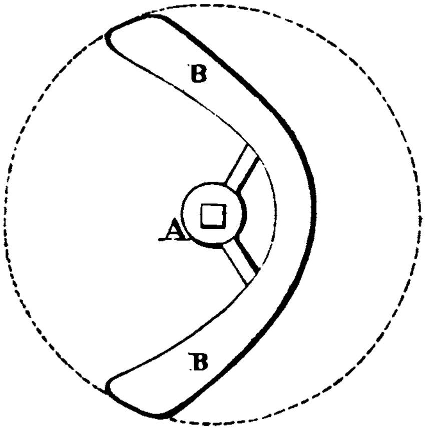
leave a semicircular aperture between their conical and concave circumferences corresponding to the groove. The effect of these rollers is to bend the edges of the already bent plate in towards each other, and down upon the mandril. The plate then slides, with the mandril inside, under another revolving grooved roller, which completes the bending down of the edges, and renders it more effectual and permanent, and the tube is thereby completed. The seam may be closed by the means usually employed.

The tubes may be made oval or polygonal by forming the groove, the concavities, and convexities of the rollers to suit the required shape.

BOOMERANG PROPELLER.

Moses Poole, of the Patent Office, London, gentleman, for "*improvements in propelling vessels.*" (Communicated from Lieut.-Colonel Sir T. Levingston Mitchell.)—Granted May 26; Enrolled November 25, 1848.

This propeller is called by its inventor the "Boomerang propeller," from its action being supposed to be similar to that of the boomerang, a wooden missile used by the natives of New Zealand. On observing the motion of the boomerang in the air, whirling round a hollow centre and leaving a vacant centre of gravity, it occurred to Lieut-Col. Mitchell that its centre of motion would be found to be on a right line, which would divide the boomerang into three portions, in such manner as that the eccentric portions should equal the central one; and this he subsequently proved to be the case. The bearing of the boomerang propeller, in which the rotary shaft fits, is consequently to be placed in this newly-discovered centre of motion, and suitably attached. The advantages of this form of propeller are stated to consist in its working in the water obliquely to the radius of rotary motion, and being free from lateral pressure.



The form of this propeller and its centre of motion are shown in the annexed diagram, A being the shaft on which it revolves, and B the propeller blade.

PREVENTION OF SMOKY CHIMNEYS.

Sir Henry Hart, Commissioner of Greenwich Hospital, Rear-Admiral R.N., for "*improvements in apparatus for preventing what are called smoky chimneys.*"—Granted June 13; Enrolled December 13, 1848.

The claim of the patentee of this invention is for the employment of wheels made to rotate by the wind, so as to withdraw the air from the chimney or flue, and brought into position by means of an arrow or vane. The patentee represents three modes of applying his invention. One consists in placing a fan-wheel partially within the revolving part of the top of the chimney; so that a current of air may act upon the fans which project above it, and thereby create a draft. Another, in cutting away a portion of the top part of the chimney, and placing the fan-wheel therein, taking care however to leave a portion of the fans exposed to the action of the wind. A third, in placing the fan-wheel within the side of the chimney fronting the wind, and covering the top fans with a shield, so that the air may act upon the bottom ones, and drive the smoke up the chimney.

STEAM-BOILERS.

William Seaton, of Camden-town, Middlesex, gentleman, for "*improvements in closing tubes, and in preventing and removing incrustation of boilers.*—Granted May 30; Enrolled November 30, 1848.

The first part of this invention consists in a method of closing the ends of the tubes of steam-boilers, by contracting the metal into a hemispherical form. When the tubes are of iron they are heated to a welding heat, and placed on a vertical mandril, with the end to be closed projecting slightly beyond it, and submitted to the action of a suitably-formed die under pressure. When the tubes are of copper, or of any alloy of that metal, they are submitted to the same process, with the exception of heating; and as the end cannot be perfectly closed, a small hole is left or made in it, which is afterwards closed by a rivet of the same metal, in the usual way.

The second part of the invention consists in removing and preventing incrustation in steam-boilers, by precipitating the lime (of which the incrustations are generally formed), by oxalic acid, or carbonate of potash, or carbonate of soda, or other chemical agents, in a tank, and filtering it through charcoal and sand. Or, in employing chemical agents, such as nitric, muriatic, or acetic acid, &c., to hold the lime in solution, and enable it to be blown off from time to time. Or, in using in the steam-boiler or generator, sawdust or charcoal, which by its mechanical action prevents the formation of deposits. When operating on salt water, salt, soda, or saltwort is used. The relative quantities of the chemical agents to be employed, are to be determined by a previous analysis of the water; and to remove any incrustation which may have been previously formed, an excess of the chemical agent employed must be used.

GAS APPARATUS.

Richard Barnes, of Wigan, Lancashire, gas-engineer, for "*certain improved apparatus for manufacturing gas for illumination; part of which improvements is applicable to retorts for distilling pyroligneous acid, and other similar purposes*"—Granted June 6; Enrolled December 6, 1848.

This apparatus is intended for the manufacture of gas in a small way. The stove is built of fire-brick, with openings in the front or side, but without grate or bars. The retort is suspended in the stove by its flanges, which rest upon horizontal iron supports let into the brickwork, and to which is attached a circular iron plate, standing upwards. The cover is formed with two rims, one within the other. The inside one takes into a groove formed by the projection of the retort above the flanges and the circular iron plate, while the outside rim dips into another groove, filled with water, and supported from the brickwork of the stove. The circular iron plate passes up between these two rims, so as to intercept the radiation of heat from the inside one, and consequently to prevent the evaporation of the water which is contained in the groove in which the outside rim dips. The tar, &c., which drips from the cover between the projection of the retort and the inside rim, together with the water-joint, prevent the escape of gas into the atmosphere.

Inside the retort is the cradle for holding the coal from which the gas is to be evolved. The gas passes from the retort, through a pipe fitted into the cover, into the refrigerator, the hydraulic main, the condenser, the wash vessel, the purifier, and lastly into the gasometer. The gasometer contains the purifier, the advantage of which arrangement is, that the gas is constantly exposed to the action of the lime. The gas, as it is evolved, passes through the apparatus into the gasometer: and when the coal is exhausted, the cradle is taken out, and placed in an extinguisher, so constructed as to prevent the admission of air to the coke, and also the escape of noxious vapours from it.

The patentee claims the constructing the stove with openings in front or in the sides, but without grate or bars, and in closing the mouth of the retorts used in the manufacture of coal gas, or pyroligneous acid, or other similar purposes, by a cover made gas-tight by a water-joint. Also, the peculiar construction and general arrangement of refrigerator, condenser, wash vessel, purifier, and gasometer, as described.

OSCILLATING STEAM ENGINE.*

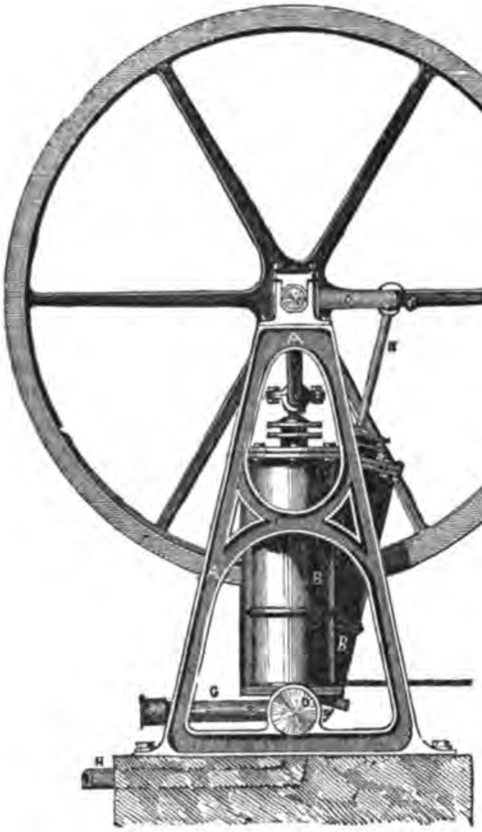


Fig. 1.

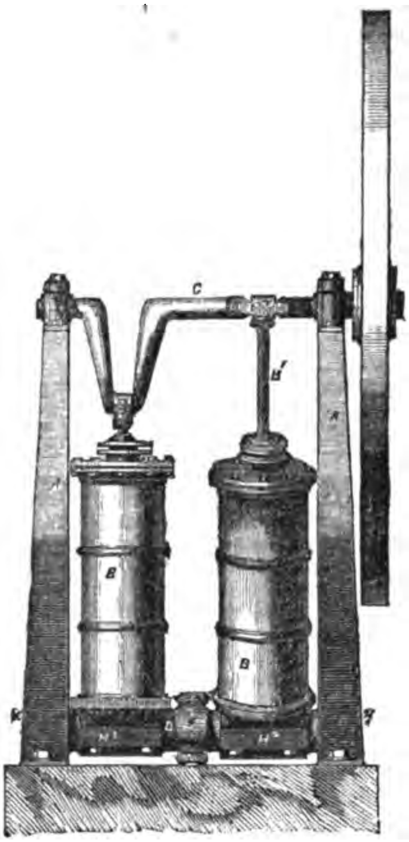


Fig. 2.

Richard Want and George Vernum, of Enfield, Middlesex, engineers, for "*an improved steam-engine, which may also be worked by air and other fluids.*"—Granted June 10; Enrolled December 10, 1848. [Reported in the *Mechanics' Magazine.*]

The distinguishing feature between this invention and the oscillating engines hitherto made, consists in their having the point of oscillation at the bottom instead of in the centre of the cylinders, by which arrangement the piston-rod makes a much less angle with the crank-shaft. The engraving, fig. 1, represents a side elevation, and fig. 2 a front elevation, of a double-cylinder high-pressure engine made on this principle. A A is the framework; B B are two vertical cylinders which oscillate on a hollow transverse bearing, or trunnion, D, with which they communicate at bottom. B' B' are the piston-rods, which are attached at top to the crank shaft, C. The cranks are placed at right angles to each other, so that the piston of one cylinder may be passing through the most effective portion of its stroke while the other is at its dead point. The hollow transverse bearing D, is divided into two sets of passages, and F, a six-way cock, occupies the centre of the bearing, through which steam may be admitted from the pipe G, which communicates directly with the boiler, into either of the sets of passages. The passages are so arranged in connection with the six-way cock, as to admit the steam into the cylinders, and to permit it to escape at the proper times; the whole of the pipes for supply and eduction being introduced through the hollow trunnion. In the single-cylinder engines, and in the locomotive engines constructed on this principle, some alterations are made, to adapt them to their different circumstances; but in the main principle of the invention they are alike.

The patentees claim the manner in which the cylinders are centred on and communicate with the hollow trunnion, and the mode in which that trunnion is constructed internally.

SAWING MACHINE.

Thomas Hunt Barber, of King-street, Cheapside, London, for "*improvements in machinery for sawing wood.*" (A communication.) —Granted June 1; Enrolled December 1, 1848.

The specification of this invention became due only a week before the trial involving the validity of Mr. Junius Smith's patent for a similar machine, which occupied the Court of Queen's Bench six days; and it would appear as if the principal object of this invention were to supply the omissions in the former, which caused the verdict to be given against the patentee. The objects of Mr. Barber's invention are to provide, in the first place, for supporting timber otherwise than at the end, while being cut at the various bevels which may be required. Secondly, he claims certain additions in the chucks, or apparatus for holding timber while being sawn. Thirdly, a means of giving the log the necessary turning motion, in order to facilitate the cutting or siding to the desired bevels. Fourthly, improvements in the gates or frames for holding the saws in the machine. Fifthly, improvements in the means of moving the bevelling bar, or apparatus for governing the bevels to be cut. Sixthly, a means of giving stability to the head-block, or apparatus for holding a log when being secured; and lastly, improvements in the apparatus for indicating the directions and bevels of the cuts in the timber.

With regard to the support for the timber, it consists of a roller placed transversely immediately under the log near the saw frames. This roller is of small diameter, but of sufficient length to receive a log in any portion of the width of the machine, and is supported at each end by pivots in a swing frame, supported on a journal in the centre of the machine. The journal, which forms a point of oscillation, is carried by an upright, moving in a vertical guide; and is supported on the end of a lever, by which it is either raised or depressed to suit the size of the log. This is effected by the other end of the lever being raised or lowered by a chain wound on a barrel, the spindle of which is furnished with a screw-wheel gearing into an endless screw, actuated by a suitable hand-wheel The supporting roller being free to oscillate on the central fulcrum, it adapts itself, at a suitable angle, to the inclined position of the log when turned. From the method adopted for supporting

---

* By reference to the "Civil Engineer and Architect's Journal," vol. vii., 1845, Plate IV., there will be seen described the same description of engine, invented by M. Legendre, and exhibited at the Exposition in Paris, in 1844.

the log in the chucks, by this movement, the log is thrown out of the centre, to counterbalance which, the under-side of the roller-frame carries two weights, one at either end, which slide on arms or from the fulcrum; the distance being regulated to suit the position of the log, when being cut.

The chuck for holding the timber, consists of a vertical plate, pendant from a shaft, which oscillates in suitable bearings; the lower end of the plate projecting at right angles, and forming a table on which the wood rests. The improvement consists in the addition of a claw, hinged at the upper part, which is brought down and driven into the wood.

For the purpose of giving the necessary inclination to the log to cut a bevel, the patentee employs a bevelling-bar, secured to the chuck at the lower end. The upper part being hinged to a nut, works on a transverse screw over the top of the machine; but, as the distance between this nut and the chuck, will vary according to the inclination given, the bevelling-bar is therefore made in two pieces, the one to slide on the other, for the purpose of elongating or contracting as required.

The improvements in the saw frames consist in applying a double frame within the same gate or outer frame; these saw frames are one within the other, and admit of giving a separate motion and adjustment to the saws. The improved means of giving stability to the head block consists in the adaptation of a central rail, on which the table part of the chuck slides during the operation of sawing; it has also the addition of a right-angled piece at the back part of the chuck-plate, which also slides on this rail.

The apparatus for indicating the bevels being cut, consists of a plumb line, which hangs from the apparatus at the upper part of the bevelling-bar; this is immediately in front of a graduated index, showing the number of degrees from the centre, or zero, which is the horizontal position of the log. This line is readily moved to suit the position of the log when first placed in the machine.

WATER SUPPLY FOR PLYMOUTH.

Mr Beardmore has recently issued a report in the form of a letter addressed to Lord Ebrington, on improving the supply of water to the important towns of Plymouth, Devonport, and Stonehouse: the three may be considered as one large town. He first investigates the present supply, and shows that the mode by which it is now obtained is most objectionable; and then explains, very successfully, how it may be vastly improved. With regard to that part of the report which describes the way the water is to be collected in the reservoir, we have one alteration to suggest; that is, instead of making the one at Torr both a *settling* and *distributing* reservoir, we recommend that it be used only for the latter purpose; and that the intermediate reservoir should be made larger, so as to allow the water there to deposit its solid particles, and become perfectly pellucid before it goes into the Torr reservoir. With these few observations, we shall proceed to give some extracts from the report :—

> The water is to be taken from the River Plym or Mew, at a weir two miles above Meavy, and runs in an open winding leat, 18 miles in length, until it arrives at Plymouth, where part of it falls into two small reservoirs, about 135 feet above high-water, from which the distributions are made; but at this point, a diverging branch carries about two-thirds of the entire quantity brought into Plymouth, into a mill-course, which successively works several mills on its passage to the tide at Millbay.
>
> The evil of this to the public health is not, perhaps, at present great, until the water arrives at the lower part of the town; here, for about half-a-mile, it is ponded up for working a mill situate at the point where it falls into the tide at Millbay.
>
> My first proposition is, *that the entire water-power on the leat-course through Plymouth, and the profit arising from it, should be abandoned, so that the whole water entering Plymouth could be diverted to domestic use, public and trade purposes, surface and sewer cleansing, and for street watering in dry weather*.... I apprehend that the utmost obstacle to the extinction of water-mill power, would be the purchase of the leases. Assuming the available fall to be about 50 feet, and the supply 10 cubic feet per second, which is very much beyond what the miller can ever obtain, the power is equal to ·83 horse-power per foot of fall, or 50 × ·83 = 41·5 horse-power *in toto*, which, if valued as steam-power to be extinguished in 16 years, would represent a loss to the corporation of 580*l.* per annum, or 14*l.* per horse.
>
> A most important matter of economy is in the use which can be made of water for street cleansing and summer watering. The general streets of Plymouth are well paved for cleansing by hose, and the cost of placing additional stand-pipes or valves, required as they are for other purposes, becomes a mere trifle. At a small expense, stand-pipes, or a few more fire-plugs than now exist, should be placed so that a range of hose from 100 to 200 feet in length can be attached, at least once a day, for the purpose of washing and watering. One man, with the head of water available, and the general rapid fall of the streets, could wash thoroughly 10,000 square yards per diem, or, at an average of 8 yards wide, a length of 1,250 yards, or two-thirds of a mile of street, per diem. Now, in efficient sweeping by hand, one man can cleanse not more than 800 square yards, or 100 yards lineal at 8 yards wide. If the sweeping cart be used, the comparison is not so good, but watering then becomes an advantage, as it enables the machine to work more efficiently, especially on macadamised roads.
>
> With the astounding number of persons living in single rooms in Plymouth, there should be a systematic arrangement for a vertical pipe, with branches to the different floors of houses let off in rooms, like the plan of supply up the common stairs of the flats of Edinburgh and Glasgow, where, of course, each *tenant is charged a separate water rent.* Now a charge of three shillings per annum, allowing a deduction of 25 per cent. for payment by the landlord, would at once bring accession of revenue to a large amount, and be an incalculable boon to the poorer community. An objection may be taken to the apparent expense of this arrangement; but if galvanised wrought-iron were used for the vertical pipes, it would be small. If a service were combined with a sink and waste-pipe for each floor, the cost would be thus—

	£	s.	d.
Thirty feet of vertical iron pipe at 8d. fixed, including 3 branches	1	0	0
Three pipes and taps	0	10	6
Three sinks of slate, to be erected in staircase angle	1	4	0
Waste-pipe (stack pipe available)	0	15	0
Cost per house with three floors	£3	9	6

> This would be a charge upon the landlord, including interest and repayment of first expenditure 1*l.* 3*s.* per floor, or per service; or assuming two rooms let off per floor, having the joint use, his weekly loss would be ¼ of a penny per tenant, which would be fully made up by the increased convenience of the lodging, as a merely voluntary question. If compulsory service of water be put into force, *houses let out in rooms or floors ought to be treated as separate tenements*, and charged at cottage rates; a measure of this kind would save the poor labour, remove bad habits, and promote cleanliness in every way. The effect of obtaining small tenants is always beneficial to the revenue; more water is paid for, and *cœteris paribus*, little more is taken, as the poor *must* have water to some extent.
>
> The charge for houses under 6*l.* per annum rack rent, is fixed by Act of Parliament for Edinburgh and Leith at 3*s.* if paid by the landlord, or 4*s.* if paid by the tenant. Out of 25,410 houses supplied in the whole district, 11,519 houses (floors or single rooms in fact) are supplied at this low rate. In Glasgow the average rates for domestic purposes in 1843 were 8*s.* 7*d.* per renter—a striking proof of the advantage of selling water for trade purposes.
>
> The subject of fire is one that will be immediately responded to, as it is not many months since the lamentable destruction of life in the lower part of Plymouth, when there was delay in procuring the fire-engines.
>
> An instrument used at Leeds, is so simple, and has so entirely removed the necessity of fire-engines, that it is worthy of description as an excellent example for the surveyor of the borough, for it might easily be at once adopted for the lower and thickly-inhabited parts of Plymouth, where the mains are constantly charged with sufficient pressure for the purpose. A light-built tumbrel or hand-cart is kept at various stations, with a hose coiled round a reel on its axle, carrying, likewise, a copper stand-pipe with two diverging branches.* On alarm of fire, one man can run with this, stop at the nearest fire-plug, run it out, and attach the hose to the nozzle of the stand-pipe, which he immediately introduces into the fire-plug seat, and by a few turns of the apparatus, the water is let into the hose and at full play on the site of danger. There is, likewise, no reason why the arrangement for fire-cocks should not be the same as that required for washing and watering streets, but with less expensive hose, and this might obviously vary to suit locality, water-mains, &c.

Mr. Beardmore next proceeds to explain the two questions of *quality* and *height of supply*, and successfully shows that the delicious and spring-like quality of the water, as taken from the Mountain Plym at Meavy, might be delivered, with a head of 275 feet above high-water, in lieu of the present pressure of 135 feet, and placed in a reservoir, at this height, in such manner that the entire course from Knackersknowle to Plymouth, should be no longer used for the conveyance of the town supplies; thereby avoiding about five miles of circuitous and sidelong course through pasture fields, for three-fourths of the distance, where, with the utmost care, it will and must receive a vast quantity of drainage of an unpleasant character, if of no further detriment.

Mr. Beardmore proposes to take the leat into a culvert below Widey Mill, and carrying the water thence by a pipe across the Manadon Valley, would deliver it into a large distributing reservoir, at an excellent site on the elevated

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* [The best arrangement is a fire-cock that shall always be ready, either for watering the streets or in case of fire, without requiring a stand-pipe. The Editor has recently had a cock made for the Falmouth Waterworks, by Messrs. Lambert and Sons.—The arrangement consists of a 2-inch diaphragm patent cock made in iron, with a bayonet joint to receive the brass swivel of the hose-pipe, a cast-iron case and cover, and a flange elbow to attach to a 2-inch branch from the main. The whole cost is only 32*s.*—Ed. C.E. & A. Journal].

ground in front of Torr-house. This position is commanding and centrically situate, not only for Plymouth, but for *Devonport* and *Stonehouse.* The reservoir could be made at moderate expense to hold six days' supply for the entire population of the *three* towns, with an increase of 50 per cent. or say 150,000 people, supposing that the large quantity of 36 gallons per head per diem be required; it would be 275 feet above high-water, a height sufficient to give full fire-engine power, at the most elevated point in Plymouth or the neighbourhood, including the high quarter round Lipson-terrace, which is now quite above all water supply.

The available supply is proposed to be taken from a water-shed district, under the control of the Corporation of Plymouth, and contains about 5,000 acres. The minimum rain-fall taken at 42 inches per annum on 5,000 acres, is 762,300,000 cubic feet per annum, representing an average of 1,450 cubic feet per minute, flowing off the ground. To make this available for supplying Plymouth, we may assume that one-third would unavoidably run to waste, which would leave a stream of 966 cubic feet per minute. If so much as 200 feet was let down for the mills on the Plym,—below the Head Weir, there would be 766 cubic feet per minute, left for Plymouth.

Now the quantity of 36 gallons per head for 150,000 people will require only 600 cubic feet per minute, consequently there would still be an ample margin; but this is only to be secured as a regular supply, by forming *a Store Reservoir on the River Plym,—by walling or embanking up the narrow and picturesque gorge below Sheepstor-bridge;* this done, 40 to 50 acres of water may be gathered with a depth of 20 to 25 feet; the land is inexpensive, and the dam would be of a trifling cost.

The foregoing outline of my plan has been described in a somewhat retrograde form, so as to show the suggested improvements in the order that they might be executed, and of their necessity. If fully carried out, the purest water, in sufficient quantity, to supply 150,000 people with 36 gallons per head per diem, can be delivered into a settling and distributing reservoir 275 feet above high-water, affording 60 feet of head to the highest parts that can be built upon, and distant only two miles from the centres of the towns of Plymouth, Devonport, and Stonehouse.

The total expense, of course, cannot be precisely stated from the general plans only that have formed my study, nor is it my object to give precise estimates, because if thought worthy of notice, there is sufficient to show the line of policy that should direct to the results in view. On a general calculation the cost would be as follows:—

	£	s.	d.
For extending Services, Pipes, and Fire-plugs, &c. Hose-reels, and Stand-pipes in Plymouth, say	4,000	0	0
For abandoning mills, purchasing leases, &c. .... For Great Distributing Reservoir at Torr .... For Line of Main from Torr to Plymouth .. .. For Tanks and Pipes across Manadon Valley	15,000	0	0
Improving Leat Course	1,000	0	0
	£20,000	0	0
For Store Reservoir on the River Plym, at Sheepstor-bridge	8,000	0	0
Total	£28,000	0	0

The report next proceeds to make some observations on the advantages that will arise from a surplus of water to the washing of sewers, and how sewers might be formed in Plymouth; and it concludes by showing the economy that might arise by amalgamating the Plymouth works with those of Devonport and Stonehouse.

VULCANISED INDIA-RUBBER JOINTS FOR WATER AND GAS PIPES.

From the Report of Thomas Wicksteed, Esq., *Engineer to the East London Waterworks, &c.*

On the 29th of February last, Mr. Brockedon* called my attention to a new method of making the joints of socket-pipes for water and gas. He exhibited a spigot and socket-pipe made of glass of 2 inches bore, and upon the spigot stretched a ring of vulcanised india-rubber, the external diameter of the ring, when stretched, being greater than the internal diameter of the socket into which it was to be introduced. In stretching the ring upon the extreme end of the spigot, care was taken to avoid twisting it. He then, with very great ease, pushed the spigot, with the ring upon it, into the socket, and the operation of making the joint was completed. When the spigot was pushed into the socket, the ring rolled along the pipe until the end of the spigot came home, the ring remaining fixed about the middle of the depth of the socket. If the ring had been twisted it would not have rolled in regularly, and would not therefore have been equally compressed.

The facility with which the joint was made was very remarkable, the whole operation being completed in a minute, and in this respect the saving of time and labour, as compared with that required for lead or wood joints, is very considerable.

Mr. Brockedon wished me to try experiments upon this new joint, and make such investigations as I might consider necessary to satisfy myself of its value with a view to its general introduction. This I have done, and the result is very favourable.

The facts to be ascertained were, the durability of the material as compared with materials usually employed, its capability of resisting pressure, and the cost of making the joint, all equally important in a commercial point of view.

First. *As regards its durability.* I consider it a question that should be determined by chemists; and the report of Mr. Arthur Aikin, given at the end of this report, satisfied me of its superiority, in this respect, to lead or wood; and I believe practical experience, since the introduction of vulcanised india-rubber, fully corroborates these opinions. As, however, the question of durability cannot be practically determined in a few years, and as it is most important, in a commercial point of view, that the material used for joints should be very durable; so, the time since the introduction of this material being comparatively short, I felt it was necessary to have the opinions of those who were well qualified to give them upon the probable durability of the material, as compared with others now employed. One fact is well worthy of notice, as regards the action of the products of coal upon this material, especially as they appear to be the only liquids that affect it. Naphtha, it appears, will *dissolve* simple or unvulcanised caoutchouc, but only *swells* it when vulcanised; and thus the effect, which for some purposes would be injurious, for this purpose is advantageous, as the effect of it is to make the joint tighter.

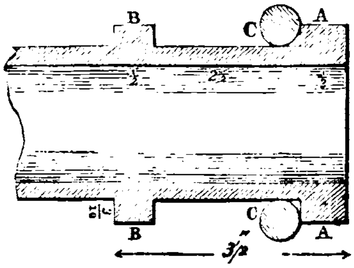
As a general principle, there can be no doubt that, *cæteris paribus*, the more elastic the material for a joint the better, as the friction of an elastic body pressing against the pipes is much greater than that of an inelastic body; and hence the resistance to pressure, or force exerted to displace it, must be much greater. In a joint made with lead, the resistance to the pressure is owing to the melted lead filling up any irregularities in the surfaces of the spigot and socket, thus forming a key, and also to the compression of the lead, effected in "setting up." Now, this effect does not extend above a quarter of an inch beyond the external face of the joint, and, therefore, it is most important that this operation should be carefully performed. Great force is employed in "setting up;" it is, therefore, necessary to have the thickness of the sockets greater than the rest of the pipe, to prevent its splitting during this operation. Again, in a wood joint, the operation of driving in the wooden wedge causes it to be compressed; thus the wedge which, before driving, is from ½ an inch to ⅝ths of an inch in thickness, is compressed to the thickness of ⅜ths of an inch when in its place, this compressed part being about 1 inch in depth of the socket. Now, in this operation, although the wedge may be driven in so tight that neither air nor water can pass through, and so far this cause of decay avoided, nevertheless, the fibres of the wood are injured by the operation of driving, and its elasticity consequently much impaired. In this case also it is necessary to have the sockets made strong to resist the force applied in driving in the wedges. With a body as elastic as the vulcanised india-rubber, however, such force is not necessary, the material cannot be forced or driven in with a hammer, it is merely rolled in; and the ring which, before compression, is round, when its place takes the form of a flat belt instead of a circular ring. Thus, supposing the thickness of a ring to be ⅜ths of an inch diameter before compression, when rolled into the socket, with a space of ¼ of an inch between the spigot and socket, it becomes a belt of $\frac{5}{32} \times \frac{13}{32}$; or the depth of the belt is more than double its thickness; and this elastic flat belt of rubber, which has naturally an excessive tendency to resist sliding, is constantly endeavouring to resume its circular form, and hence the great friction exerted on the sides of the pipes, while in this compressed state.

[Here follows an account of seventeen different experiments made by Mr. Wicksteed to test the efficiency of these joints.]

The time occupied in these trials has been above five months, and I am now enabled to speak very confidently of the value of the new joints.

It appears that, for a 4-inch joint, the space between the spigot and socket being ¼ of an inch all round, the vulcanised india-rubber ring should weigh 1¼ ounce, and for a 12-inch ring; the space between the spigot and socket being the same, viz., ¼ of an inch, the weight of the ring should be 5¼ ounces.

Section of spigot-end of pipe.



A, end fillet or belt. B, upper fillet. C, section of vulcanised india-rubber ring.

The spigot and socket ends of pipes to suit the vulcanised india-rubber rings should be formed as follows:—The depth of the socket for all pipes up to 12 inches, which is the largest I have experimented upon, should be 3½ inches; the thickness of the joint or space between the outside of the spigot and inside the socket, should be ¼ of an inch. There will be no oc-

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* Of the firm of Messrs. Mackintosh and Co.

casion for extra strenght in the sockets, as they are not exposed to any blows or to the force of the wedge in making the joint, as in lead and wood joints. The spigot should have a square head or belt $\frac{3}{16}$ths of an inch thick, and ½ an inch deep, cast on the end, then a clear space of 2½ inches, and then another belt of the same dimensions, as shown in the engraving.

This will allow a play of $\frac{1}{16}$th of an inch all round, and the upper belt will effectually prevent the joint blowing out; should there be any slight deficiency of thickness in the india-rubber ring, or should the ring be put on the spigot carelessly, so as not to roll regularly; this, however, can scarcely ever happen, as the fillet at the end of the spigot will be a guide to the workman, and very much facilitate the fixing of the ring properly.

I have calculated the weight and cost of 100 rings of various sizes, which will be the number required for 300 yards of pipes, as follows:—

Size. Inches.	Weight. lb.	oz.	Per lb.	£	s.	d.
3	7	0	At 5s.*	1	15	0
4	9	6	..	2	6	10½
5	12	5	..	3	1	6¾
6	15	4	..	3	16	3
7	18	3	..	4	10	11¼
8	22	2	..	5	5	7½
9	24	1	..	6	0	3¾
10	27	0	..	6	15	0
11	29	15	..	7	9	8¼
12	32	14	..	8	4	4½

To make a comparison between the cost of the india-rubber joints, and lead or wood joints, I have in the following statement included the material, the labour in making the joint, and the excavation, and filling in of the trench only, but including 10 per cent. profit:—

	At per yard run.						Vulcanised India-rubber.	
	Lead.		Wood.		India-rubber.		cheaper than Lead.	cheaper than Wood.
	s.	d.	s.	d.	s.	d.		
4 inch......		$6\frac{6}{10}$		$4\frac{6}{10}$		$3\frac{3}{10}$	100 per cent.†	42 per cent.
12 inch......	1	7		11		$9\frac{9}{10}$	91 „	11 „
3, 4, 5, 6, 7, 8, 9, 10, 11, 12, in. one yard of each	10	0	6	2	5	2	93 „	19 „

Taking one yard of each sized pipe, from three inches to 12 inches inclusive, and in addition to the above, adding the average cost of carting the pipes to the trench, removing surplus earth, repairing drains, lead pipes, &c., and all other charges and risks, and guarantee for twelve months, excepting the charges of the Commissioners of Roads or Streets for paving, &c., the cost will be as follows:—

Lead.	Wood.	India-rubber.	India rubber cheaper than lead.	India-rubber cheaper than wood.
23*s*. 10*d*.	20*s*. 6*d*.	19*s*. 6*d*.	22 per cent.	5 per cent.

The prices given may vary according to the locality and nature of the ground, but, I believe, will be found in every case very moderate for good and sound work. Where there is rock, or paved or Macadamised roads to be excavated for the trench, the saving in laying the joints with India-rubber rings will be very great, as the extra excavation required round the joint for lead, cement, or wood joints, to afford sufficient room for the joint-maker to work all round the joint, will not be required for the India-rubber joints; and hence the saving in excavating through rock, and excavating or taking up and renewing the paved and Macadamised roads, will be considerable.

When the wood joints are used (and they have been used very extensively in the East London district for the last sixteen or seventeen years, and found to answer remarkably well), it is necessary to expose the joints to the pressure of water they are intended to bear, before the ground is filled in, to be certain that the joints are tight; hence, unless in connection with mains already charged, they cannot be employed, for the expense of working a force pump to fill every length of pipe before it is covered, swallows up all the saving that, under other and more favourable circumstances, is effected; so that for new towns, or places where there are no charged mains already in existence, they cannot be used; and for gas pipes they are not at all applicable.

An objection was made many years ago to the wooden joints; that where the pipes had to be much curved, it would not be safe to make an unequal joint thick on one side and thin on the other, while with lead this might be safely done by a clever joint-maker. The same objection may be made to the proposed joint, on account of the belts preventing a greater play than $\frac{1}{16}$th of an inch in the socket,—the answer given in the first instance will do in the second, should it be made; viz., that the number of joints required to be so made, formed an inconsiderable per centage upon the whole number made, and, therefore, formed no sufficient objection to the *general* use of a cheaper joint.

As regards its applicability to gas pipes, I have some hesitation in giving a strong opinion; but as Mr. Aikin's Report proves that it is a durable material, and is not injuriously affected by the products of coal gas which collect in the pipes; and as it appears from my experiments that the joint can stand an enormous pressure, I think it may, probably, be found the *best* material that could be used for a gas joint. I believe it will be admitted, that with the materials ordinarily employed in joining gas pipes, it is difficult to fill the joint so thoroughly as to prevent the escape of gas, which the colour of the earth near the joints of gas pipes will prove: and although a lead or wood joint may be made capable of withstanding great pressure, and so as to prevent *water* leaking through, nevertheless *gas* will escape through. Reasoning upon the matter would, therefore, lead to the conclusion, that if a very elastic body is used, pressing with great force on all the surfaces of the iron in contact with it, so as to fill every space, there is much greater certainty of forming a tight joint than with a non-elastic substance, where the density of the material is all that prevents the escape of *gas;* it must be borne in mind that the India-rubber is impervious, and can never be liable to have fissures in it, or pores through it, which may be the case with lead, cement, or wood, if not perfectly made,—not so large as to allow a liquid to pass through, but sufficiently so as to allow gas to pass through.

As regards pipes made of earthenware or glass, or other brittle material, which would be broken, if it were attempted to make joints of lead or wood, to withstand a pressure of water, this material is very applicable, as no force is applied in making the joint that would in the slightest degree tend to split or break the socket of the pipe. This joint removes the only mechanical objection that I believe exists to the use of these materials; but the chances of breaking when laid, and the cost of the pipes when so joined (increased by the shortness of the lengths of the pipes requiring a greater number of joints), are questions to be considered by those who propose using such materials. It appears that none of the products of the sewers would injuriously affect the vulcanized India-rubber. The improvement in making the india-rubber rings since I received the first for trial is very great. The first *set* varied in thickness and weight very much; the last are as regular in thickness, as can be proved by the weights of several of the same size being as nearly as possible the same. This is most important, as a variation in weight, which is the same as a variation in thickness, would prevent the certainty of tightness of the joint. I have, nevertheless, in the weights given in the table, allowed an extra weight as a precaution.

In conclusion, I beg leave to say, that it appears that for strength, durability, resistance to pressure, and for the closeness of the joint preventing the escape of gases, this material is better suited than the ordinary materials in use; and, that the cost of the joint is less than the cost of those in ordinary use for iron pipes.

REPORT OF ARTHUR AIKIN, ESQ., F.L.S., ETC.

Will Rings of Vulcanized Caoutchouc, when used as Fastenings of Cast-Iron Pipes, retain their Elasticity, and what will be their probable Durability?

The resilient spring of vulcanized caoutchonc is far more complete than that of the caoutchouc not vulcanized. In other words, the former is far liable to *tire* than the latter. Caoutchouc is vulcanized by combination with a certain small proportion of sulphur. As long, therefore, as caoutchouc remains vulcanized, that is, as long as it retains its sulphur, it may be expected to retain those qualities by which it is characterised. But iron has a strong attraction for sulphur. Is it not, therefore, probable that vulcanized caoutchouc remaining long in contact with iron, may give up its sulphur to this latter, and thus be reduced to the state of common caoutchouc?

I see no satisfactory way of bringing this question to the test of experiment, as both cast-iron and common bar not unfrequently contain sulphur in various proportions. The rings of vulcanized caoutchouc that I have seen taken out of iron pipes return to their original form as soon as the nip or strong compression to which they were subject while in the pipes has been relieved; and they are stained externally by a little oxide of iron rubbed off from the inner surface of the pipe, in consequence of the strong friction and compression to which they are exposed in the act of inserting one pipe into the other. Beyond this merely superficial attrition, I do not think that any sensible action would take place between the ring and the iron, even for a very long time, at common temperatures.

If the pipes are intended for the conveyance of water, the exposure of the projecting edge of the ring to this liquid at common temperatures cannot possibly have any injurious effect; for I have boiled vulcanized as well as common caoutchouc for an hour in water at 300°, and the pieces, when they have become dry, have shown no diminution of their respective degrees of elasticity. If the pipes are to be employed in conveying coal gas, the original question becomes complicated with the consideration, how far the volatile products of the distillation of coal are capable of acting on vulcanized caoutchouc? The principal matters driven off from coal during its distillation are carburetted hydrogen and olefiant gas, sulphuretted hydrogen, ammonia, tar. I believe, that in a very short time the projecting edges of the vulcanized rings would be covered with a thin layer of tar, which would effectually prevent their contact with the other matters, even assuming these latter to have any action on vulcanized caoutchouc. Naptha, the product of the rectification of coal tar, is capable of dissolving caoutchouc; but the only effect which it has, even when boiling hot, on *vulcanized* caoutchouc, is to cause it to swell. If the crude tar should have any such effect (which I doubt), the consequence would be, that the projecting edge of the ring

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* The wholesale price of vulcanised india-rubber; for small quantities it is 6s. per lb.

† 100 per cent. cheaper is an erroneous expression; it would make the india-rubber cost nothing, for if 100 per cent. be taken from 100, there remains 0. It should be 50, 48, and 48 per cent. less than lead, and 29, 10, and 16 per cent. less than wood.

would swell, and thus render still more effectual a fastening which was sufficiently so before. The strongest liquid ammonia, as I know by experiment, has no solvent action whatever, even on common caoutchouc, by digesting in it for several months. Sulphuretted hydrogen has no sensible effect on common caoutchouc immersed in it for some days. If by long-continued action on vulcanized caoutchouc, any sulphur was taken up, no injury to the ring would result from this; for vulcanized caoutchouc may contain a great excess of sulphur, without at all impairing its elasticity and other valuable properties.

With regard to the durability of vulcanized caoutchouc compared with that of wood or lead, which, I believe, are the only substances at present used in joining iron pipes, the following circumstances must be taken into consideration.

The compression and violence which wood undergoes in the act of being driven in, will more or less damage its texture, and weaken the lateral cohesion of its fibres. Caoutchouc being without visible pores, and being of a perfectly uniform consistence, and possessed of great elasticity, will not only exclude air and moisture from the space which it occupies, but is scarcely susceptible of mechanical injury, even from the strongest compression.

Lead is no more porous than caoutchouc, but being almost totally inelastic, will, on this account, be a less effectual preventive of leakage. Some galvanic action will probably take place between the lead and iron tending to oxidise this latter; and, when galvanic action has ceased, from the interposition of a layer of oxide of iron between the two metallic surfaces, the lead itself will become oxidised superficially, from the combined effect of air and moisture.

I do not, therefore, see any reason to doubt that rings of vulcanised caoutchouc, when used as a fastening of iron pipes employed in the conveyance of water or coal gas, would be, at least, as durable as the best of the methods now practised, and probably more secure from leakage.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

SOCIETY OF ARTS, LONDON.

Nov. 29, 1848.—J. K. Brunel, Esq., in the Chair.

"*On Hydraulic Pressure Engines, and on the employment of High Falls of Water, acting by their Weight or Pressure upon a Piston working in a Cylinder, to produce a Reciprocating or Alternating Motion.*" By Joseph Glynn, Esq., F.R.S.

"It appears," observed Mr. Glynn, "that in the year 1769, this subject had been brought before the Society of Arts by Mr. Smeaton, the celebrated engineer, whose construction of the Eddystone lighthouse has since served as a guide in similar works.

Owing to the great improvement subsequently made in the steam-engine, by Watt, water-engines of all kinds were thrown into abeyance, and the water-pressure engine remained unemployed in England until its use was revived by Trevithick, who was distinguished by the invention of locomotive engines to be used on railways, or rather upon the tramways of his time. Trevithick erected several water-pressure engines, and in 1804 he made one for a lead mine in Derbyshire, which is still working well in the Alport Mines near Bakewell. In 1841, the proprietors of the mines, by the advice of Mr. John Taylor, resolved to erect a very powerful engine of this kind, to clear the mines from water; this was made by the Butterley company, under the direction of Mr. Glynn, and set to work early in the following year. It is one of the most powerful and efficient engines of this kind hitherto made; the work it performs is equal to 168-horse power, and its useful effect is equal to 70 per cent. of the theoretic power of the water fall. The column of water in this instance is 132 feet high, the stroke of the piston is 10 feet, and the diameter of the cylinder 50 inches; consequently, the pressure on the piston is equal to a weight of 50 tons. This engine is capable of making 7 strokes per minute, without any concussion in the descending column. An excellent model of this engine, now in the Museum of Economic Geology, was made by Mr. Jordan, whose admirable invention of machinery for carving in wood has since established his reputation for mechanical skill.—The water-pressure engine, although neglected in England, has been extensively used in Germany, and drawings of some of the best German engines were exhibited, to illustrate the paper.

A lengthened discussion followed the reading of the paper, in which Mr. Jordan suggested a means of overcoming the concussion, hitherto so objectionable in the working of all engines of this class.—Mr. Glynn also stated the situations in which he considered hydraulic engines could be advantageously employed, and in which it would be impossible to make use of any class of water wheel. He also described an ingenious application of hydraulic power, in the case of a crane used on the Quay at Liverpool.

The thanks of the meeting were presented to Mr. Glynn for his communication.

Messrs. Staite and Petrie were present at this meeting, and exhibited their *Electric Light*, and showed the prismatic ray, and the ray concentrated by means of a lens.—A lengthened discussion ensued, as to the peculiar form of the shadow from the flame of a candle, and the band of light which surrounded it.

The thanks of the meeting were presented to Messrs. Staite and Petrie, who promised on an early evening to submit a paper on the two leading features of the invention—namely, rendering the light permanent by means of a self-regulating magnetic apparatus, also rendering the system economical by allowing only so much of the current to pass through the electroes as is developed in light; and also to make a statement as to the cost of producing and maintaining the light.

Mr. C. Ruding submitted a paper on Mr. J. B. Piatti's "*Compressed-Air Atmospheric Railway,*" and a model of the tube, valve, and piston were exhibited.

Dec. 6, 1848.—J. L. Ricardo, Esq., M.P., in the Chair.

Mr. T. B. Jordan read a paper "*On improvements in Carving machinery.*" The three great improvements which Mr. Jordan has effected in his carving machine are as follows:—Firstly, in the construction of what he terms a Vertical Machine. The peculiarity of this arrangement is that it enables him to carve blocks of stone of any required size, for architectural or decorative purposes, without having to move the weight of the block, as would be the case if it was placed on the horizontal bed of his first machine. The cutting drills are, by the vertical machine, brought in contact at right angles to the face of the stone, the stone itself being placed on a chuck or centre, upon which it is made to revolve, so as to afford the necessary facility for bringing every portion of the surface into contact with the drill.—Secondly, in applying mathematical instruments on the floating tables to the production of working mouldings from drawings, without the use of models. This he does by having the cutting edges of the drills made in the form of one-half of the section of the moulding to be produced.—Thirdly, in affording the means of producing a reverse copy of any required pattern, so that the two curves on a chair-back, or other piece of furniture, can be cut out from a single mould at one and the same time. This he effects by dividing the upper floating table into two parts, and fixing a centre under the machine and between the two floating tables; on this centre is a fixed lever, which is connected at each end, by means of iron rods, to the floating tables, so that whatever motion is given to the right-hand table, is exactly copied, in a reverse direction, by the left-hand table. This is the case only so long as the radii of the two arms of the fixed lever are exactly alike; but by altering the length of either arm, a fourth improvement is effected, as the inventor is enabled to compress a pattern so as to produce a narrow panel from an original of much greater breadth.

A model of the Horizontal machine, and diagrams of the Vertical machine, with specimens of work cut by each, were exhibited.

Dec. 13, 1848.—T. Webster, Esq., F.R.S., in the Chair.

"*On the Present State of Electricity, as applied to Telegraphs.*" By Mr. N. J. Holmes.

Mr. Holmes, in bringing the subject forward, stated that it was his intention on this occasion to consider only the principles of the best known forms of existing telegraphs, and not to enter into the various modifications into which the subject had extended, as many of the recent adaptations were merely simple evasions of original patents, without any claim to merit for the advancement of science. Having given a succinct, but comprehensive, history of the state of electricity, with respect to the application, *sub judice*, from 1746 to 1800, when Volta discovered that the current obtained from his pile had the property of overcoming the difficulties presented by the use of free electricity, he dated the progressive advancement of the science from Œrsted's grand discovery, in 1819, of the rotatory influence exercised by an electric current upon a magnetic needle, immediately followed by that of Arago, in the formation of the electro magnet. The introduction of the telegraph into this country did not take place until the year 1837, at which period the subject was occupying the attention of the scientific, and many were endeavouring to carry out practically the idea, but without success; and it was not until Professor Wheatstone's researches into the more theoretical portion of the science, that the requisite perfection was obtained. The existing telegraphs were classified into two great divisions—namely, those of a mechanical nature, in which the intervention of clockwork, set in motion through the agency of electricity, was used to produce the necessary indication; and others embracing a more theoretical construction, depending upon the direct action of the current, either by induction upon a magnetic bar, producing deflection, or by the decomposition of certain chemical solutions, placed so as to form a part of the metallic circuit. With respect to telegraphs generally, it was stated that their adoption could not be advocated for either railway or commercial purposes, where great attention could not be bestowed on their working in detail—the imperfections arising from their mechanical liabilities destroying their utility. The only railway in this country, out of the 2,000 miles of telegraph laid down, upon which they had been adopted, was the South Devon, and there they were used to give the signals for starting the fixed engines in connection with the atmospheric system. Previously to the abandonment of that principle, such was the perfection to which Mr. Holmes (under whose superintendence they were erected) had arrived, that as many as 2,000 signals were sometimes given through the series without the commission of a single error.

After adverting to the numerous varieties of printing telegraphs and alarums, Mr. Holmes exhibited his new signal, as a substitute for the old clockwork bell, producing the sound by means of an air-whistle. Mr. Holmes then proceeded to the second division, pointing out the various errors in the old forms of needle instruments, as well as the several improvements which had been effected—first, by the introducion of his diamond instrument, now working over all the commercial stations in England, and producing an enormous decrease in the battery power; and, secondly, by his new form of helix, which further reduced the helical resistance in the instrument, which was a point of considerable importance.

In speaking of the chemical telegraph, recently improved by Mr. Bain, by which communication had been effected between Liverpool, London, and Manchester, he observed, that owing to the imperfections in the instrument used, the powers of that improvement were not fully developed—great resistance and want of rapid reciprocity, in cases of error, still existing. With respect to insulation, he (Mr. Holmes) stated, that the application of electricity to telegraphs was still very imperfect. The uncovered wires, extending over the lines in the country, were necessarily exposed to the injurious influences of the atmosphere, arising from rains, fogs, deposition of saline matter in the neighbourhood of the sea-coast, as well as the action of decomposed vegetable matter. This existed to an extent that frequently interrupted the communication, and rendered it necessary to clean the insulators with soap and water. The street work in the metropolis was also open to serious objection, being founded upon a fundamental error—namely, that of enclosing one conductor in another improperly protected. To remedy the defects, he (Mr. Holmes) exhibited a plan by which it was purposed to improve the insulation—the wires being enclosed in a non-conducting substance from end to end, and illustrated the practical operation of his theory by some very beautiful specimens of the improvements it would effect. Mr. Holmes concluded, by briefly noticing the derangement the telegraph was liable to receive from lightning and the influence of magnetic storms; and the methods hitherto adopted were demonstrated to be quite inadequate to counteract the effects of these phenomena.

ROYAL SCOTTISH SOCIETY OF ARTS.

Nov. 13, 1848: Annual General Meeting.—George Buchanan, Esq., C.E., F.R.S.E., President, in the Chair.

The President, before proceeding with the business of the evening, begged to congratulate the Society on their re-assembling for the commencement of a new session, and on the prospect which their past experience afforded that this session would not prove behind any of the others in the importance of the subjects to be laid before them, and the discussions to which they might lead. During the last session, various interesting communications had been received, and ingenious inventions, as the Prize List now circulated among the members would show, and which, he trusted, would be satisfactory to the inventors, and an encouragement to perseverance in the field of improvement. From what he had seen of the proceedings of this Society, the truly useful and practical nature of the subjects brought before it, the free discussions with which they were canvassed at the meetings, and their merits, farther investigated and sifted in the committees, and rewarded, according to their ability, with a liberal but impartial hand; and the opportunity afforded by the meetings of friendly intercourse among men of all professions and parties, he was satisfied that this Society was eminently calculated for promoting the great object of the "Improvement of the Useful Arts;" and he had no doubt it would continue to flourish and maintain its high character among the important institutions of this country.

Notwithstanding the unexampled depression in the general business of the country, and in every branch of industry and the arts, twenty-two new members had been admitted during the session. Losses, however, he lamented to say, they had met with by death, of valuable and distinguished members, of whom might be noticed—

The Duke of Argyll, the Marquis of Bute, and the Earl of Moray, noblemen whose station and character, and their great attention to agricultural and other improvements in the useful arts, were of essential service in promoting the interests and upholding the character of the Society;

Sir George Mackenzie and Sir Thomas Dick Lauder, two most eminent members, whose character and talents, and their great interests in, and attention to, the matters of the Society, and whose valuable services, as well when they presided over it as at other times, were too well known to require any eulogy here;

Sir Charles G. Stuart Menteith, of Closeburn, well known by his great attention to the arts, and by various interesting communications to the Society.

Of the professional members, he could not avoid noticing the late eminent Mr. Nixon, architect in this city for the Woods and Forests Commissioners, and whose talents and high character, during the period he had been in Scotland, had gained the esteem of all who had the pleasure of knowing him. The Queen's Drive alone, which was entirely designed and executed by him, will remain a monument of his taste and skill. The Society has also lost Mr. Brookes, a young and promising engineer, cut off suddenly. Lastly, among the associate members was the name of the celebrated Mr. Thom, of Ascog, near Rothesay, whose magnificent improvements in hydraulic architecture, exemplified in the Shaws and other waterworks, and his ingenious inventions of self-acting sluices, and plans for conducting and rendering available the waters of different districts, have raised him among the distinguished engineers of the day.

A paper on Cast and Wrought Iron Bridges, by Mr. Buchanan, the President, was read, which is given in another part of the *Journal*, p. 13, and also in vol. xi., p. 125 and 153.

Report of the Committee appointed to award Prizes for Communications during Session 1847-8.

The committee awarded the following Prizes:—

1. To George Buchanan, Esq., for his "Description of a Marine Hydrometer, for ascertaining on the spot the comparative Saltness or Freshness of Sea and River water." (See *Journal*, vol. xi., p. 91.)—The Honorary Silver Medal.

2. To Andrew Fyfe, M.D., for his communication "On the Value of Gases from different Coals, and the price of Light in different places; also a new mode of estimating the Consumpt of Gases, &c., and of estimating Illuminating Power." (See *Journal*, vol. xi., p. 184.)—The Honorary Silver Medal.

3. To J. Stewart Hepburn, Esq., of Colquhalzie, for his "Description and Drawing of an Improved Railway Break." (See *Journal*, vol. xi., p. 32.)—The Honorary Silver Medal.

4. To Thomas Stevenson, Esq., C.E., for his "Description, Drawing, and Model of a Portable Cofferdam, successfully used by him in Marine Works." (See *Journal*, vol. xi., p. 62, and 231.)—The Honorary Silver Medal.

Note.—Though unknown to Mr. Stevenson, the committee find that a portable cofferdam, with double walings, had been previously used in engineering works by the late Mr. Smith, of Montrose, which was put together on dry ground, and then floated to its place. But the committee consider that Mr. Stevenson's cofferdam differs from it, and possesses certain advantages, from its greater portability, and more ready adaptation to an irregular bottom.

Silver Medals were awarded—

5. To Mr. John M'Dowall, for his "Description and Working Model of a New Machine or Screw Pump for Lifting Water."

6. To Mr. Robert Montgomery, for "a Self-acting Safety-Break for Railway Carriages."

7. To Mr. William Kemp, Manager of the Gasworks at Galashiels, for his communication "On Economising Fuel in Gasworks." (See *Journal*, vol. xi., p. 155.)

8. To Mr. Frederick Schenck, for his communication, "On the Progress and Position of Lithography in Scotland, and, in particular, his method of preserving Correct Register in Colour Printing."

9. To Mr. Daniel Erskine, for his "Description of a New Ball-Cock and Nose-Cock, for Cisterns and other purposes." (See *Journal*, vol. xi., p. 185.)

10. To Mr. James Robb, for his "Description and Model of a Stop-Cock for Corrosive Fluids." (See *Journal*, vol. xi., p. 185.)

11. To Mr. John Kolbe Milne, for his "Description and Model of an Overarch Suspension Bridge."—It being understood that it is recommended in its present form not for Railway Bridges, but for Foot Bridges and others of comparatively small span. (See *Journal*, vol. xi., p. 32.)

A variety of other prizes were also awarded.

Nov. 27.—John Cay, Esq., F.R.S.E., President, in the Chair.

The following communications were read;—

1. "*Description, with two Drawings, of an Hydraulic Dock, especially adapted for places where there is little or no rise and fall of the Tide.*" By Mr. James Scott.

This dock is built of boiler-plate iron, with a cavity in the bottom and round the sides, capable of being filled with water, which sinks the dock, and the ship is floated into it; the water is then pumped out, when the dock rises, bearing the ship with it, and that part underneath the ship being left perfectly dry, the ship-carpenter can have access to every part of the ship's bottom for all necessary repairs, without having recourse to the dangerous process of "heaving down." The inventor states that a ship is much less liable to be strained in such a floating dock, than by being hauled up a long and irregular inclined plane, as the present slips are found in practice to be when laid down in places where there is little or no rise and fall of tide, and where there is frequently an irregular coral bottom.

2. "*Description of an Electric Clock, on an improved principle.*" By Mr. J. Blackie.—This clock was stated to be an improvement upon Mr. Bain's electric clock, both in the mode of adjusting the permanent magnets, and in the mode of breaking and re-establishing the circuit; the break being less liable to oxidise. It was also stated that the electric current acted to greater advantage on the coil of the pendulum. Mr. Blackie also claimed as new the simple train of the movement, which consists of very few wheels; and he also claimed a delicate method of adjusting the length of the pendulum.

3. "*Description of an improved Balance or Equilibrium Valve for Locomotives, &c.*"—The object of this valve is to extinguish the friction usually attendant on the use of the common slide-valve in locomotive engines, and which is the result of the pressure of the steam acting upon the back or

exterior surface of these valves. By the proposed construction, the steam is brought to the ports by a method that places the valve in an equilibrium of pressure, on the principle of action and reaction being equal and in opposite directions. The usual friction of the slide is expected to be thereby almost entirely removed.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

Dec. 4.—T. Bellamy, V.P., in the Chair.

A paper "*On the Infinity of Geometric Design as regards Tracery,*" was read by Mr. R. H. Billings.

The object of this paper was to show that design, as regards Gothic tracery, is a field as yet almost untouched; from diagrams of the most simple character, and composed of purely geometric curves, an infinity of beautiful tracery may be produced. By varying the diagrams which serve as the foundation of the tracery to be produced, an endless variety of designs may be obtained. This Mr. Billings illustrated by means of one of the most simple forms of diagram; consisting of a circle, within which were four others touching the circumference, and whose diameters were one-third that of the larger one. Numerous drawings of the designs produced from this simple form were exhibited; as well as engravings of upwards of one hundred others, all obtained from the same skeleton form, —and which are a portion of a work by which Mr. Billings is about to make known to the profession at large the results of his studies on this subject.

Dec. 18.—Amongst the donations announced was a MS. volume from a Dutch architect, containing notices of 100 Dutch architects, from the middle ages to the present time.—A discussion took place on the merits and defects of sea sand in the formation of mortar. Mr. Burn expressed an opinion that an analysis then on the table bore out his own feeling, that *blown* sea sand was not the cause of damp in houses.—Mr. W. W. Pocock stated that in two houses in the Isle of Wight near the sea, built simultaneously on sea sand, covering a stone foundation, saline to taste, one finished with pit sand was perfectly dry, while that in which the ceilings were worked out with sand from the sea-shore gave water out to the extent of dropping. He added that a chemist supplied a powerful wash, boiling hot, which removed the evil.—Dr. Dickinson mentioned that sulphuric acid in an earthen vase placed in a damp room would soon absorb the vapour.—Mr. C. H. Smith suggested alum might have been employed. Mr. Donaldson observed that sea sand could only be used when well washed by the rain.

A communication was read from Messrs. J. and T. Smith, of Darnick, on the use of Whinstone rubble in construction of bridges, with details of one lately built over the Tweed at Ashiestiel, price 1,200*l.*, 131 ft. 6 in. span, 16 feet wide in the middle.

Messrs. Fox and Barrett's patent floor was explained (see *Journal*, vol. xi., p. 359), and a plan of Northwoods was exhibited.

At the meeting held Nov. 20th last, the following Royal Medals, together with the Premiums in Books, awarded during the last Session, were presented by the President, as follows:—

The Royal Gold Medal of the Institute, to CHARLES ROBERT COCKERELL, Esq., R.A., Professor of Architecture in the Royal Academy of Arts, London, Member of the Institute of France, &c.; in testimony of his distinguished merits as an Architect.

The Soane Medallion, to Mr. JAMES MACLAREN, of Edinburgh; for a Design for a Building to contain Public Baths.

The Silver Medal of the Institute, to Mr. HENRY BAYLY GARLING, Associate; for the best Essay on the application of Sculpture and Sculptured Ornament to Architecture.

A Copy of Sir W. Chambers' Treatise on the Decorative Part of Civil Architecture, to Mr THOS. HILL, Student; for a Design for a Garden Pavilion, &c.

A Copy of Gwilt's Encyclopædia of Architecture, to Mr. BRIGHT SMITH, Student; for the best Series of Sketches from Subjects given monthly by the Council during the Session.

ROYAL SOCIETY.

Dec. 7, 1848.—The Earl of ROSSE, President, in the Chair.

Dr. Faraday delivered the Bakerian lecture, "*On the Crystalline Polarity of Bismuth and other bodies, and on its Relation to the Magnetic Form of Force.*"

The author states that in preparing small cylinders of bismuth by casting them in glass tubes, he had often been embarrassed by the anomalous magnetic results which they gave, and that having determined to investigate the matter closely, it ended in a reference of the effects to the crystalline condition of the bismuth, which may be thus briefly stated. If bismuth be crystalized in the ordinary way, and then crystal, or a group of symmetric crystals, be selected and suspended in the magnetic field between horizontal poles, it immediately either points in a given direction or vibrates about that position, as a small magnetic needle would do, and if disturbed from this position it returns to it. On resuspending the crystal so that the horizontal line which is transverse to the magnetic axis shall become the vertical line, the crystal then points with its maximum degree of force. If it be again resuspended so that the line parallel to the magnetic axis be rendered vertical, the crystal loses all directive force. This line of direction therefore, which tends to place itself parallel to the magnetic axis, the author calls the *magne-crystallic axis* of the crystal. It is perpendicular, or nearly so, to the brightest and most perfect of the four cleavage planes of the crystal. It is the same for all crystals of bismuth. Whether this magne-crystallic axis is parallel or transverse to the magnetic axis, the bismuth is in both cases repelled from a single or the stronger pole; its diamagnetic relations being in no way affected. If the crystal be broken up, or if it be fused and resolidified, and the metal then subjected to the action of the magnet, the diamagnetic phenomena remain, but the magne-crystallic results disappear, because of the confused and opposing crystalline condition of the various parts. If an ingot of bismuth be broken up and fragmentary plates selected which are crystallised uniformly throughout, these also point; the magne-crystallic axis being, as before, perpendicular to the chief plane of cleavage, and the external form, in this respect, of no consequence. The effect takes place when the crystal is surrounded by masses of bismuth, or when it is immersed in water or solution of sulphate of iron, and with as much force apparently as if nothing intervened. The position of the crystal in the magnetic field is affected by the approximation of extra magnets or of soft iron; but the author does not believe that this results from any attractive or repulsive force exerted on the bismuth, but only from the disturbance of the lines of force or resultants of magnetic action, by which they acquire as it were new forms; and, as the law of action which he gives is, that *the line or axis of magne-crystallic force tends to place itself parallel, or as a tangent, to the magnetic curve or line of magnetic force, passing through the place where the crystal is situated,* so the crystal changes its position with any change of direction in these lines. After noticing the magne-crystallic condition of various bodies, the author enters upon a consideration *of the nature of the magne-crystallic force.* In the first place he examines closely whether a crystal of bismuth has exactly the same amount of repulsion, diamagnetic or otherwise, when presenting its magne-crystallic axis *parallel* or *transverse* to the lines of magnetic force acting on it. For this purpose the crystal was suspended either from a torsion balance, or as a pendulum thirty feet in length, but whatever the position of the magne-crystallic axis, the amount of repulsion was the same. In other experiments, a vertical axis was constructed of cocoon silk, and the body to be examined was attached at right angles to it as radius; a prismatic crystal of sulphate of iron, for instance, whose length was four times its breadth, was fixed on the axis with its length as radius and its magne-crystallic axis horizontal, and therefore as tangent; then, when this crystal was at rest under the torsion force of the axis, an electro-magnetic pole with a conical termination was so placed that the axial line of magnetic force should be, when exerted, oblique to both the length and the magne-crystallic axis of the crystal; and the consequence was, that, when the electric current circulated round the magnet, the crystal actually *receded* from the magnet under the influence of the force, which tended to place the magne-crystallic axis and the magnetic axis parallel. Employing a crystal or plate of bismuth, that body could be made to *approach* the magnetic pole under the influence of the magne-crystallic force; and this force is so strong as to counteract either the tendency of the magnetic body to approach or of the diamagnetic body to retreat, when it is exerted in the contrary direction. Hence the author concludes that it is neither attraction nor repulsion which causes the set or determines the final position of a magne-crystallic body. He next considers it as a force dependent upon the crystalline condition of the body, and therefore associated with the original molecular forces of the matter. He shows experimentally, that, as the magnet can move a crystal, so also a crystal can move a magnet. Also that heat takes away this power just before the crystal fuses, and that cooling restores it in its original direction. He next considers whether the effects are due to a force altogether original and inherent in the crystal, or whether that which appears in it is not partly induced by the magnetic and electric forces; and he concludes, that the force manifested in the magnetic field, which appears by external actions and causes the motion of the mass, is chiefly, and almost entirely *induced* in a manner subject indeed to the crystalline force and additive to it; but at the same time exalting the force and the effects to a degree which they could not have approached without the induction. To this part of the force he applies the word *magneto crystallic*, in contradistinction to magne-crystallic, which is employed to express the condition, quality, or power which belongs essentially to the crystal. The author then remarks upon the extraordinary character of the power, which he cannot refer to polarity, and gives expression to certain considerations and views which will be best learned from the paper itself. After this, he resumes the consideration of Plucker's results "*upon the repulsion of the optic axes of crystals*" already referred to, and arrives at the conclusion that his results and those now described have one common origin and cause. He then considers Plucker's results in relation to those which he formerly obtained with heavy optical glass and many other bodies. In conclusion he remarks, "how rapidly the knowledge of molecular forces grows upon us, and how strikingly every investigation tends to develope more and more their importance and their extreme attraction as an object of study. A few years ago magnetism was to us an occult power affecting only a few bodies; now it is found to influence all bodies, and to possess the most intimate relations with electricity, heat, chemical action, light, crystallisation, and, through it, with the forces concerned in cohesion; and we may, in the present state of things, well feel urged to continue in our labours, encouraged by the hope of bringing it into a bond of union with gravity itself."

EXPERIMENTS AT THE ROYAL ARSENAL.

Woolwich, Dec. 14.—A series of experiments have been lately carried on in the Royal Arsenal, to ascertain the practicability of Captain Chads' suggestion of employing two shots at one firing in actual service, and how far danger was to be apprehended to those employed in working the guns when double-shotted. Captain Chads made several experiments on his principle on board the *Excellent* gunnery-ship at Portsmouth, which were most satisfactory to him, and on submitting the plan to the authorities, the matter was referred to the members of the Select Committee at Woolwich, who gave instructions that an 8-inch gun of 65 cwt., 9 feet long, should be selected from a quantity recently received from the Low Moor Company in Yorkshire. The gun selected had been previously tested in the usual way by firing two rounds with one solid shot and 20 lb. of powder each time, and the experiments were commenced by firing two 56-pounder hollow shot, with 5 lb. of powder each charge, and continued with the double shot and the same quantity of powder up to the 60th round. From the 61st to the 70th round 6 lb. of powder were used in each charge; from the 71st to the 80th round, 7 lb.; from the 81st to the 90th round, 8 lb.; from the 91st to the 100th round, 9 lb.; from the 101st to the 110th round, 10 lb.; from the 111th to the 120th round, 11 lb.; from the 121st to the 130th round, 12 lb.; from the 131st to the 140th round, 13 lb.; from the 141st to the 150th round, 14 lb.; from 151st to the 160th round, 15 lb.; from the 161st to the 170th round, 16 lb.; from the 171st to the 180th round, 17 lb.; from the 181st to the 190th round, 18 lb.; from the 191st to the 200th round, 19 lb.; from the 201st to the 210th round, 20 lb.; and from the 211th to the 220th round, 21 lb. The last 10 rounds, with the heavy charge of 21 lb. of powder, and the gun double-shotted each time, were fired yesterday; and on examining the gun after the experiment, it did not appear to have sustained any perceptible injury, notwithstanding the severe test it had undergone. The gun is only of cast metal, but this trial has shown the superiority of the castings of the Low Moor Company, and the small risk to the gunners employed in firing the guns under a test which it was never contemplated they would be subjected to. It is intended to carry on the experiment until the gun is burst, and to add an additional pound weight of powder to each charge of every 10 rounds. The firing has already disabled one carriage, and a carpenter attends the experiments in case of injury to the platform by the recoil. The ultimate result is now looked forward to with great anxiety, the test the gun has already experienced having far exceeded the anticipations of the officers who have witnessed the experiments.

Dec. 20.—The experiments were renewed in the Woolwich Marshes, in the presence of Colonel Dundas, C.B., Inspector of Artillery, and Lt.-Col. Chalmers, Assistant Director-General of Artillery. A new description of 32-pounder shell was submitted by Capt. Thistle, of the American army, who was also present. This shell is formed very similar in shape to a sugar-loaf, only rather more tapering at the point, into which a nipple is inserted, and grooves are made along the cone nearly its entire length, in a slightly curved form, which caused the shell apparently, when fired, to go forward in a straight direction like an arrow, instead of revolving in the same manner as the common circular shells.

Experiments with Capt. Thistle's Shell, weight 32 lb., *and* 4 lb. *charge of Powder.*

No. of Rounds.	Dimensions of Gun.	Charge of Powder.	Shot or Shell.	Range, in Yards.
1	32-pounder	4 lb.	T. Shell*	550
2	8-in. gun	4 lb.	8-in Shell, 56 lb.	850
3	32-pounder	4 lb.	T. Shell	950
4	8-in. gun	4 lb.	8-in Shell, 56 lb.	875
5	32-pounder	4 lb.	T. Shell	550
6	8-in. gun	4 lb.	8-in Shell, 56 lb.	875
7	32-pounder	4 lb.	T. Shell	550
8	8-in. gun	4 lb.	8-in Shell, 56 lb.	850
9	32-pounder	4 lb.	32-lb. Shot	1000
10	32 pounder	4 lb.	32-lb. Shot	1000

* Capt. Thistle's 32-lb. Shell.

All the rounds of both guns were fired at an elevation of 3½ degrees, and showed that the service of the guns and the shells used in the British service could be depended upon when Capt. Thistle's shells only in one instance made a range of 950 yards, and the three others only 550 yards, with the same advantages in every respect.

NOTES OF THE MONTH.

Royal Academy.—Silver Medals were awarded to Mr. J. Bidlake and Mr. C. A. Gould, on the 9th ult., for drawings of the Whitehall front of the Banqueting House.—The Professor of Architecture, Mr. Cockerell, will, we understand, commence his course of lectures to the students of the Academy on Thursday, the 4th inst.,—and continue them during the five succeeding Thursdays.

Gas Meter for the Houses of Parliament.—A gas meter, of very large dimensions, has been constructed for registering the gas at the New Houses of Parliament, at Messrs. Glover's iron-foundry, Drury-lane. It is constructed and cast under the superintendence of Mr. Defries, of 67, St. Martin's-lane, the inventor and patentee. This machine, which is to be placed in the New Palace at Westminster, is an almost stupendous piece of mechanism, being upwards of 10 feet in height and 20 feet in circumference or girth; it is in form a hexagon, the designs are in the Gothic manner, and in exact keeping with the interior of the New Houses of Parliament, so that it is an ornamental as well as a useful addition to them, and ought to be placed so as to be seen by the public. The machine weighs four tons, and is of capacity to pass 10,000 feet of gas per hour, and of supplying 2,000 lights with, according to calculation, the loss of only half a tenth of pressure; at which pressure it will work with the greatest ease. The principle and the action of the machine are very simple, and yet very accurate. There are two chambers, the lower containing three partitions, called diaphragms; as the gas, in its passage through the valve, acts upon these diaphragms, they move the machinery in the upper chamber, and by these means the quantity of gas consumed is registered. The index consists of six small dials almost similar to those of watches; on these the consumption can be calculated with very minute accuracy. The iron has been bronzed, and has a fine surface, the castings being remarkably sharp and clean. The name of the patentee and the title of the Chartered Gas Company and the Royal arms are introduced. This meter far exceeds in dimensions anything of the sort ever before attempted.

The Tyne River.—The conservators of the River Tyne have for some years been engaged in deepening the river and removing obstructions to the shipping. One of the most formidable bars, which has long defied their exertions, was Cockran Sand, about five miles below Newcastle. The removal of this sand exposed a stupendous oak tree; which, on the 4th ult, after being skilfully and securely chained to a vessel at low water, was at high tide weighed and carried to Newcastle, where, by means of a powerful crane, it was raised and laid on the quay. It measured 16 ft. 6 in. in circumference by 18 ft. long, and it is conjectured that it must weigh at least 15 tons. A tree of such dimensions (and this may be considered but a moiety of the length of the stem) must lead us back to a very early period. Certain it is, that from the appearance of decay it must have been many centuries in its late position. Before it bowed its leafy head it must have been at least of from 400 to 500 years' growth. The surface of the side on which it lay is covered with a metallic coating of iron pyrites, which, with another scaly covering of pyrites, forms a kind of gallery, in some parts ¾in. to 1½in, apart, having in many parts the intermediate space filled up with beautiful crystals of pyrites of minute size like needles. It appears clear that the tree must have fallen or remained in the position in which it was found; as below it and imbedded with it were quantities of small pieces of branch wood and hazel nuts, most of which were perforated at the top, and empty. The wood or bark below the pyrites appears to the extent of ¾in. completely charred; and for 3in. or 4in. further the wood, although it has not changed its colour (the laminæ being distinct), is yet quite decayed. After this part is removed the rest is quite sound.—*Newcastle Guardian.*

Discovery of an Ancient City in Asia Minor.—The *Constantinople Journal* gives some curious details regarding a city said to have been discovered in Asia Minor by Dr. Brunner,—one of the agents employed by the government of the Sublime Porte in penetrating into the most remote and inaccessible regions of the empire for the purpose of taking a census. While occupied in exploring the extensive excavations of Bosouk, on the confines of Pontus, Cappadocia, and Galatia, Dr. Brunner, whose attention was attracted by the bold and curious passages opened into the living rock, was accosted by a villager who offered to show him things far more interesting on the other side of the mountain if he would trust to his guidance. After some hesitation, the Doctor armed himself and followed his guide, taking his servant with him. Half-an-hour brought them round the mountain; and then the Doctor found himself, says the narrative, in presence of the ruins of a considerable town. These ruins are situated to the south-east of the village of Yunkeuï and to the north of the village of Tschépué, distant half-a-league from one another; and the Doctor's profound study of all the accounts, ancient and modern, of Asia Minor furnish no trace by which he can identify them. The site of the town is half a league in length. It contains seven temples with cupolas and two hundred and eighteen houses; some in good preservation, others half choked up with their own ruins and with vast fragments of rock detached from the overhanging mountain. The houses have compartments of three, four, and six chambers,—and the temples are also flanked with chambers. The largest of these edifices is twenty feet long by twenty-eight wide. So far as the ruins would permit the Doctor to estimate it, he conjectures the height of some of the temples to be from twenty to thirty feet. There are traces of plaster on the interior walls; but not an emblem or indication, says Dr. Brunner, to suggest the origin or date of the ruined city. All his inquiries on the subject produced from the natives no better answer than that these remains are "monuments of the infidels." Some old men remembered to have seen birds and trees painted in fresco on the walls.—Dr. Brunner proposes his deserted city as a puzzle for the archæologists.

Statue of the Duke of Wellington.—The marble statue of the Duke of Wellington, executed by Mr. Milner, was placed on Tuesday, 12th December, within the Tower of London, of which his grace is High Constable. The figure was deposited on a granite pedestal 19 feet in height, midway between the White Tower and the green fronting the flight of steps leading from Traitors'-gate. The figure is about eight feet high. His grace is represented uncovered, attired in a plain military coat, with a cloak loosely suspended from the shoulders by a cord and tassel.

Restorations at Cambridge.—A correspondent of the *Athenæum* sends the following notes relating to improvements now taking place at Cambridge:—The principal interest continues to be concentrated in Jesus College Chapel, Cambridge, where the work of restoration is still proceeding,—slowly indeed, but on the whole satisfactorily. I had hoped long ere this to have been able to announce its completion; but funds have flowed in tardily; while the difficulty and expense of the work have been enormously increased by the unexpected failure of the N.E. Tower Pier—which having for the last three centuries been propped up by the masonry with which Bishop Alcock filled up the aisle arches (like a man who has accustomed himself to the support of a stick until at last he cannot stand without one), when this was removed began to show alarming symptoms of speedy downfall. At first they tried to patch up the broken pier by ashlar-work (as one puts splints to a broken leg), but in vain; the superincumbent weight crushed the new stones as it had done the old, and the whole seemed to be coming down on the heads of the renovators,—as it were to appease the *manes* of the good old Bishop. The right course now would have been to have underpinned the tower with timber shores, and have removed the faulty pier, rebuilding it from the foundation,—as has been accomplished so successfully at Hereford and Armagh, under the direction of the late Mr. Cottingham. But more timid counsels prevailed at Cambridge; and Mr. Salvin contented himself with building an internal buttress, and filling up the lower part of the arches with a wall—thus in part undoing his own work, and altogether making rather an unsightly botch. Much time and money have been consumed in these operations, but meanwhile the other works have not been quite at a standstill. The large naked-looking east window has been replaced by three exquisite lancets,—the eastern gable has been raised to its original high pitch,—and the flat plaster ceiling has made way for a lofty carved roof of timber, well according with the upward soaring tendency of the lines of the architecture below. By the munificence of one lay member of the college, to whose exertions this work of restoration owes much, the chapel has been provided with a beautiful organ, for which Mr. Pugin has designed a very rich case. The same architect who has succeeded Mr. Salvin in the superintendence of the work, has furnished an elegant oak screen to be erected at the entrance of the choir; which, together with the rich stalls to be arranged on either side, are the work of Rattee, the wood carver of Cambridge. Painted glass is understood to be in progress for the eastern triplet; and the five lancets to the south are to be filled in a style corresponding with the Five Sisters at York, by Dr. French, the Master of the College. It is to be hoped the four lancets opposite will not long want the same appropriate decoration. The exterior of the chapel has been left untouched, with the exception of the elevation of the choir roof; which, now that it is crowned with Pugin's favourite ridge ornament of metal, has a very stately appearance. So much for Jesus Chapel. Of the others, Magdalene, of which I have already spoken on a former occasion, has had its noble roof of carved oak, which has been brought to light by the removal of a flat plaster ceiling (as represented in Le Keux's "Memorials") thoroughly repaired,—and the east window, which had been blocked up by a plaster altar screen, opened and restored. On the removal of the screen, fragments of exquisite niches were discovered behind it, which had been pulled down to make way for this modern excrescence. One of these has been already restored in the most admirable manner, and the others are in progress. The windows are to be filled with stained glass; and new and appropriate stalls and other fittings are to be erected under the active superintendence of the Dean of Windsor, the present Master of the College. The Chapel of Christ's has been decorated with a very gorgeous east window of painted glass, by the munificence of Miss Caroline Burney,—to whom the University is already largely indebted in other ways. The window is designed to be a memorial of her brother,—who was a member of the college. The artist is Mr. Clutterbuck, of Stratford-le-Bow, who has succeeded admirably in the difficult problem of filling a large perpendicular window with an historical subject. That subject is the Crucifixion—and the effect is rich without confusion. The other windows will soon be filled by the members of the college.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM NOVEMBER 23, TO DECEMBER 21, 1848.

Six Months allowed for Enrolment, unless otherwise expressed.

Pierre Armand Lecomte de Fontainemoreau, of Skinner's-place, Sise-lane, City, for certain improvements in the process of and apparatus for treating fatty bodies, and in the application of the products thereof to various useful purposes. (A communication.) Sealed Nov. 25,

John Goucher, of Woodsetts, Yorkshire, agricultural machine maker, for a machine for thrashing corn and other grain.—Nov. 25.

John Lane, and John Taylor, of Liverpool, engineers, for improvements in engines, boilers, and pumps in rotary carriages, in propelling vessels, in the construction of boats, in extinguishing fire, and in brewing.—Nov. 29.

Edward Schunck, of Rochdale, Lancashire, chemist, for improvements in the manufacture of malleable iron, and in treating other products obtained in the process.—Nov. 29.

William Rothwell Lomax, of Banbury, Oxford, engineer, for improvements in machines for cutting hay and straw into chaff, and for cutting other vegetable substances.—Nov. 29.

Jonah Davies and George Davies, of the Albion Iron Foundry, Staffordshire, iron-founders, for improvements in steam-engines.—Dec. 2.

Robert Burn, of Edinburgh, for an improved roller gin, used in separating the seed from cotton.—Dec. 2.

Francis Hastings Greenstreet, of Liverpool, engineer, for certain improvements in hydraulic engines,—Dec. 2.

John Armstrong, of Edinburgh, brass-founder, for improvements in constructing water-closets.—Dec. 2.

George Armstrong, of Newcastle-upon-Tyne, gentleman, for certain improvements in steam-engines.—Dec. 2.

Frederick Collier Bakewell, of Hampstead, gentleman, for improvements in making communications from one place to another by electricity.—Dec. 2.

William Young, of the firm of Henry Bannerman and Sons, of Manchester, merchant, for certain improvements in machinery or apparatus for winding, balling, or spooling thread, yard, or other fibrous materials.—Dec. 2.

Nobert Nelson Collins, of Oxford-court, Cannon-street, druggist, for certain improved compounds to be used for the prevention of injury to health under certain circumstances.—Dec. 2.

James Taylor, of Furnival's-inn, gentleman, for improvements in propelling ships and other vessels.—Dec. 2; two months.

John Henderson Porter, of Adelaide-place, London Bridge, engineer, for an improved mode of applying corrugated iron in the formation of fire-proof floors, roofs, and other like structures.—Dec. 2.

John Daley, of Northampton, iron-founder, for certain improvements in the construction and arrangement of stoves for cooking, and other purposes.—Dec. 2.

Thomas Drayton, of Regent-street, practical chemist, for improvements in silvering glass and other surfaces.—Dec. 4.

James Young, of Manchester, manufacturing chemist, for improvements in the preparation of certain materials used in dyeing and printing.—Dec. 9.

John Gardner, of Wokingham, engineer, for improvements in girders for bridges and other structures.—Dec. 9.

William Ironside Tait, of Rugby, Warwickshire, printer and bookseller, for an improved method or methods of producing outlines on paper, pasteboard, parchment, papier maché, and other like fabrics.—Dec. 9.

Andrew Lamb, of Southampton, engineer, and William Alltoft Summers, of Millbrook, Southampton, engineer, for certain improvements in steam-engines and steam-boilers, and in certain apparatus connected therewith.—Dec. 9.

John Tutton, of 29, South Audley-street, London, mechanic, for certain improvements in the construction and arrangement of certain parts of buildings.—Dec. 9.

Christopher Nickels, of Albany-road, Camberwell, gentleman, for improvements in the manufacture of gloves, and articles of dress and furniture.—Dec. 9.

William Palmer, of Sutton-street, Clerkenwell, manufacturer, for improvements in the manufacture of candles.—Dec. 9.

George Lawrence Lee, of Holborn, Middlesex, lithographer, for improvements in producing ornamental designs.—Dec. 9.

Edmund Hartley, of Oldham, Lancashire, mechanic, for certain improvements in machinery or apparatus to be employed in the preparation and spinning of cotton and other fibrous substances.—Dec. 11.

Joseph Eccles, of Moorgate Fold Mill, near Blackburn, Lancaster, cotton spinner, and James Bradshaw and William Bradshaw, of the same place, watch makers, for certain improvements in, and applicable to looms, for weaving various descriptions of plain and ornamental textile fabrics.—Dec. 15.

William Wharton, superintendent of the carriage department of the London and North Western Railway Station, Euston-square, for certain improvements in the construction of vehicles used on railways, or on other roads and ways.—Dec. 15.

Henry Walker, of Gresham-street, London, needle manufacturer, for certain improvements in the process or processes of manufacturing needles.—Dec. 16.

William Wild, of Salford, Lancaster, moulder, for certain improvements in rotary steam-engines.—Dec. 16.

Alfred Vincent Newton, of Chancery-lane, for improvements in casting printing types and other similar raised surfaces, and also in casting quadrats and spaces. (A communication.)—Dec. 16.

William Clay, of Clifton Lodge, Cumberland, engineer, for certain improvements in machinery for rolling iron or other metals, parts of which improvements are applicable to other machinery in which cylinders or rollers are used.—Dec. 16.

Joseph Deeley, of Newport, Monmouth, engineer, for improvements in ovens and furnaces.—Dec. 16.

Edward Smith, of Kentish Town, window blind manufacturer, for improvements in window blinds, and in springs applicable to window blinds, doors, and other like purposes.—Dec. 16.

William Major, of Culchett, near Leigh, Lancaster, manufacturer, for improvements in looms for weaving certain descriptions of cloths.—Dec. 16.

John Cartwright, of Sheffield, York, tool maker, for an improved brace for the use of carpenters and others.—Dec. 16.

John Clinton, of Greek-street, Soho-square, professor of music, for improvements in flutes.—Dec. 16.

John Travis, and John M'Innes, of Liverpool, lard refiners, for improvements in packing lard.—Dec. 16.

William Curtain, of Retreat-place, Homerton, gentleman, for certain improvements in the method of manufacturing Brussels tapestry, Turkey, and velvet, or cut pile carpets and velvets, silks, linen, mixed cloths, and rugs of all descriptions, by which method less warp is required, and perfect and regular figures or patterns are produced.—Dec. 16.

Thomas Dickins, of Middleton, Lancaster, silk manufacturer, for certain improvements in machinery or apparatus for warping and beaming yarns or threads composed of silk or other fibrous materials.—Dec. 21.

William Wilkinson, of Dudley, Worcester, manufacturer, for a certain improvement or certain improvements in the construction and manufacture of vices.—Dec. 21.

James Henry Staple Wildsmith, of the City-road, London, experimental chemist, for improvements in the purification of naphtha (called wood spirit and hydrated oxide of Methyte), pyroligneous acid, and eupion, and certain other products of the destructive distillation of wood, peat, and certain other vegetable matters, and of acetate of lime and shale, and in the purification of coal tar and mineral naphtha, likewise spirit being the products of fermentation.—Dec. 21.

Charles Augustus Hohn, of King William-street, civil engineer, for improvements in printing.—Dec. 21.

John Penn, Greenwich, Kent, engineer, for certain improvements in steam-engines.—Dec. 21.

Pierre Armand Le Compte de Fontainemoreau, of South-street, Finsbury, London, for certain hygienic apparatus and processes for preventing and curing chronical and other affections, and to prevent or stop certain epidemic diseases. (A communication.)—Dec. 21.

CANDIDUS'S NOTE-BOOK,

FASCICULUS XC.

> "I must have liberty
> Withal, as large a charter as the winds,
> To blow on whom I please."

I. "Pedantic prejudice," says Taylor, in his Notes from Books, "is of all prejudice the most obstinate;" wherefore, all the more unlucky is it that it should so greatly infect both architectural study and architectural practice. The consequence is, that while the study is pursued chiefly historically and archæologically, without any exercise of impartial æsthetic judgment, practice is more technical than artistic. Such is the state of the art at the present day, that we are not only content with getting both modern and second-hand antiquity, and modern and second-hand mediævalism, but actually plume ourselves upon doing so, as if we ourselves had thereby accomplished some extraordinary achievement. To such absurdly preposterous extent is the blind and superstitious reverence for mediævalism carried by some,—or in other words, such is the arrant humbug now practised, that with "art" in their mouths, people do not scruple to affect admiration for the most atrocious barbarism. I could name a very carefully and expensively got-up publication, which exhibits as specimens of orthodox mediæval art some of the most hideous monsters and monstrosities conceivable,—truly diabolical angels, and *hagiai* or female saints that would better answer to the idea and name of hags. Still, such is the force of superstition, though it be only the superstition of fashion, or fashionable archæology, that it can prevail upon people to overcome instinctive disgust, and pretend to admire figures which, were they to appear to them in reality, would throw them into fits. I particularly remember a figure of St. George, of such intense ugliness and deformity that they of themselves were quite sufficient to scare the poor dragon to death. That things of the kind may and do possess interest for antiquaries and those who have got an acquired relish for them, is not denied. As records of the infantine lispings of art, and accordingly as curiosities, they have a certain fictitious value; but to propose them as actual studies, and to think of imitating them at the present day, is as exquisitely preposterous as it would be for grown-up persons to affect to speak in the dialect of the nursery, and imitate the charming nonsense of the "pretty darlings." Even papas and mammas themselves do not venture to do that. Such degree of intrepidity in defying common-sense is reserved for our Pugins and Puginists, whose ultra-orthodoxy in adhering to venerable uncouthness and deformity is more calculated to shock than to edify the uninitiated, and artists most especially. Fashion can sanctify the grossest absurdities; therefore, so long as Puginistic taste and orthodoxy can maintain themselves as a fashion, they will go down,—as go down they also will and must in a different sense of that expression; and then fashion will cry out against them as much or more than it now does for them.

II. As one instance of the length to which fashion can go, it was once the fashion to admire Strawberry Hill, although it was such a doggrel piece of architecture that it ought to have entirely destroyed Walpole's credit as a critic and connoisseur. Nevertheless, it has been expressely praised by one who passed in his day for an eminent authority in the Gothic style. To our very great astonishment now, we read from his pen as follows: "The connoisseur will here" (viz., the Duke of Devonshire's villa at Chiswick) "contemplate all that is exquisite in *the* Palladian architecture, and all that is fascinating in the Gothic style at Strawberry Hill." Oh! James Dallaway—for thou art the man—thou must have been mellowed by an extra *post-prandian* potation, ere thou couldst have written that, and could not have got exactly sober when thou printedst it. He goes on to say: "The noble architect, who pursued the study of English antiquities with so much science and grace, withheld from his own work the merit of a perfect imitation, attributed to it by his friends less versed in architecture than himself." Almost incredible is it, that a man like Dallaway, who set himself up for a judge in matters of architecture, and of Gothic more especially, should have brought himself to speak as he did of Strawberry Hill, instead of denouncing it as the abortion of an equally vulgar and puerile taste. Although Gothic was not then by any means so well understood and appreciated as it now is, Dallaway himself, it is to be presumed, had studied and was intimately familiar with the best models of all its varieties in this kingdom; and ought, therefore, in decency to have been scandalised at Walpole's wretched parody and gimcrack imitation of it. As it is, his extravagantly hyperbolic praise in that instance—and assuredly nothing else than extravagant it was to speak of Strawberry Hill as exhibiting "all that is *fascinating* in the Gothic style"—discredits his judgment generally, and renders his opinions valueless,—at any rate, of very questionable value.

III. Attention to rules and the authority of examples will suffice for producing the prosaic—the respectable, but still prosaic. The poetical, however, is not to be so achieved even in architecture; for criticism does not bestow that epithet on what is merely borrowed or reflected from the genial conceptions of other minds. At present, we are content with the mere *moonshine* of art (alias Fergusson's "monkey styles"), reflected upon us from luminaries now set and departed. And we are fain to mistake such reflected lustre for the rising sun of art, and to bow down to it like devout Persians. It must be admitted that moonshine has its advantages, one of them being that people are not dazzled by it; it is besides mild and melancholy, inspiring pensivenes and cogitation; and reason we have to be thankful—no, not thankful, but thoughtful—and pensive and melancholy when we find that we are likely never more to have any of the genial and invigorating sunshine of art. Melancholy I certainly am just now, mild I need not add,—for when am I ever otherwise?

IV. Even buildings have a sort of destiny attached to them which, wholly irrespective of actual merit, either ensures or denies them celebrity. While it is the fate of some to be continually spoken of—to be noticed again and again in books, and represented over and over again in engravings, it is that of others to obtain no mention from tongue, pen, or pencil. Many of the smaller towns of Italy, for instance, contain unedited specimens of architecture, quite as well worth studying, some of them perhaps more so, than those which are repeatedly published and spoken of, because they happen to be of greater notoriety and guide-book fame, and also to be in the usual route of tourists,—a route which even artists who go abroad professionally and professedly "in search of the picturesque," like Dr. Combe's hero, rarely ever deviate from. There are edifices, too, for which even celebrity itself cannot secure from the pencil the attention which they merit. We have one here at home which may be said to be a virgin subject, notwithstanding that it is a most noble work, a monumental pile, and one which England is justly proud of, it being what no other country can match. I do not say that no view of it exists, since one there is which seems to have been stereotyped, and repeated on every occasion; but how far does a mere single general view go towards the graphic and architectural illustration of a pile which would furnish subjects for at the very least fifty engravings? Yet, so it is: no one has ever thought, even as mere matter of speculation—and a safe speculation it assuredly would be—of bringing out a complete work, entirely devoted to—what I will not yet name. Such a subject would employ the pen as much as the pencil, for many are the heroes and the deeds of heroism—of British heroism, with its achievements and triumphs, which might with great propriety be recorded. It might have been thought that national pride alone would long ere this have induced England and Englishmen to exhibit, in the worthiest possible form, graphic and architectural illustrations of what, if nothing else, is still the noblest pile upon the banks of the Thames, in spite of the New Palace of Westminster.—Reader, you will not now ask its name, or inquire what it is that I allude to, or I must blush for either your obtuseness or your ignorance, should you not have felt almost all along that it can be no other than

GREENWICH HOSPITAL,

which, although certainly not faultless, possesses a majesty and glory that would atone for far greater defects. My Public, only put on your best spectacles, and compare the Palace hight Buckingham, and the Hospital hight Greenwich, and if you be not seized with exceedingly unpleasant feelings and qualms, all I can say is, I do not envy your taste, however much I may envy your stoical imperturbility.

V. Another noble edifice, St. Paul's Cathedral, is in the same predicament as Greenwich Hospital, it being similarly slighted by the pencil, instead of being made the subject of graphic illustration in a complete series of views. The interior would afford many highly scenic subjects to an artist capable of doing them justice, and selecting the most picturesque points, so as to bring out the architecture and place it in its most attractive attitudes; which is certainly what has not been yet attempted. Hitherto, the pencil has done for St. Paul's scarcely anything more than to exhibit a formal frigid view of the nave,—a sort of dry architectural anatomy; hardly at all more pictorial than a section, without the accuracy and trustworthiness of one. It might be thought that the professed admirers of "the great Sir Christopher Wren" would long ere this have suggested,—and not only suggested, but earnestly promoted, some work which should have for its object the satisfactory illustration of his master-piece. Indeed, a kind of fatality, untoward fate, or destiny seems to hang over St. Paul's; for to what else than fatality, except it be to the most unaccountable perverseness, can we ascribe its truly-wretched *emplacement*, in which everything stands *askew!* It is not so much too confined, as it is confusedly huddled-up. Were the same space equalised, and reduced into some regular shape, it would perhaps be sufficient, and preferable to a more extended one; inasmuch as too great space around it tends to diminish to the eye the apparent bulk of a building. For the meanness of the surrounding houses it is not at all difficult to account; but most unaccountable it is that they should have been permitted to grow up quite capriciously,—zigzaggedly, and at all sorts of angles, without the slightest regard to that *alignement* which is observed for ordinary streets, and which ought most assuredly to have been *enforced* there. At present, St. Paul's Churchyard is a reproach to the City and its "powers that be;" the more so as there is no spot in the whole metropolis that holds out greater opportunity for architectural display, while at the same time such display could not but be generally beneficial to the City itself, by serving as a counterpoise to attractions at the west-end of the town. No doubt the value of property just around St. Paul's is so very great as to render any systematic plan of improvement a formidable undertaking; still, were any scheme of the kind carried out, a considerable rise in the value of the property might reasonably be looked for. If, however, the outlay required for improvement accounts for the actual deformity of the whole area not being corrected, it does not account for the deformity itself, which appears to have been established perfectly for the nonce. Nothing less than inexplicable is it, that whatever irregularity was permitted elsewhere, some stringent measures should not have been enforced to ensure at least a decent *locale* for the new cathedral, if only by making the lines of the surrounding houses parallel to its plan, and equidistant from the edifice on every side. Schemes of improvement have been put forth: one of them, nearly fifty years ago, by the late George Dance, which, besides greatly extending and symmetrizing the area immediately around the church, planned a new street carried from the east end of the Churchyard, in a straight line to the Monument,—now more wanted than it then was, in order to relieve the excessive traffic through Cheapside, increased as it now is by that to the railways on the other side of London-bridge. There was certainly something happy, too, in the idea of approximating, as it were, two of Wren's works, by forming a vista, one end of which would have been terminated by the Monument, and the other by St. Paul's. Little more than twenty years afterwards, Mr. James Elmes brought forward another scheme, confined to the improvement of the "Churchyard," which was ingeniously shaped to follow the outline of the plan of the Cathedral, there being a small crescent facing each of the transepts and its semicircular portico. The scheme was to have been promoted by the Duke of York, but he died before any steps could be taken in it, and it dropped at once. Now, there exists an obstacle to such complete improvement which did not at that time, the present St. Paul's School not being then erected.

NOTES ON ENGINEERING.—No. XII.

By Homersham Cox, B.A.

The Centrifugal Strains of Wheels of Railway Carriages.

The investigation of the strains of the tyres of wheels of railway carriages, produced by rotation, is interesting, not only on account of its importance with respect to public safety, but also on account of the very instructive example which it affords of the application of dynamical principles.

Little more than a year ago, a fatal accident occurred on one of the principal railways of this kingdom, by the tyre of a railway carriage in motion being thrown off by its centrifugal force, and striking a carriage of another train. Many other cases have occurred of the similar disruption and violent projection of the ponderous masses of metal of which the tyres of railway wheels are composed. The practical importance of the question, therefore, becomes very great, when it is considered that the centrifugal strains upon tyres may be so great as to seriously affect their strength, and that the momentum which they acquire when projected may be so great as to render them most destructive agents.

When a material substance is moving in a curve, the total external force acting on it in a direction normal to the curve may be estimated from a knowledge of the actual velocity and the radius of curvature. This normal force is usually called centrifugal; and the principal value of the theory of centrifugal force consists in this—that it leads to a determination of the normally-resolved part of the external forces acting on a moving body, when the magnitudes and directions of the external forces themselves cannot be ascertained.

By a principle which need not be here demonstrated, since it is to be found in numerous mechanical treatises, *The centrifugal force* (in pounds) *of a small body moving in a curve = the weight* (in pounds) × *the square of the number of feet described per second* ÷ $32\frac{1}{6}$ *times the radius of curvature* (in feet). For instance—if the weight of a body be 10 lb., and its velocity 8 feet per second, in a curve of which the radius is 5 feet, the product of the weight and square of the number of feet per second is 10 × square of 8 = 10 × 64 = 640. This divided by $32\frac{1}{6}$ times the radius (= $32\frac{1}{6}$ × 5, or 161) gives $\frac{640}{161}$ lb., or nearly 4 lb. for the amount of the centrifugal force.

The rule above enunciated. when expressed by a mathematical formula, gives the value of the centrifugal force equal to

$$\frac{m v^2}{r} = \frac{W}{g} \cdot \frac{v^2}{r},$$

where m is the mass of the body, v its velocity, W its weight, r the radius of curvature of its path, and g the force of gravity. When the velocity is expressed in feet per second, the force g must be similarly expressed, and therefore = $32\frac{1}{6}$, since that is the velocity, in feet, generated during one second in a body falling freely by the action of gravity.

The formula just given will now be applied to determine the tension due to centrifugal force of a circular ring revolving uniformly about a fixed centre.

Since every part of the ring revolves with the same velocity about the same centre, it is acted on by the same centrifugal force. It is easily seen, then, that if the ring were perfectly flexible, its circular form would not be altered by the centrifugal forces. Hence, it follows that at every point its tension is tangential, or in the direction of its length, as it would be if the ring were a flexible string. If the tension were in any other than the tangential direction, it would tend to *bend* the ring. It is also clear that the tension is the same in every part of the ring: let this tension be called T.

This being premised, let us consider the forces acting on a quadrant of the ring. The quadrant at its two extremities is acted on by two tangential forces, T, which are evidently at right angles to each other; and also at every point by its centrifugal forces normally. If ds be an element of the arc, μds its mass, v its linear velocity, and r the radius of the ring, the centrifugal force of any element of it, by the principle above laid down, is

$$\mu ds \cdot \frac{v^2}{r}.$$

If the radius at any point of the quadrant be inclined to the radius at one extremity at an angle θ, the part of the centrifugal force resolved parallel to that radius is

$$\mu ds \cdot \frac{v^2}{r} \cos\theta; \quad \text{or, } \mu d\theta\, v^2 \cos\theta;$$

since $ds = r d\theta$.

Now, the sum of the resolved parts of the centrifugal force parallel to T must equal T, since there is equilibrium, and all the other forces acting on the quadrant are perpendicular to these. Hence,

$$T = \int \mu d\theta\, v^2 \cos\theta = \mu v^2,$$

integrating between limits 0 and 90°. Let l be the length of the whole circle, and therefore μl its mass. Therefore, putting its weight = W, $\mu = \frac{W}{gl}$. Also, if t be the time of revolution, or that in which any point of the ring moves through the space l, we have $vt = l$, and $v = \frac{l}{t}$. Substituting these values of v and μ in the above expression for T,

$$\textit{tension of ring} = \frac{W\,l}{gt^2};$$

which formula gives the following rule for finding the tension due to centrifugal force in a ring revolving uniformly. *The tension* (in pounds) = *the weight of the ring* (in pounds) × *by its length* (in feet) ÷ *by* 32½ *times the square of the number of seconds in which the ring revolves.*

We shall next examine the effect of a progressive motion combined with the rotation of the ring, and proceed to show that if the centre of the ring have a progressive motion, the tension will be the same as if the centre were fixed. This may be easily seen from the following illustrations. Suppose that in a ship or carriage moving with uniform rectilineal motion, a string with a weight at one end of it were whirled rapidly,—it is quite clear that the tension of the string would not be at all influenced by the progression of the carriage or vessel; the centrifugal force would be the same, whether the plane of the string's rotation were horizontal or vertical—parallel or perpendicular, to the direction of progression. Again, a hoop rolled along smooth ground with an assigned velocity, whether it be directed eastward or southward, or to any other point of the compass—that is, whether its progressive motion coincide with or be inclined to the course of the earth's diurnal rotation. So also, a body *resting* at any point on the earth's surface, except its poles, suffers a diminution of weight on account of the centrifugal force arising from rotation about the earth's axis; but this diminution is not at all influenced by the annual or progressive motion: the centrifugal force is also the same for every hour of the day, and on every day of the year—that is, for every angle at which the diurnal motion at the point in question can be inclined to the earth's orbit.

We see then that the centrifugal force of a body rotating in a circle about an assigned centre, is measured, not by the *absolute* motion, but by the rotation *relatively* to that centre. Consequently, the rule above given for determining the tension of a ring revolving about a fixed centre, applies to the tyres of railway wheels, which have not only a circular motion about their axles, but a uniform progressive motion also.

It may, however, be more convenient to transform the rule, so as to express the tension of the tyre in terms of the velocity of the train. We have shown that $T = \frac{Wl}{gt^2}$, where l is the length of the circumference, and t the time of revolution. Now, if the wheel do not slip, the train moves through a distance l during the time t; therefore, if V be the velocity of the train, $V = \frac{}{t}$, and the above expression becomes $T = \frac{WV^2}{gl}$ Let κ be the sectional area of the tyre, and τ the tension per unit of area; $T = \tau\kappa$. Also, it is evident that the solid content of the ring may be put equal to its length multiplied by its sectional area ($= l\kappa$). Hence, if the weight of a unit of volume be w, we have $W = wl\kappa$. Substituting then for W and T,

$$\tau\kappa = w\kappa\frac{V^2}{g}; \quad \text{or, } T = \frac{wV^2}{g}.$$

Now, this expression, if we take a foot for the unit of length, gives the tension per square foot of the metal; but what is usually required is the tension per square inch, which is of course the 144th part of the tension per square foot. Hence the following very simple rule, since $144\,g = 144 \times 32\tfrac{1}{3} = 4637$:—

The tension of the tyre in pounds per square inch due to centrifugal force equals the 4637th *part of the weight in pounds of a cubic foot of the metal multiplied by the square of the number of feet which the train travels in a second.*

The facility of applying this rule depends materially on its independence of the radius and other dimensions of the tyre. As the weight of a cubic foot of iron or steel varies from about 4,600 to 4,800 lb., the following rule is sufficiently accurate for practical purposes:—

The tension in pounds on every square inch of the sectional area of the tyre = THE SQUARE OF THE NUMBER OF FEET WHICH THE TRAIN TRAVELS IN A SECOND.

For example, if the train moved 85 feet per second (a mile per minute), the strain on the metal per square inch would be 7225 lb. = 3·23 tons. It is curious to observe, that in the same train every tyre would be subject to the same degree of strain, whatever its radius, width, and thickness.

SUBMARINE FOUNDATIONS.

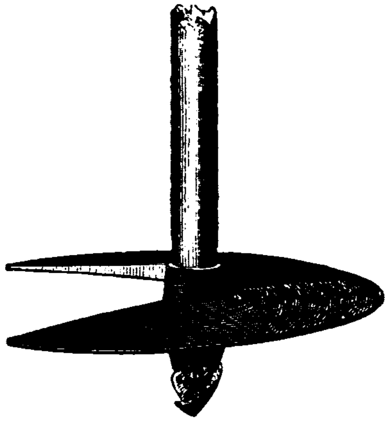
On Submarine Foundations; particularly the Screw-Pile and Moorings. By ALEXANDER MITCHELL, M. Inst. C.E.—(Paper read at the Institution of Civil Engineers.)*

The entire subject of the methods of preparing submarine foundations, if treated of in as general and comprehensive a manner as its importance demands, would not only far exceed the limits of a paper for the Institution of Civil Engineers, but would be tedious and unnecessary, as the majority of the members are thoroughly conversant with the various systems in their daily practice; it is proposed, therefore, to limit the present inquiry to a cursory mention of the ordinary methods, and to devote the greater space to a description of the Screw Pile and the Screw Mooring, and of the works in which they have been employed. Sheet piling, whether of wood, or iron, is now familiar to every one, as the driving it is an operation of daily occurrence, and the numerous scientific treatises on stone foundations, placed in positions of peculiar difficulty and danger, render all comment upon them quite superfluous.

The Eddystone and Bell Rock Lighthouses furnish splendid examples of such works. The scientific skill employed in joining and binding together their parts, giving to them almost a monolythic solidity and strength, is beyond all praise; and yet were lighthouses now required to be placed in similarly exposed positions, it is more than probable that strong open-work structures, upon iron piles, would be substituted for solid stone towers, as a vast saving would thus be effected, and the strength would be increased by removing the only cause of danger; for the waves are only formidable when they are inflexibly opposed. In that part of the subject which relates to foundations placed in banks of loose sand or mud, covered by the sea, the author would confine his observations to his own practical experience, and studiously avoid all comparison with other modes of proceeding, which he is aware may, and probably will, be brought before the Institution, and will doubtless receive the usual impartial consideration.

An account of the circumstances which led to the introduction of the screw-pile and screw-mooring, would possess but little general interest, and is not necessary. It will suffice to observe, that a project, contemplated by the author, involved the necessity of a much greater holding power than was possessed by any pile or mooring then in use; the former being nothing more than a pointed stake of considerable size, easily either driven into or extracted from the ground, and the latter a large mass of stone or iron, which when submerged became of limited power, and was quite incapable of resisting an upward strain.

Fig. 1.



The plan which appeared best adapted for obtaining a firm hold of soft ground or sand, was to insert to a considerable distance beneath the surface, a bar of iron (fig. 1.) having at its lower extremity a broad plate, or disc of metal, in a spiral or helical form, on the principle of the screw, in order that it should enter the ground with facility, thrusting aside any obstacles to its descent, without materially disturbing the texture of the strata it passed through, and that it should at the same time offer an extended base, either for resisting downward pressure, or an upward strain. Whether this broad spiral flange, or "Ground Screw," as it may be termed, be applied to the foot of a pile to support a superincumbent weight, or be employed as a mooring to resist an upward strain, its holding power entirely depends upon the area of its disc, the nature of the ground into which it is inserted, and the depth to which it is forced beneath the surface. The proper area of the screw should, in every case, be determined by the nature of the ground in which it is to be placed, and which must be ascertained by previous experiment. The largest size hitherto used has been 4 feet in diameter; but within certain sizes, prescribed by the facility of manufacturing them, the dimensions may be ex-

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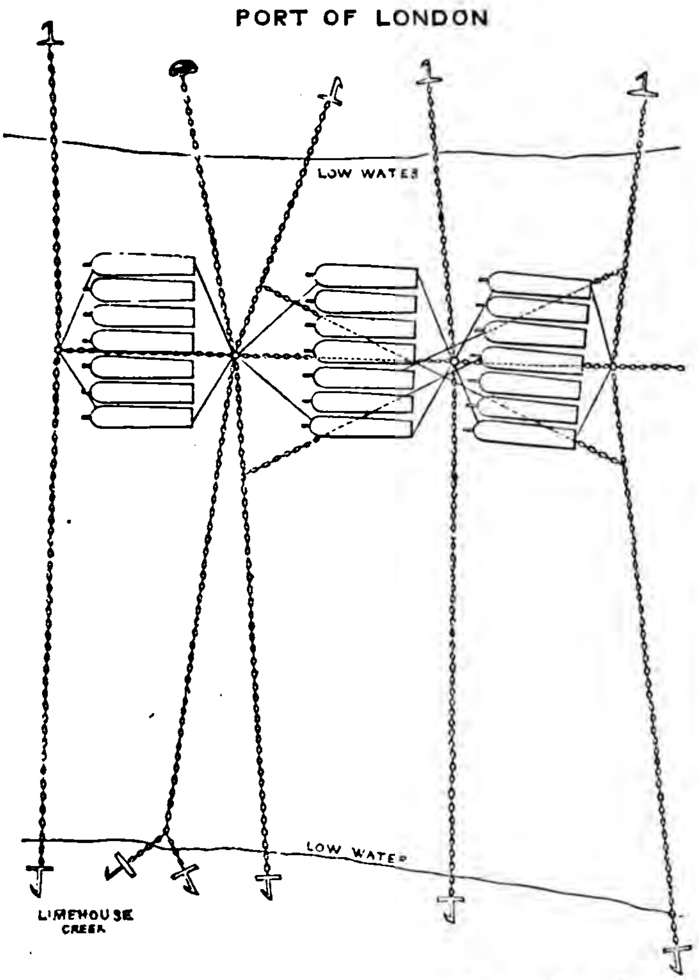
* An abstract of this paper was given in the Journal, Vol. XI. (1848), p. 22.

tended to meet any case, and may be said to be limited only by the power available for forcing them into the ground. Either the screw-pile, or the screw-mooring can be employed in every description of ground, hard rock alone excepted: for its helical form enables it to force its way among stones, and even to thrust aside medium-sized boulders. In ports, harbours, estuaries, and roadsteads, rock is, however, seldom met with, except in detached masses, the ground being usually an accumulation of alluvial deposit, which is well adapted for the reception of such foundations, and is also that in which they are generally most required. The ground screw has been already extensively used for several purposes, and its applicability to many others will be evident from a succinct account of its present employment.

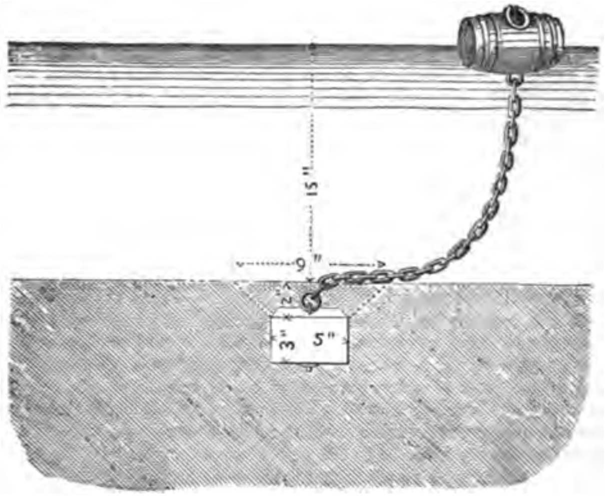
Fig. 2.



The fixed, or permanent moorings most commonly used are of two kinds; the span-chain mooring, and the sinker or mooring-block. The former of these (fig. 2) consists of a strong chain of considerable length, stretched along the ground (across the river), and retained by heavy anchors, or mooring-blocks, at either end, and to the middle of the ground-chain the buoy-chain is shackled. Many of these moorings were formerly laid down in the Thames, at great expense, and they still continue to be the only moorings in use at the royal dockyards. The disadvantages of these moorings are their expense and the obstruction they present to navigation; for should a vessel cast anchor in the neighbourhood, it is almost certain to get hooked into the chain, from which it can only be freed by the assistance of a chain-lighter, at considerable expense and loss of time. In fact, mooring-chains across the anchorage were adopted to insure the anchors of vessels bringing up, when the harbour was crowded, and in such cases the harbour flat was obliged to attend to clear the anchor at slack water. Messrs. Hemmans, Parkes, and others, state the expense of each government mooring of this kind to be about 2,500*l.*

The other kind, which is more generally employed [illegible] of a heavy sinker, to which a strong chain is attached [illegible] buoy shackled at the other end (fig. 3). This sinker, which is a block of stone or iron, is either laid upon the surface of the ground, or is placed in an excavation prepared for its reception.

Fig. 3.



The advantages of this system are its simplicity and cheapness of construction, with the power of holding nearly equally well in every direction; but, on the other hand, when the sinker is subjected to a heavy strain, it is generally found deficient in holding-power, because it chiefly depends upon the specific gravity of the mass, and because the ground, which must be greatly broken up for its reception, offers only a feeble resistance to its subsequent extraction. Another disadvantage is, that being generally confined to shallow bays and harbours, vessels are often as seriously injured by grounding upon them, as when they come in contact with anchors, which it is contended should never be permitted to be used in harbours or rivers. Moorings are sometimes formed of timber frames, loaded with stone and buried in the bed of the river, as in the harbour of Sunderland, where they have been extensively applied by Mr. Meik.

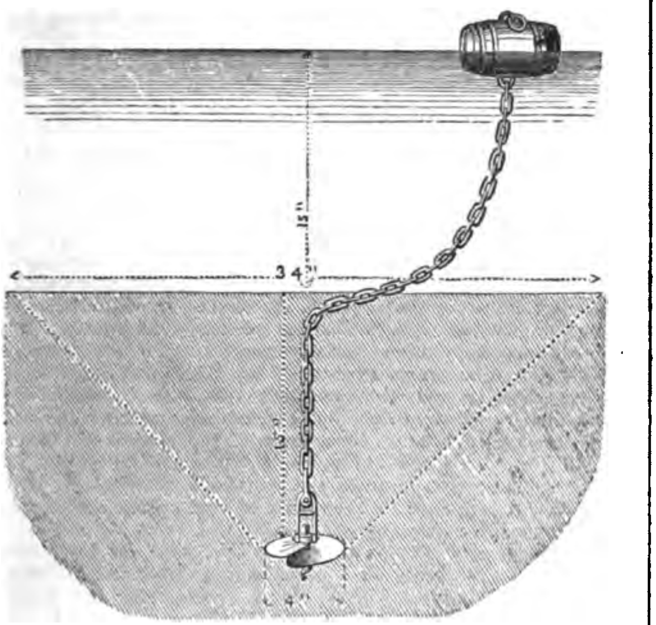
Fig. 4.

These evident defects in the ordinary systems of mooring, induced the author, whilst seeking for a simple, effective, and at the same time inexpensive mode of holding the buoy-chain down, to adopt a modification of the screw-pile (fig. 4); because it offered great facilities for entering the ground, and when arrived at the required depth, it evidently afforded greater holding power than any other form.

Every description of earth is more or less adhesive, and the greater its tenacity the larger must be the portion disturbed before the mooring can be displaced by any direct force. The mass of ground thus affected, in the case of the screw-mooring, is in the form of the frustrum of a cone, inverted; that is, with its base at the surface, the breadth of the base being in proportion to the tenacity of the ground; this is pressed on by a cylinder of water equal to its diameter, the axis of which is its depth, and the water again bears the weight of a column of air of the diameter of the cylinder. The comparative masses of ground which must be removed in dragging up the two kinds of moorings are shown by the dotted lines in figs. 3 and 5.

It is evident, therefore, that if a cast-iron screw, of a given area, be forced into the earth to a certain depth, it must afford a firm point of attachment for a buoy-chain, in every direction (fig. 5), and will oppose a powerful resistance even to a vertical strain, which generally proves fatal to sinker moorings, depending (as they do) chiefly on their specific gravity.

Fig. 5.



The first trials were upon a comparatively small scale; but their success was so decisive, that the merits of the moorings were acknowledged, and their use soon became extended. The depth to which these moorings have been screwed varies from 8 feet to 18 feet; the former is deep enough where the soil is of a firm and unyielding description, and the latter depth is found to give sufficient firmness in a very weak bottom. It is evident from its form, that every part of the screw-mooring is so far beneath the surface, as to prevent a vessel from receiving injury from grounding immediately above it; the mooring chain alone protruding from the ground, and it is also obvious, that anchors, dropped in the neighbourhood, cannot be hooked into, or get foul of the chain, one end alone being attached to the ground. Although economy should be the last consideration where a large amount of property and many lives are at stake, still if the end can be safely attained by less costly means, it is the duty of those having charge of public works to consider the question. It is right, therefore, to state, that screw-moorings, of the most powerful description, can be put down at a tenth part of the cost of the span-chain mooring (fig. 1), and at even less than the common stone mooring (fig. 2), provided it be of equal power with the former; setting aside the defects which have been noticed. Indeed, with respect to the screw-moorings, it may be stated, that where they have been longest in use and are best known, they are most appreciated, as is well shown in the recent agreement with the Corporation of Newcastle-on-Tyne, who paid for the permission to use the patent in the Tyne, as applied to moorings alone, the sum of 2,500*l.*, within a few months of the expiration of the inventor's privilege, and when the renewal of it appeared doubtful.*

In fixing these moorings in the ports and harbours where they have been used, the persons hitherto engaged in the operation have been generally compelled to avail themselves of any means within their reach, for the construction of a floating stage or platform, on which the men could execute the work. Barges, lighters, and pontoons have been therefore indifferently employed; those that were without decks being planked over for the purpose. Two such vessels being lashed broadside to each other, with a certain space between them, are securely moored over the spot, and the screw-mooring lowered, with the chain attached to the shackle, from the centre of the stage to the level of the water; and as it descends to the bottom, the lengths of the apparatus for screwing it into the ground are successively attached. This apparatus (fig. 6) consists of a strong wrought-iron shaft, in lengths of 10 or 12 feet each, connected with each other by key joints or couplings, the lower extremity having a square socket to fit the head of the centre pin or axis of the mooring. When the centre pin rests on the bottom, a capstan is firmly keyed upon the shaft at a convenient height; the men then ship the capstan-bars, and apply their power whilst travelling round upon the stage, the capstan being lifted and again fixed as the mooring is screwed down into the ground. The operation is continued until the men can no longer move the shaft round, or until it is considered to have been forced to a sufficient depth. In the river Tyne, where many of these moorings have been laid down, a barge of peculiar construction has been prepared for the purpose, containing within itself all that is necessary to facilitate the work.

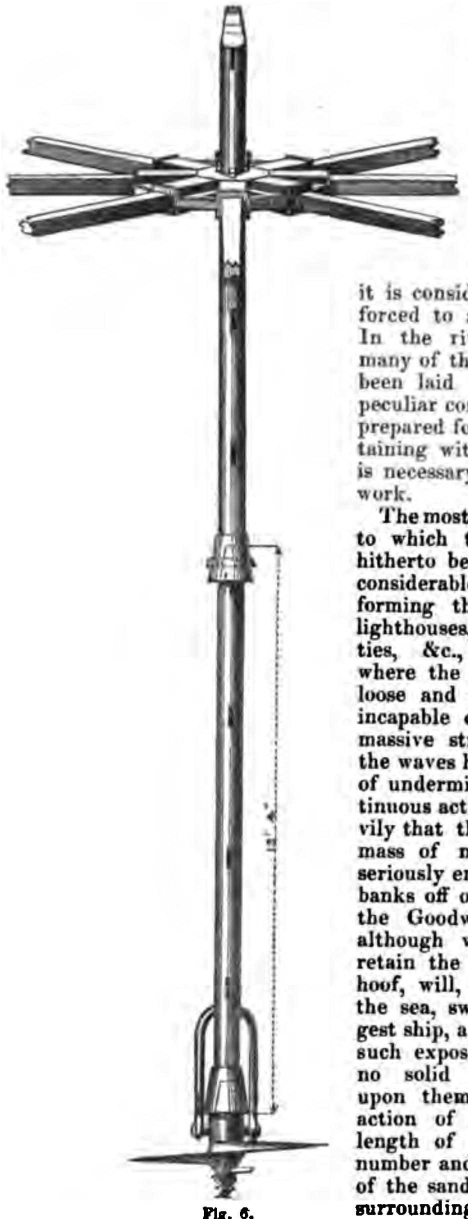


Fig. 6.

The most important purpose to which the screw-pile has hitherto been applied, to any considerable extent, is for forming the foundations of lighthouses, beacons, jetties, &c., in situations where the soil or sand is so loose and unstable as to be incapable of supporting any massive structure, or where the waves have so much power of undermining by their continuous action, or beat so heavily that the stability of any mass of masonry would be seriously endangered. Many banks off our coasts are like the Goodwin Sands, which, although when dry scarcely retain the print of a horse's hoof, will, when covered by the sea, swallow up the largest ship, and are moreover in such exposed situations that no solid structure erected upon them could resist the action of the sea for any length of time. From the number and dangerous nature of the sand-banks and shoals surrounding the United Kingdom, the means of placing conspicuous and permanent marks upon them becomes an object of the highest importance to navigation. But nothing of the nature of a lighthouse upon a submarine sandbank was ever proposed prior to the year 1834, the project till then being considered extremely hazardous, if not impossible.

The author having at that time satisfied himself as to the holding power of the screw-mooring, and made some successful experiments with the screw-pile, was applied to by the Society of Merchant Venturers at Bristol, to devise the means of placing a fixed light on the Dumball, an accumulation of mud and other alluvial deposit at the entrance of the Avon, and about the end of the year 1834 he laid before that society the plan, specification, and estimate of a screw-pile lighthouse, similar in principle to those since erected by him and his son; but the Corporation of the Trinity House having subsequently undertaken to buoy and light the Bristol Channel, the author's plan was abandoned, and a stone lighthouse was placed on the firm ground in the neighbourhood.

Between the years 1834 and 1838, some unsuccessful attempts were made to introduce the plan in various localities. In the latter year, at the suggestion of Captain (now Admiral) Beaufort, of the Admiralty, he laid a plan before the Corporation of the Trinity House, by whom, at the recommendation of Mr. Walker, their engineer, it was favourably considered, and in the month of August

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* The patent has been renewed for a term of fourteen years, from the year 1847.

in that year, the author and his son laid the foundation of Maplin Sand Lighthouse. (See *Journal*, Vol. V., 1842, p. 352.)

Before determining the length of the piles and the area of the screws to be employed, a careful examination of the ground was made, and it was proposed to use nine malleable iron piles of 5 in. diameter, and 26 feet in length, with a cast-iron screw of 4 feet diameter, secured to the foot of each. Eight of the piles were placed at the angles of an octagon, and one in the centre; these were put down in nine consecutive days, being screwed into the bank to the depth of 22 feet, leaving 4 feet above the surface. The tide rises on the bank about 16 feet, and seldom leaves the surface dry. The instrument used in trying the nature of the ground was also employed in testing its holding power. It consisted of a jointed rod 30 feet long, and 1¼ inch diameter, having at its foot a spiral flange of 6 inches diameter. It was moved round by means of cross levers, keyed upon the boring-rod: and upon these levers, when the screw was turned to the depth of 27 feet, a few boards were laid, forming a platform sufficiently large to support twelve men. A bar was then driven into the bank at some distance, its top being brought to the same level as that of the boring-rod. Twelve men were then placed upon the platform to ascertain if their weight, together with the apparatus, in all about one ton, sufficed to depress the screw. After some time, the men were removed, and the level was again applied: but no sensible depression of the screw could be observed.

Although this was the first screw-pile foundation that was laid for the reception of a lighthouse on a bank of loose sand covered by the sea, it was not the first that was erected, as the piles remained untouched for two years, in order to ascertain if any change would occur from the action of the sea, or other causes.

Pending this term of probation, a lighthouse was proposed to be erected in Morecombe Bay, and it was decided to use screw-piles for the foundation. The novelty of the work, the peculiarity of the situation, and the dread of failure if it were intrusted to strangers or those who were not interested in it, rendered it obligatory upon the author and his son not only to send in a design for the foundation, but also for the superstructure, and afterwards to devote their attention most assiduously to the superintendence of the erection of the whole structure, which was commenced in the latter part of 1839, and the lantern was lighted on the 6th of June, 1840,—every part, with the exception of the top of the lantern, being completed in the month of March. As this lighthouse was the first of its kind, and it was, perhaps, the first attempt to place a habitation of any description in a position so proverbially unstable, a short description of the structure and of the locality becomes necessary.

The situation selected for the lighthouse (see *Journal*, Vol. III., 1840, p. 181) is about two miles from the nearest shore, on the verge of a bank of loose sand, which shifted occasionally, until it was fixed beneath and around the house by a superposed mass, several feet deep, of strong argillaceous earth and stones. It may be remarked, that banks of pure sand are very liable to shift at their surface, and it is extremely difficult to penetrate them to any considerable depth, the absence of clay or any plastic material rendering the particles nearly incompressible. In this case, seven wrought-iron piles, 16 feet long, with cast-iron screws 3 feet in diameter, were employed, one being placed at each angle of a hexagon, and one in the centre. Seven balks of Baltic timber, 14 inches square, of the best quality, were selected for the supports of the house; the six exterior balks were each 48 feet long, and the centre one was 57 feet in length, to admit of its rising through the house to the base of the lantern, which it assists in supporting, and to give additional stability to the whole structure. In the foot of each of these supports, a hole, 5 inches in diameter, was bored to the depth of 7 feet, to receive the end of the pile upon which it was shipped; and to strengthen them for the same distance upwards, several strong iron hoops were driven on hot. A small spiral flange was fixed on the foot of each balk, to draw it into the sand, in the same manner as in putting down the piles. The diameter of the hexagonal base is 50 feet, and the diameter of the platform on which the house stands is 27 feet; the exterior piles having an inclination inwards of 1 foot in 5. It should be observed, that any degree of inclination can be given to a pile whilst it is in motion, by merely placing at a corresponding angle the platform upon which the men work. The floor of the house is 45 feet above the surface of the bank, and the tide rises about 32 feet on the supports, at the equinoctial springs.

A more detailed account of this lighthouse would be superfluous, the remainder of the work being of the ordinary character for structures of this kind; but it may be observed that since the time of its erection in the winter of 1839 and '40, the only repair it has received or required is the occasional application of a little paint. The total expense of this house was about 3,350*l.*, of which the dioptric apparatus for lighting cost nearly 1,000*l.*

This, as before observed, being the first lighthouse placed on a bank of loose sand covered by the sea, and from its proximity to a deep channel, entering fairly into competition with floating lights, a few words on the comparative merits of fixed and floating lights may not be out of place.

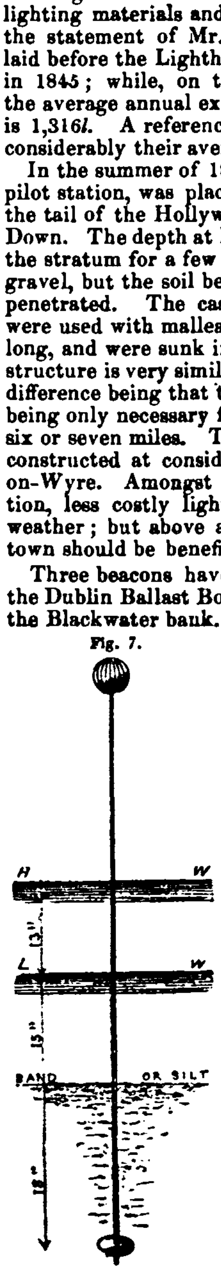
In looking out at night for narrow and intricate channels far from land, it is of the utmost importance that the mariner should rely with undoubting confidence, not only on the stability of the light, but also on its unvarying position and appearance. All these advantages are possessed by the Fleetwood lighthouse, and the others constructed on the same principle; but in tempestous weather, the floating light ships are nearly obscured by the spray, and their lights have no steadiness, on account of the constant motion, whilst hundreds of lives and millions of property have been lost in consequence of their breaking from their moorings. Nor can they be said to occupy any precise position, shifting as they do with the wind and tide, twice the length of the chains by which they ride.

The comparative expense of these two modes of lighting is yet to be considered; and here the advantage is still more in favour of fixed lights. The annual expense of the Fleetwood lighthouse, in lighting materials and attendance, amounts to 335*l.*, as appears by the statement of Mr. P. Bidder, resident engineer at Fleetwood, laid before the Lighthouse Committee of the House of Commons in 1845; while, on the authority of Captain Washington, R.N., the average annual expense of the floating lights of Great Britain is 1,316*l.* A reference to the report of that committee augments considerably their average cost.

In the summer of 1844, a screw-pile lighthouse, serving also as a pilot station, was placed in Belfast Lough, Carrickfergus Bay, on the tail of the Hollywood bank, about a mile from the coast of Down. The depth at low water where the house is placed is 9 feet; the stratum for a few feet next the surface was coarse sand and gravel, but the soil beneath was tenacious blue clay, and was easily penetrated. The cast-iron screws were 3 ft. 6 in. diameter, and were used with malleable iron piles, 5 inches diameter and 26 feet long, and were sunk into the bank to the depth of 16 feet. The structure is very similar in principle to that at Fleetwood, the only difference being that the house is larger and the lantern smaller, it being only necessary for the light to be visible from a distance of six or seven miles. This lighthouse, from a variety of causes, was constructed at considerably less expense than that at Fleetwood-on-Wyre. Amongst these may be mentioned the sheltered position, less costly lighting apparatus, cheap labour, and summer weather; but above all, the desire of the author that his native town should be benefited by his labours.

Three beacons have been erected by the author and his son for the Dublin Ballast Board, on the Kish bank, the Arklow bank, and the Blackwater bank. These have all been put down with the intention of placing lighthouses on their sites, should they appear eventually to suffer no change by the action of the sea. All these beacons are similar in form and principle (fig. 7); each consisting of a single pile of wrought-iron in two joints, connected by a strong screw coupling, and measuring, when together, 63 feet in length; their diameter at the surface of the ground is 8 inches, diminishing from thence both up and down. The incompressible nature of the sand offering considerable opposition to the descent of the pile, screws of only 2 feet in diameter were used, and on the top of each pile, when fixed, a ball was placed of 3 ft. 6 in. diameter. The screws used for the Blackwater and the Arklow beacons were forged of malleable iron, and turned in the lathe, at great expense; but that will probably never again be necessary, as they can generally be quite as well made of cast-iron and at much less cost. One of these beacons was fixed in June, 1843, the other two in the summer of 1846, and are all standing, though two of them diverge considerably from the perpendicular, having been frequently struck by vessels in heavy weather.

Fig. 7.



In the summer of 1846, a larger and more important beacon was placed between the Queen's and

Prince's Channels; the two most frequented passages into the Thames. It stands at the eastern extremity of the Tongue sand, in a depth, at low water, of 17 feet. The foundation is formed of five screw-piles in the form of the letter X, the diagonals being 40 feet apart, one being placed at each extremity and one in the centre. These piles are of malleable iron, 6 inches in diameter and 43 feet long. Screws, 2 feet in diameter, were used, and they were sunk to the depth of 19 feet into the bank, which was very hard. The work was constructed after the design, and under the direction of Mr. Walker, C.E., and stands about 40 feet above the level of low-water spring tides. The method of putting down these piles was the same as that adopted at the Maplin Sand; but, owing to the greater solidity of the ground, a raft of much greater size and strength was required, to admit of stronger apparatus being used with levers of greater length. The raft required also to be much more securely moored by its four angles, being always in deep water and in a strong tideway.

In the summer of 1847, the screw-pile was subject to a new trial, in the construction of a pier, or jetty, near the village of Courtown, about twelve miles south of Arklow, on an open and exposed part of the coast of Wexford. On its commencement, a startling difficulty presented itself. Barges, or strongly-constructed rafts, had been previously found sufficiently steady to act as stages for the workmen, when screwing down either piles or moorings; but the coast at Courtown being unprotected nearly from north to south, with an open sea of 70 miles in front, a surf of great height and force beats almost without intermission upon the shore, preventing the use of any floating body in the construction of the works. As a steady footing for the men is to a certain extent essential, it became indispensable that the screwing down of the piles should be effected from the work itself. The method of construction that was adopted was very cheap and simple. The piles were to be placed 17 feet apart, in a direct line outwards; a projecting stage was therefore rigged, extending that distance forwards, with the other end resting upon and temporarily attached to the solid part of the pier. The screw-pile was then run forward upon rollers, lifted by tackle, and placed vertically in the situation it was intended to occupy. A wheel, 32 feet in diameter, formed of capstan-bars lashed together at their ends, with a deeply-grooved end to each, was keyed upon the body of the pile, and an endless rope-band was passed around it, and held in tension round a smaller grooved pulley, fixed about 150 feet back towards the shore. The tendency to pull the pile out of the vertical line was resisted by a guide-pole, with a grooved pulley at its extremity. which pressed against the shore side of the pile. These preparations being made, a number of men hauling upon the endless band gave a rotary motion to the large wheel, and screwed the pile down to its place with great ease. The same operation was repeated for the next pile laterally,—the cross-beams were laid on, the overhanging platform was pushed forward, and two more piles were inserted. During this time the cross-braces were applied, and the permanent platform was finished.

The works were by this means conducted with such facility and regularity, that, in spite of rough weather, one bay of 17 feet in advance was generally completed in a day; and it is evident, that by a modification of the same system, even more could be accomplished, with greater distances between the sets of piles, if such extension should be considered necessary.

The new part of the Courtown jetty is 260 feet in length beyond the solid stone part of the old jetty. The main roadway is 18 ft. 6 in. wide, with a line of railway laid upon each side, leaving a space for passengers in the centre between the lines. It is terminated by a cross-head or platform, 54 feet long by 36 feet wide, with a landing stage at each end, which can be raised or depressed, to suit the convenience of the vessels loading or discharging. Small colliers, coasting craft, and the largest class of fishing smacks can now receive or discharge their cargoes very rapidly and without grounding. The bottom into which the piles were inserted consisted of an average depth of about 8 feet of sand and gravel, upon a firm blue clay. Screws of 2 feet diameter were therefore sufficient, with wrought-iron piles, of 5 inches diameter, inserted in the ground to a depth varying between 11 feet and 15 feet.

The expense of the construction of the extension of this jetty, including everything, from the screw piles to the finished platform, with the lines of railway, turn-tables, landing-stages, &c., was 4,150*l*., or 47*l*. 10*s*. per lineal yard current. In stating this sum, it must be remembered, that it was the first work of the kind; ample allowance was therefore made for contingencies, and as materials were much more expensive than at present, works of this kind could now be executed at less cost.

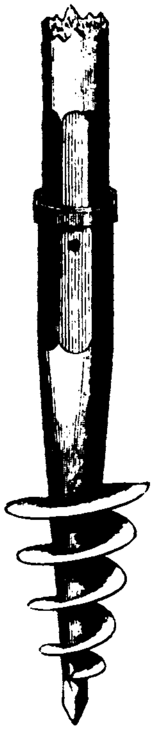
The success attending these applications of the system induced its extension to other works, of which it will suffice to mention a few instances, to demonstrate the large field opened for it, not only in engineering works, but for agricultural and other purposes.

Messrs. Ransome and May (of Ipswich) have constructed several kinds of cast-iron screw points, shown in figs. 8, 9, 10, and 11.

Fig. 8.

Weight 2 cwt. 3 qr. 14 lb.

Fig. 9.



Weight 3 qr. 22 lb.

Fig. 10.

Weight 2 qr. 4 lb.

Fig. 8 shows the largest size, adapted for whole timber piles, which are so often splintered and shattered, and even set on fire, by the rapid blows of the steam pile-driver, when traversing compact ground, and where wrought-iron shoes are generally crushed into the timber, even in ordinary ground, with the force of the common pile-engine. The small screw-point opens the way for the conical part, and the larger screw not only draws the pile down, but, when it has penetrated to a sufficient depth, affords an extended base for preventing further depression. Thus several feet of timber must be saved, and the general length of the pile can be reduced, as it will bear a greater weight, and offer a more solid base, when introduced to a less distance than when it rests upon the ordinary sharp wrought-iron pointed shoe.

Fig. 9 shows the shape adapted for railway signal-posts, and fig. 10 that for the supports for the wires of the electric telegraph. For these purposes the screw points must be very useful, as, independent of the economy of labour in putting them down by merely screwing them into the ground, instead of digging holes to introduce the cross-feet, all possibility of injury to the banks would be precluded; whereas, at present, there is always a liability of causing a slip by disturbing uncertain ground, and admitting water in the sides of cuttings.

The cast-iron screw-socket points (fig. 8) have recently been very successfully applied, for the supporting posts or columns of timber-sheds and buildings, for railway stations and other purposes. These are generally constructed upon made ground, and the foundation for each column is prepared for excavating a hole about 6 feet deep, to be filled with concrete, which is either rammed round the post, or carries a large stone into which the column is inserted. Or sometimes by having a transverse sill and struts at the foot of the post, which must all be buried in the ground, and be liable to decay from the wet. By the system now introduced, the iron screw-socket alone is inserted into the ground, by screwing it in with capstan-bars; an operation which only occupies a very short time: the earth around is not disturbed, and the timber cannot be exposed to injury or decay.

As an instance of the stability and the power of holding of these screw points, it may be stated that when trying experiments upon the various forms, Messrs. Ransome and May screwed a casting of the form of fig. 9 to a depth of 4 feet into the gravel of the yard of their works, and after fixing into it a pole 38 feet in height, a man climbed to the top, and caused it to vibrate as much as possible, without apparently affecting the stability of the foot. A steelyard was then attached to it, and a power of 4 tons was applied with direct vertical tension; but without being able to draw it out of the ground, and the pole is now standing as firmly as ever. Since then, with a larger sized screw point (fig. 8), a mast 82 feet in height, with a vane at the top 5 feet in length, has been placed, and although only inserted 5 feet into the ground, it is perfectly steady, with three very short gye-ropes.

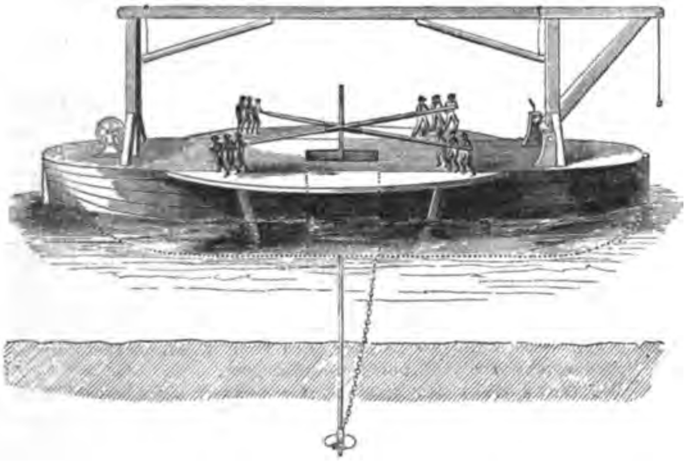
Fig. 11 shows the applicability to smaller objects, and a tent-pin has been selected as the most familiar example, as it requires to be removed so frequently, and shows the use that may be made of the screw, for the standards of fencing, and for an infinite number of agricultural and other purposes.


Fig. 11.

Remarks after the reading of the above Paper.

Mr. Brooks said he had considerable experience in the use and merits of the screw-moorings, and must accord them his entire approval. It was more conclusive to give facts than opinions, and therefore, although he had not come prepared to address the meeting, he would state succinctly what had been done in the Tyne. A heavy ground chain, composed of links each 3 feet in length, of round iron 3¼ inches in diameter, was stretched along the bed of the river in the deep water, and in the direction of the current, instead of according to the old system, placing it as a bridle across the stream (as shown in the wood-cut, fig. 2.) To this chain, at given distances, marking the centre of each tier, and the mid-distance between, were shackled studded link mooring-chains of 2¼-inch iron, which had been previously laid down, with the lower extremity of each attached to a screw-mooring, inserted into the bottom of the river at each spot to depths varying from 10 feet to 20 feet. The chain attached to the sheer-screw was two fathoms longer than that to which the mooring-screws were shackled, so as to allow the strain to come upon the mooring-screws, instead of upon the sheer-screws, which latter were only intended to bear the strain arising from the vessels ranging across the stream, when the wind was off either shore. The moorings were placed where the depth varied at low-water spring tides from 15 to 24 feet. The bed of the river consisted of sand for about six feet in depth, and then clay for about four feet; rock was generally met with, but the latter, where it consisted of a stratum of shale, was penetrated by the wrought-iron screw point, for about one foot, or as far as the underside of the table of the screw. The screw-moorings which were used were four feet in diameter, and unless they were stopped by rock, they were easily inserted to a depth of 15 feet into the sand and clay, in about an hour and a half. Some of them had been screwed down to a depth of 21 feet in less than two hours. It must be observed, however, that a very efficient apparatus was constructed expressly for the operation (figs. 12, 13, and 14)): it consisted of a hopper barge, with semicircular leaves on each side, forming, when lowered, a platform of about 40 feet in diameter. The capstan had eight bars, each 20 feet in length, requiring four or five men to each bar, according to the quality of the soil into which the screws were to be forced (fig. 6.) Each screw was intended by Messrs. Mitchell and Son to bear a strain of four heavy ships; but during the crowded state of the port, for several months of the winter of 1847, double that number of vessels generally made fast to them.

Fig. 12.



Mr. Walker said, with respect to the screw-piles for foundations for lighthouses upon sand or mud-banks, those upon the Maplin Sand had been very successful; for, although the sand on the surface had shifted considerably, being carried away and brought back again by different states of the sea, the screw-piles stood perfectly; in fact, they offered no obstruction to the passage of the waves, and caused no scour. With respect to the Goodwin Sands, it was not generally known, that the Corporation of the Trinity House had caused a beacon to be placed on the back of the sand, consisting of a base of cut stones well secured together, with an octagon-sided vessel, or caisson, which was towed to the spot and grounded; the sides were then unshipped, leaving the bottom under the mass of stone, and an iron beacon mast was stepped into it. This beacon was now the only one in existence upon the sands. He believed, that beacons, or other structures, erected upon screw-piles, would stand as well on the Goodwin Sands as on the Maplin and other places. Schemes for lighthouses to be placed upon the Goodwin Sands were constantly pressed upon his notice; but it did not appear to be understood, that any solid edifice, to be erected in that locality, must have its foundation carried down to the chalk, to insure its durability. The Corporation of the Trinity House wished it to be understood, that it was not their intention to place lights upon the Goodwin Sands; but rather to place them around that spot, in order that vessels might avoid its dangers. At present, floating lights were employed; but if fixed lights could be placed in the same, or equally useful localities, he had no doubt the project would be entertained. He had a good opinion of the screw-piles for this purpose, and when the question came before him in a tangible form he should be ready to give it his attention, for he thought, that a lighthouse could be erected on that principle, in a difficult position, more economically than by any other plan. The Corporation of the Trinity House was now about to test the strength of iron lighthouses, by erecting one upon the Bishop Rock, in the Scilly Islands, in a situation which was even more exposed than the Eddystone. The plan adopted for fixing the foundations was, to bore holes in the rock, to clamp masses of iron into them, and then bolt down the lighthouse upon these fixed irons. Whether this system would answer, or whether stone or iron for the structure would be the most durable, remained to be proved. At the Point of Ayr, Mr. Walker had adopted another system for the foundation of a lighthouse placed upon piles. Cast-iron cylinders were sunk into the bank, the piles were placed within them, and each was filled with concrete; this system was practicable in certain situations, where the bank was dry at low water, but was evidently not so generally available as the screw pile, which offered great facilities, by the rapidity with which it could be inserted even at considerable depths under water, with very simple and inexpensive apparatus.*

Fig. 13.

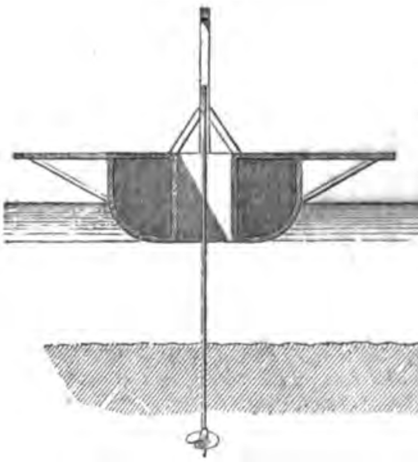
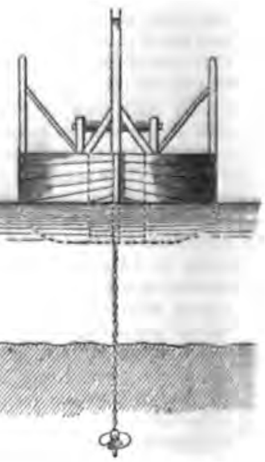


Fig. 14.



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* Mr. Brunel has recently caused a very interesting and conclusive experiment to be tried, near the proposed site of the bridge for carrying the South Wales Railway across the river Wye, at Chepstow. A cast-iron cylinder, 3 feet diameter externally, 1⅛ inch in thickness, cast in lengths 10 feet each, with internal socket and joggle joints, secured with pins and run with lead, was armed at the extreme bottom with a sharp wrought-iron hoop, and a little above it was a helical flanch projecting 12 inches all round from the body of the cylinder, around which it made an entire revolution, with a pitch of 7 inches. By means of capstan-bars worked by manual labour, and by strong winches, this cylinder was screwed into the ground, near the bank of the river, but out of the influence of the tide, to a depth of 58 feet, in 48 hours and 14 minutes, through stiff clay and sand down to the marl rock. In descending to that depth the cylinder made 142 revolutions, and the average rate of sinking per revolution, very nearly accorded with the pitch of the screw. The time quoted is only that which was actually consumed in forcing the cylinder down, as it was allowed to rest for long periods, whilst the interior core of clay was repeatedly cleared out, and on account of the breakages of the ropes and the capstan-bars, and other casualties incidental to all first experiments. It is the intention o Mr. Brunel to try a cylinder 6 feet diameter, with a larger helical flanch or screw, before deciding upon the dimensions of the cylinders for the foundations of his bridges, to be placed in situations where there is a great depth of mud, stiff clay, and sand. Of this and the subsequent experiments, accounts may probably be given hereafter.

ON THE STRENGTH OF MATERIALS.

On the Strength of Materials, as Influenced by the Existence or non-Existence of certain Mutual Strains among the Particles composing them. By James Thomson, Jun., M.A., College, Glasgow. —[From the *Cambridge and Dublin Mathematical Journal*, November, 1848.]

My principal object in the following paper is to show that the absolute strength of any material composed of a substance possessing ductility (and few substances, if any, are entirely devoid of this property), may vary to a great extent, according to the state of tension or relaxation in which the particles have been made to exist when the material as a whole is subject to external strain.

Let, for instance, a cylindrical bar of malleable iron, or a piece of iron wire, be made red hot, and then be allowed to cool. Its particles may now be regarded as being all completely relaxed. Let next the one end of the bar be fixed, and the other be made to revolve by torsion, till the particles at the circumference of the bar are strained to the utmost extent of which they can admit without undergoing a permanent alteration in their mutual connection.* In this condition, equal elements of the cross-section of the bar afford resistances proportional to the distances of the elements from the centre of the bar; since the particles are displaced from their positions of relaxation through spaces which are proportional to the distances of the particles from the centre. The couple which the bar now resists, and which is equal to the sum of the couples due to the resistances of all the elements of the section, is that which is commonly assumed as the measure of the strength of the bar. For future reference, this couple may be denoted by L, and the angle through which it has twisted the loose end of the bar by θ.

The twisting of the bar may, however, be carried still farther, and during the progress of this process the outer particles will yield in virtue of their ductility, those towards the interior assuming successively the condition of greatest tension; until, when the twisting has been sufficiently continued, all the particles in the section, except those quite close to the centre, will have been brought to afford their utmost resistance. Hence, if we suppose that no change in the hardness of the substance composing the material has resulted from the sliding of its particles past one another—and that, therefore, all small elements of the section of the bar afford the same resistance, no matter what their distances from the centre may be—it is easy to prove that the total resistance of the bar is now $\frac{4}{3}$ of what it was in the former case; or, according to the notation already adopted, it is now $\frac{4}{3}$L.

To prove this, let r be the radius of the bar, η the utmost force of a unit of area of the section to resist a strain tending to make the particles slide past one another; or to resist a shearing strain, as it is commonly called. Also, let the section of the bar be supposed to be divided into an infinite number of concentric annular elements; the radius of any one of these being denoted by x, and its area by $2\pi x dx$.

Now, when only the particles at the circumference are strained to the utmost; and when, therefore, the forces on equal areas of the various elements are proportional to the distances of the elements from the centre, we have $\eta\frac{x}{r}$ for the force of a unit of area at the distance x from the centre.

Hence the total tangential force of the element is

$$= 2\pi x\,dx\,.\,\eta\frac{x}{r};$$

and the couple due to the same element is

$$= x\,.\,2\pi x\,dx\,.\,\eta\frac{x}{r} = 2\pi\eta\frac{1}{r}\,.\,x^3 dx:$$

and therefore the total couple, which has been denoted above by L, is

$$= 2\pi\eta\frac{1}{r}\int_0^r x^3 dx, \text{—that is}$$

$$L = \tfrac{1}{2}\pi\eta r^3 \ldots\ldots\ldots\ldots\ldots\ldots (a).$$

Next, when the bar has been twisted so much that all the particles in its section afford their utmost resistance, we have the total tangential force of the element $= 2\pi x\,dx\,.\,\eta$;
and the couple due to the same element $= x\,.\,2\pi x\,dx\,.\,\eta = 2\pi\eta\,.\,x^2 dx$.
Hence the total couple due to the entire section is

$$= 2\pi\eta\int_0^r x^2 dx = \tfrac{2}{3}\pi\eta r^3.$$

But this quantity is $\frac{4}{3}$ of the value of L in formula (a). That is, the couple which the bar resists in this case is $\frac{4}{3}$ L, or $\frac{4}{3}$ of that which it resists in the former case.

If, after this, all external strain be removed from the bar, it will assume a position of equilibrium, in which the outer particles will be strained in the direction opposite to that in which it was twisted and the inner ones in the same as that of the twisting,—the two sets of opposite couples thus produced among the particles of the bar balancing one another. It is easy to show that the line of separation between the particles strained in the one direction, and those in the other, is a circle whose radius is $\frac{3}{4}$ of the radius of the bar. The particles in this line are evidently subject to no strain* when no external couple is applied. The bar with its new molecular arrangement may now be subjected, *as often as we please*,† to the couple $\frac{4}{3}$ L, without undergoing any farther alteration; and therefore its ultimate strength to resist torsion, in the *direction of the couple* L, has been considerably increased. Its strength to resist torsion in the opposite direction has, however, by the same process, been much diminished; for, as soon as its free extremity has been made to revolve backwards through an angle of $\frac{2}{3}\theta$ from the position of equilibrium, the particles at the circumference will have suffered the utmost displacement of which they can admit without undergoing permanent alteration. Now it is easy to prove that the couple required to produce a certain angle of torsion is the same in the new state of the bar as in the old.‡ Hence the ultimate strength of the bar when twisted backwards, is represented by a couple amounting to only $\frac{2}{3}$ L. But, as we have seen, it is $\frac{4}{3}$ L when the wire is twisted forwards. That is, *The wire in its new state has twice as much strength to resist torsion in the one direction as it has to resist it in the other.*

Principles quite similar to the foregoing, operate in regard to beams subjected to cross strains. As, however my chief object at present is to point out the existence of such principles, to indicate the mode in which they are to be applied, and to show their great practical importance in the determination of the strength of materials, I need not enter fully into their application in the case of cross-strain. The investigation in this case closely resembles that in the case of torsion, but is more complicated on account of the different ultimate resistances afforded by any material to tension and to compression, and on account of the numerous varieties in the form of section of beams which for different purposes it is found advisable to adopt. I shall therefore merely make a few remarks on this subject.

If a bent bar of wrought-iron, or other ductile material, be straightened, its particles will thus be put into such a state, that its strength to resist cross-strain, in the direction towards which it has been straightened, will be very much greater than its strength to resist it in the opposite direction, each of these two resistances being entirely different from that which the same bar would afford were its particles all relaxed when the entire bar is free from external strain. The actual ratios of these various resistances depend on the comparative ultimate resistances afforded by the substance to compression and extension; and also, in a very material degree, on the form of the section of the bar. I may however state that in general the variations in the strength of a bar to resist cross-strains, which are occasioned by variations in its molecular arrangement, are much greater even than those which have already been pointed out as occurring in the strength of bars subjected to torsion.

What has been already stated is quite sufficient to account for many very discordant and perplexing results which have been arrived at by different experimenters on the strength of materials. It scarcely ever occurs that a material is presented to us, either for experiment or for application to a practical use, in which the particles are free from great mutual strains. Processes have already been pointed out, by which we may at pleasure produce certain peculiar strains of this kind. These, or other processes producing somewhat similar strains, are used in the manufacture

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* I here assume the existence of a definite "elastic limit," or a limit within which if two particles of a substance be displaced, they will return to their original relative positions when the disturbing force is removed. The opposite conclusion, to which Mr. Hodgkinson seems to have been led by some interesting experimental results, will be considered at a more advanced part of this paper.

* Or at least they are subject to no strain of torsion either in the one direction or in the other; though they may perhaps be subject to a strain of compression or extension in the direction of the length of the bar. This, however, does not fall to be considered in the present investigation.

† This statement, if not strictly, is at least extremely nearly true: since from the experiments made by Mr. Fairbairn and Mr. Hodgkinson on cast-iron (see various Reports of the British Association), we may conclude that the metals are influenced only in an extremely slight degree by time. Were the bars composed of some substance such as sealing-wax or hard pitch, possessing a sensible amount of viscidity, the statement in the text would not hold good.

‡ To prove this, let the bar be supposed to be divided into an infinite number of elementary concentric tubes (like the so-called annual rings of growth in trees); to twist each of these tubes through a certain angle, the same couple will be required whether the tube is already subject to the action of a couple of any moderate amount in either direction or not. Hence, to twist them all, or what is the same thing, to twist the whole bar, through a certain angle, the same couple will be required whether the various elementary tubes be or be not relaxed, when the bar as a whole is free from external strain.

of almost all materials. Thus, for instance, when malleable iron has received its final conformation by the process termed *cold swaging*, that is by hammering it till it is cold, the outer particles exist in a state of extreme compression, and the internal ones in a state of extreme tension. The same seems to be the case in cast-iron when it is taken from the mould in which it has been cast. The outer portions have cooled first, and have therefore contracted while the inner ones still continued expanded by heat. The inner ones then contract as they subsequently cool, and thus they as it were pull the outer ones together. That is, in the end, the outer ones are in a state of compression, and the inner ones in the opposite condition.

The foregoing principles may serve to explain the true cause of an important fact observed by Mr. Eaton Hodgkinson in his valuable researches in regard to the strength of cast-iron (*Report of the British Association* for 1837, p. 362).* He found that, contrary to what had been previously supposed, a strain, however small in comparison to that which would occasion rupture, was sufficient to produce a set in the beams on which he experimented. Now this is just what should be expected in accordance with the principles which I have brought forward; for if, from some of the causes already pointed out, various parts of the beam previously to the application of an external force have been strained to the utmost, when, by the application of such force, however small, they are still farther displaced from their positions of relaxation, they must necessarily undergo a permanent alteration in their connection with one another,—an alteration permitted by the ductility of the material; or, in other words, the beam as a whole must take a set.

In accordance with the explanation of the fact observed by Mr. Hodgkinson, I do not think we are to conclude with him, that "the maxim of loading bodies within the elastic limit has no foundation in nature." It appears to me that the defect of elasticity which he has shown to occur even with very slight strains, exists only when the strain is applied for the first time; or, in other words, that if a beam has already been acted on by a considerable strain, it may again be subjected to any smaller strain in the same direction without its taking a set. It will readily be seen, however, from Mr. Hodgkinson's experiments, that the term "elastic limit," as commonly employed, is entirely vague, and must tend to lead to erroneous results.

The considerations adduced seem to me to show clearly that there really exist *two elastic limits* for any material, between which the displacements or deflections, or what may in general be termed the changes of form, must be confined, if we wish to avoid giving the material a set; or, in the case of invariable strains, if we wish to avoid giving it a continuous succession of sets, which would gradually bring about its destruction; that these two elastic limits are usually situated, one on the one side, and the other on the opposite side of the position which the material assumes when subject to no external strain, though they may be both on the same side of this position of relaxation,† and that they may, therefore, with propriety, be called the *superior* and *inferior limit* of the change of form of the material for the particular arrangement which has been given to its particles; that these two limits are not *fixed* for any given material, but that if the change of form be continued beyond either limit, two new limits will, by means of an alteration in the arrangement of the particles of the material, be given to it in place of those which it previously possessed; and lastly, that the processes employed in the manufacture of materials are usually such as to place two limits in close contiguity with one another, thus causing the material to take in the first instance a set from any strain, however slight, while the interval which may afterwards exist between the two limits, and also, as was before stated, the actual position assumed by each of them, is determined by the peculiar strains which are subsequently applied to the material.

The introduction of new, though necessary, elements into the consideration of the strength of materials may, on the one hand seem annoying from rendering the investigations more complicated. On the other hand, their introduction will really have the effect of obviating difficulties, by removing erroneous modes of viewing the subject, and preventing contradictory or incongruous results from being obtained by theory and experiment. In all investigations, in fact, in which we desire to attain, or to approach nearly to, truth, we must take facts as they actually are, not as we might be tempted to wish them to be, for enabling us to dispense with examining processes which are somewhat concealed and intricate, but are not the less influential from their hidden character.

EDUCATION OF ENGINEERS.

The study of engineering presents peculiar difficulties; not from the paucity of information, but from the multiplicity of its sources, which are so many and so widely separated, that the student may well be bewildered and discouraged when presented with a map of his future course. Let us consider a few of the branches of knowledge with which he must be adequately acquainted before he can be said to have mastered the whole of the principles of his profession.

As a large part of his business consists in adapting mineral products to useful purposes, he must be acquainted with the mechanical and chemical properties of minerals, and must be able to distinguish good metal from bad, sound building materials from those which are perishable, &c. He must, therefore, be acquainted with the science of MINERALOGY—or, at least, that part of it which is susceptible of practical application. The changes which in the progress of time are wrought in those minerals by affecting their molecular or crystalline structure, the value of different methods of working them, the chemical changes wrought by the atmosphere, and the action of foreign substances, are considerations which render indispensable an adequate knowledge of CHEMISTRY. The engineer employed in constructing railways, roads, canals, and harbours, must certainly be acquainted with GEOLOGY: for, how shall he estimate beforehand the probable cost of his works, their permanency, or the most judicious mode of carrying them on, unless he know the nature of the soils in which he will have to operate, the order of their succession, their relative depths, and stratification? To estimate the proper form and dimensions of the structures which form part of his works, he must be thoroughly versed in the science of STATICS. To determine the most effective agents of mechanical power, and the most economical methods of producing and regulating motion, the knowledge of DYNAMICS will be required. The operation of the steam-engine, atmospheric railways, the air-pump, the ventilation of mines, &c., are to be understood only by the investigation of the principles of elastic fluids—PNEUMATICS. The sciences of inelastic fluids—HYDROSTATICS, and HYDRAULICS, are essential in constructing sea-walls, breakwaters, canals, and docks, in ascertaining the power of water-mills and hydrostatic-engines, in works of drainage and water-supply, and in naval architecture.

The sciences already enumerated by no means exhaust the list included in the engineer's *curriculum*. Most of them involve a knowledge of MATHEMATICS, and some of them of its highest branches—in dynamics, for instance, the processes of the Differential Calculus are involved at every step. Mathematical knowledge will, moreover, be required in a most important branch of the engineers occupation—surveying, and the measurement of works. To lay down the course of a railway or estimate the cubic contents of an embankment, would be impossible without some knowledge of TRIGONOMETRY and SOLID GEOMETRY.

The institution of colleges expressly intended for the scientific education of young engineers, is an ample evidence of the general recognition of the value of the abstract sciences for practical purposes. There are now three colleges in London, or its vicinity—King College, University College, and the College of Civil Engineers, at Putney, in which a course of study is adopted for the especial purpose of preparation for the practice of civil engineering. In estimating the value of such institutions, it should be carefully remembered that the knowledge of the engineer is of two kinds—scientific and practical knowledge. The former may be acquired from books in the laboratory or college lecture-room—the latter is to be obtained in the workshop, or the canal or railway works.

The substitution of certainty for conjecture, of demonstration for hazardous and imperfect analogies—these, in fact, are the objects of colleges of civil engineering. The details of the

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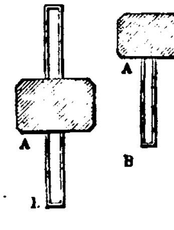
* For further information regarding Mr. Hodgkinson's views and experiments, see his communications in the "Transactions of the Sections of the British Association" for the year 1843 (p. 23) and 1844 (p. 25), and a work by him, entitled "Experimental Researches on the Strength and other properties of Cast Iron." 8vo. 1846.

† Thus, if the section of a beam be of some such form as that shown in either of the accompanying figures the one rib or the two ribs, as the case may be, being very weak in comparison to the thick part of the beam, it may readily occur that the two elastic limits of deflection may be situated both on the same side of the position assumed by the beam when free from external force. For if the beam has been supported at its extremities and loaded at its middle till the rib A B has yielded by its ductility so as to make all its particles exert their utmost tension, and if the load be now gradually removed, the particles at B may come to be compressed to the utmost before the load has been entirely removed.



courses of lectures may differ in each, but to all of these institutions may be applied the words of a printed statement respecting the Putney College, in which it is said that "the foundation of the system is laid in a knowledge of the exact sciences and properties of matter—*i.e.*, upon mathematics and chemistry." The mathematical course includes, among the sciences above referred to, as forming a necessary part of the education of the engineer, Geometry, Analysis (including the Differential and Integral Calculus), Statics, Dynamics, and Hydraulics. Fortunately—most fortunately—in all three colleges, the Mathematical lectures are delivered by *mathematicians*, not by mathematical pretenders, whose acquirements consist in a certain impudent dexterity in dazzling the eyes of those who are more ignorant than themselves, by a display of mathematical jargon. The practical classes of Chemistry afford the student the opportunity of analysing and assaying minerals by direct manipulation. The lectures on Geology include the practical application of the science to architecture, marine engineering, and mining: there are also lectures on civil engineering, machinery, mechanical drawing, &c. We will not venture to assert that this course of instruction altogether supersedes the necessity of further pupilage in the office of a civil engineer; on the contrary, the student is strongly urged to avail himself of that advantage, for without it he never will be fit to cope with any work of magnitude.

We cannot close this account without referring to an incidental advantage of these colleges, in promoting the improvement of engineering literature. For the wretchedly inaccurate works which were palmed on the practical mechanic a few years ago, we have new and admirable treatises on the various applications of the sciences, by Mr. Hodgkinson at University College, Professor Moseley and Mr. Hann at King's College, and of the Putney lecturers, by Professor Ansted, Dr. Lyon Playfair, Professor Davies, &c. It is also gratifying to add to this list, the name of Mr. Cowie, as he has announced the publication of his lectures on Hydraulics, combining his own researches with the results of the eminent continental writers on the subject. The *vexatæ questiones* of hydraulics are so many and so perplexing, that this work can scarcely fail of rendering important service to science. Truly the labours of such men are wanted to bring the engineering literature of this country up to the same standard which in France the splendid investigations of Poncelet, Navier, and others scarcely less illustrious, have attained.

THE DUNDEE COMPETITION.

By the time that this article appears in print, the designs for "an Ornamental Building to be erected at the Harbour of Dundee, commemorative of the landing of Her Majesty at that port in 1844," will have been sent in. In one respect, there is no difference between this and nearly all other competitions, the time allowed for the preparation of designs being absurdly short. Committees seem to think that architects are *improvisatori*,—that they require only to have a subject proposed to them, when their stock of ever-ready inspiration will enable them to pour forth ideas as happy as they are unpremeditated. They seem, moreover, to fancy that architects are always at leisure to sit down to their drawing-board at once, as soon as they have read an advertisement inviting them to compete. Not only quite unnecessary and absurdly preposterous, but this hurry is deplorably mischievous in its consequences; nor is it at all to be wondered at that so many crude designs should be produced on such occasions, since no time is allowed for due study and leisurely consideration of the subject. Committees are not at all aware that what are carefully-executed *drawings* may nevertheless be exceedingly careless, unstudied *designs*,—even the best of them inferior to what they would be were time allowed for correcting first ideas. It is only by attributing it to ignorance of its consequences, that we can account for the lamentable hurry with which competitions are managed, we being unable to imagine that any set of men would knowingly frustrate their own object—viz., the obtaining a really good design—through their own childish impatience, and their not affording architects leisure for properly conceiving and maturing what they are required to do. Many times have committees been strongly suspected of, if not openly charged with, unfairness towards competitors: at least, it shows some grace in them to be equally unfair to themselves, by defrauding themselves of the benefit of artistic study. At the same time, too, that it is contrary to the interest of those who invite—at least, pretend to invite talent to their aid, the very uncalled-for haste imposed upon architects in almost every instance of competition, is a real grievance to them. It frequently compels them either to forego competing altogether, or else to sit down to an additional task after the avocations of the day are over, and perhaps to sit up nearly all the night—not merely once, but two or three nights together—in order to be able to send off their drawings before the expiration of the term allowed. Thus, what should be cheerful employment is converted into mere toil, attended with feverish anxiety. Nor does the hardship stop there; for even toil may be patiently endured, if we feel assured that we are earning something by it. To cheer those who engage in architectural competition, there exists no such assurance: on the contrary, they have to bear up against the disheartening assurance that they are exerting themselves for a mere chance, since only one can possibly be the successful man.

There are surely unavoidable vexations enow attending competition, without their being increased by the heartless inconsiderateness and arbitrary whims of committees, who seem to pride themselves upon showing that the power they possess is irresponsible. Greatly would architectural competitors be relieved, were mere sketches, instead of finished drawings, to be required of them. Such draughts would exhibit the ideas of their respective authors; and when the best, or what should be judged to be the best, idea had been selected, it would then be time enough to ask for a fair and finished copy of it. Not the least advantage attending such mode would be, that it would compel—at least lead, committees to give their attention to ideas and matters of actual design; whereas now, it is to be apprehended, they frequently suffer themselves to be biassed and misled by the mere manual ability shown in drawing.[*] In fact, it may be said that, according to the present system, while they exercise their power very arbitrarily, they generally exercise it so as to dupe themselves in the end; which, though it may be some, is but very sorry, satisfaction to those who may have been, if not always exactly duped, toiled and taxed by them.

These general and preliminary remarks have detained us longer than we expected, wherefore we will not detain our readers by apologising for them; but continue without farther interruption to notice the very unusual circumstances attending this particular Competition. So far from there being the slightest vagueness or ambiguity on the part of the Committee's invitation to architects, it tells them exactly what it is that is wanted. In the case of the Nelson Monument, the competitors were left to adopt whatever form they pleased—arch, column, fountain, obelisk, trophy, pyramid, temple;—a kind of freedom that was not a little embarrassing, and which must have chilled by the perplexing doubts and misgivings attending it. Unlike the "Nelson" one, the Dundee Committee honestly inform architects that the "ornamental building" which they require is to be an arch; so that there can be no mistake in that respect. Besides which, the foundations being already laid, the plan is shaped out, and its dimensions fixed: so that the task extends to no more than that of designing a superstructure upon it. There are to be three openings or passages, the centre one 21 ft. wide, the smaller ones 10 ft. 6 in. each, and the extent of the whole rather more than 80 ft. These dimensions are so considerable, that they seem to indicate the intention of producing a monumental work; as will appear from comparing them with the corresponding dimensions of some other structures of the same nature.

	Centre Arch.				Side Arches.			
	Width		Height.		Width.		Height.	
	ft.	in.	ft.	in.	ft.	in.	ft.	in.
Arch of Constantine	21	4	38	2	11	0	24	0
Arch of Titus	19	0	26	6	none			
Porte St. Denis	26	0	50	0	none			
Marseilles	20	0	37	0	none			
Arch, Green Park	16	6	32	0	none			
Marble Arch, Buckingham Pal.	15	6	29	0	9	0	19	10
Arch of the Tuileries	14	0	28	0	8	3	16	6

These instances may suffice, although we should have liked to have given the corresponding dimensions of the Arco della Pace, at Milan, but cannot at the moment find our memorandum of them. We believe, however, that its principal opening does not exceed 18 feet by 36 feet, consequently falls short of what is fixed for the one in the intended structure at Dundee. As the width of this last is to be 21 feet, hardly can it be under 40 feet in height, unless it is to vary considerably from the usual proportions, and conse-

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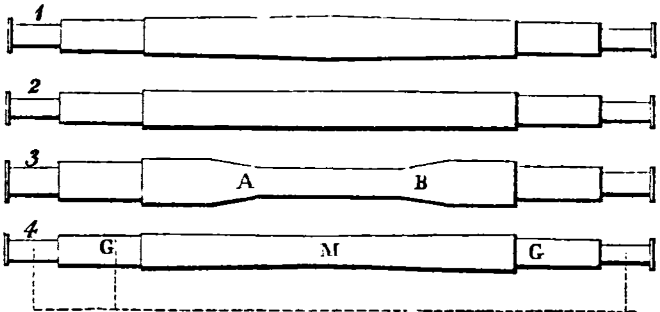
[*] Instead of operating as a recommendation, particular carefulness or merit in point of mere drawing ought to be received with suspicion, as intended to cajole the judgment, and divert from an impartial consideration of the design itself. Besides, in all probability, the author of a design has had no hand whatever in the fair copy of it, it being now-a-days a notorious practice for architects to employ other people for the purpose; as is divulged by the advertisements of parties who offer them their services in "the getting-up of Exhibition and Competition Drawings!"

quently from *precedent*,—although precedent, such as it is—and it is certainly more cockney than classical—may be found, namely Temple Bar, whose gateway is only 19 feet high, although 21 feet in width.

Supposing the large arch to be made 40 feet high in the clear, about 20 feet more will be required for the height of the whole structure—that is, according to most examples of the kind; so that the whole would form a mass about 80 feet in length by 60 feet in height. Now, we do not object to a work of such magnitude; yet how is it to be accomplished for the inadequate sum of 2,000*l*? The arch in the Green Park, which is only 62 feet in length by 60 feet in height, is stated to have cost somewhere about 30,000*l*, It must be admitted that it is so deep a mass, that two of the same size in other respects, but much shallower, might have been erected for the money: let us therefore take the cost at 10,000*l*, exclusive of foundations. Yet, allowing for the same exclusion, only one-fifth of that sum is to be expended upon an *Ornamental Building*, of very considerable size. The epithet "ornamental" implies, we presume, that a more than ordinary degree of decoration is looked for,—perhaps sculptural embellishment as well as architectural.—The problem seems to be so difficult a one, that we hope even its difficulty will be productive of good, by compelling the competitors to depart from the regular track,—to fling precedent overboard, and strike out some new ideas.

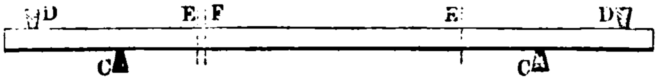
REMARKS ON RAILWAY AXLES.

Sir—A few years ago, there existed a great difference of opinion concerning the best form for railway axles, which often occasioned much unprofitable discussion among some of our mechanical engineers. The question has lately been silent, and experience or imitation appears to have decided the form now most generally approved. There is, however, a wide difference in the dimensions and quantity of material in the axles used for similar purposes by different companies. This circumstance, together with the great importance of having a safe axle, shows the necessity of an established system of proportions for future guidance, as every one connected with railways is aware of the important saving that would be effected by dispensing with only a few pounds of unnecessary material in each axle of a railway company's stock.



The four annexed figures are intended to represent the different forms that have been used. No. 1, which is thickest in the middle and tapered towards each wheel, appears to be altogether thrown aside; No. 2, which is parallel between the journals, is still frequently used; No. 3, which is parallel from A to B, and No. 4, which is diminished from each wheel to the centre, appear to be the two forms now most in use,—the latter, however, being, it is believed, the most correct.

The writer is in favour of No. 4, although he has not had the pleasure of seeing any satisfactory proof of its being the most correct. In the following experiment he was, however, convinced that these axles require to be smaller in the centre than at the wheel bosses, but in what exact proportion he has not been able to decide. In the experiment alluded to, a parallel bar of cast-iron, of longitudinal dimensions similar to those of an ordinary railway axle, was placed upon two supports, C C, as substitutes for the wheel bosses, as here shown, and then submitted to forces acting equally upon each end at equal distances from the supports, which points, D D, were supposed to be the centres of the journals: the force being gradually increased, the bar broke simultaneously through E E. The experiment was repeated; but in the second trial the bar broke only in one point, F,—being a little nearer to the middle. This was considered sufficient proof that a portion of the metal might be removed from the middle of the bar without diminishing its lateral strength; and that by adding this metal about the points E E, the lateral strength would be increased.



The result of this experiment was applied to a number of railway axles for 4 ft. 8½ in. gauge, which were to have been made of 4 in. parallel bar, but were altered to the form No. 4, being 4¼ in. diameter in the wheel bosses, and 3½ in. diameter in the middle,—which was calculated to require no more material than if they had been made 4 in. throughout, as originally intended. It still remains a question whether this difference in the diameter of the body of the axle was the most correct, as it was decided by mere supposition subsequently to the above experiment.

Besides the most economical form for the body of an axle, it is of importance to have journals equally well-proportioned. The journals were formerly very short compared with some of modern make: four inches was not an unusual length, but they have kept gradually increasing, and six inches is now become very general;—there are indeed instances which far exceed this dimension. The gradual changes which have been going on in this, as well as in other parts of the axle, also prove the want of more correct data. The object of this paper is not to lay before your readers any new idea relative to the form and proportions of railway axles, but merely to call the attention of practical men to the subject, whose long experience and observation could not fail to supply much that is required.

The narrow limits of the writer's own observation in railway matters, would not warrant him in offering more than a mere suggestion, and as such he begs to submit the following formula, which it is hoped will not be found totally void of utility.

$$\sqrt[3]{\frac{a\,b\,w}{18c\,(a+b)}} = \mathrm{D}$$

$$\sqrt{2\,\mathrm{D}^2} = \text{diameter of G (fig. 4)}$$

$$\sqrt{3\,\mathrm{D}^2} = \text{diameter of M (fig. 4)}$$

$$3\,\mathrm{D} = \text{length of the journal.}$$

Wherein a = A B (fig. 4) in inches; b = B C in inches; c = the number of wheels to the wagon; D = diameter of the journals in inches; and w = the greatest load to be borne by the wagon in cwts., including the weight of the wagon.

Your obedient servant,

Manchester, *Jan.* 6, 1849. J. N.

REVIEWS.

THE PHILOSOPHY OF NATURE AND ART.

An Historical Inquiry into the True Principles of Beauty in Art, more especially with reference to Architecture. By James Fergusson, Esq., Architect; author of "An Essay on the Ancient Topography of Jerusalem," "Picturesque Illustrations of Ancient Architecture in Hindostan," &c. Part the First. London: Longmans, 1849.

[second notice.]

We continue Mr. Fergusson's review of the state of science, and the field which is open for its further cultivation, because we think it will do good in science as in art to show how much remains to be done, and the encouragement there is for a zealous student. It was the belief there were worlds to conquer that stimulated the ambition of Alexander: it was because he knew of none open to his ambition that his energies palled. The belief that we are too near the goal has dispirited many a learner, and has done much to retard the progress of knowledge; whereas all that we have done is only a reason and a means by which to do more.

In considering the state of Botany, Mr. Fergusson dwells upon the importance of investigating the phenomena of life; but still he does not show their full influence. Botany is too much looked upon as a study of dead substances; but without we contemplate from the beginning the operations of life, we can have no good system of physiology. Life introduces action,—action, counter-action; and the first moment of life is the first indication of decay. There is a sequence throughout dependent on a first cause, and this must be carefully observed. Life constitutes, the author says, a great distinction between vegetables and minerals, for the latter, so far as we know, have a course of existence which is undetermined; but the others have a period the bounds of which are limited and in most cases known.

There are, it is true, great diversities between the lives of plants, some which die almost as soon as born—some, the giants of the forest, which live for centuries; but the career of each has its bounds. This limitation has, too, its connection necessarily with the performance of every function of being. Mr. Fergusson speaks with reservation as to the existence of minerals being limited or unlimited; and this not without good reason, though the common belief and the common systems of philosophy please themselves with the eternity of the mineral structure of the globe. If, however, there is a wide range between the life of an ephemeral fungus and of an aged dragon-tree or oak; and if, too, there is a wide range, but a less one, between the life of a day-fly and an elephant, a turtle or a raven, so, on the other hand, for aught we know, there may be a wider range which in the mineral kingdom may give thousands of years of being and a limited life to materials which we look upon as lasting for ever. We know that the hardest granite, the best consolidated clay, the purest limestone, had a beginning, and are the resultants of former combinations. We know, too, that there are minerals so fleeting in their form, that they can hardly be preserved or watched (p. 57). These are incident to the machine of the globe, and if the phenomena are not developed as those of individual beings, then they relate to those of the globe itself as an organised body, and are subject to the limitations of condition which the organs of other bodies undergo. There is therefore nothing which, in the absence of positive proof, justifies us in believing that the existence of minerals is without a limit, any more than that of plants and beasts.

We do not know whether Mr. Fergusson establishes a true distinction, when he says of the plants, that though the individual must perish, to all it is given to live on in their offspring, which differ in nothing from themselves; till it becomes more like an oscillation to-and-fro of one individual through an indefinite time, than the limited career between birth and death, which seems the beginning and end of each individual.

Botanical classification leads the writer to give some cautions on the subject of classification generally. He says truly, that it must be ever borne in mind that no such things as the classes established exist in nature. Classification, indeed, is a legitimate application of theory. In considering the laws of light, we assume the Newtonian or Huygenian theory, not admitting thereby that either represents the true facts or the true results, but taking either as a convenient general system to enable us to follow out consistently the various operations. The mistake of superficial learners is in this—that they believe the direct contrary, and adopt Newton or Huygens as the expounders of facts. The injury to science is the greater, as many are deterred from propounding new theories, which may tend to elucidate the facts. So in the classification of plants or beasts, the classification is only a matter of expediency; for in nature there is no rosaceous province, no bound within which the feline tribe is restrained. Mr. Fergusson explains that an artificial classification is not to be found in nature, because she works out her problems with a complexity and infinity of detail which man can never comprehend; and though every plant is subject to immutable laws, and perfect regularity reigns, from the minute ultimate particles to the whole aggregated kingdom, it is not such a formal arrangement as our classification attempts.

Mr. Fergusson approves of the retention for their respective purposes of both the Linnean and Jussieuan or natural system, and makes a very useful suggestion, that naturalists should, like grammarians, admit lists of irregular plants or animals, instead of forcing them into places where they do not fit, or multiplying genera to an inconvenient extent. He would likewise place between each class or genus a list of neuters, which belong equally to either. We would extend his liberality as to the two systems in botany, by using the same toleration in other branches of science. If the Newtonian theory explains some phenomena which the undulatory does not, why not admit both?—for neither Newton nor Huygens is more than a hearsay witness. A more catholic feeling on these matters is indeed most needful for the right growth of knowledge.

On proceeding to Zoology, Mr. Fergusson gives some time to Ontology, the intellectual functions of animals. Here, likewise, he steps out of the common beaten track, and instead of binding himself to the functions of instinct, he holds forth that beasts have minds of the same kind as man. He at once sets aside the *à priori* arguments derived from the Greek metaphysics and sectarian dogmata, and takes facts as he finds them. He comes to the answer, that the growth of mind agrees with that of brain; that this law is followed from the lowest polyp to the hugest beast; that man has more power only by the higher development of his nervous system; and that his mind does not differ in kind from that of beasts, but only in extent.

The next section brings us to the knowledge of man, or Anthropology. The writer here comes in contact with the two classes of philosophers, one of whom makes man into nothing more than a beast, nearly akin to the monkeys; and the other strives to set him apart altogether from the beasts, in his zeal to save the everlasting soul of man from the beasts that die. Had they, he says, only made their system of metaphysics better, instead of striving to set aside the truths of physiology or psychology, the errors of both would not have happened. The consideration of man in this respect is twofold—first, for his body, which belongs to zoology; and second, as a being having properties and faculties of which no other beasts have the like.

If, in body and in mind, man partakes of the same nature with these, yet his works show us that he has other and higher powers, and a higher destiny. Mr. Fergusson thinks that these are exemplified in the division of labour or employment, and in progress; neither of which is exemplified by the beasts. We do not think his premises support his conclusions, nor that he has here well wrought out his own system. As we said before, we consider that the special distinction of man is his subordinate creative power, and Mr. Fergusson's arguments are a proof of this. No other living being has the like power, and the organization of man is the instrument for developing this.

Mr. Fergusson says, very ingeniously (p. 65), after speaking of the division of employment, that in a civilised commonwealth like England, it would be easy to share out its twenty millions of people into a thousand classes, as distinct in their functions and in their action on the material world as the thousand species into which naturalists classify four-footed beasts, and to sub-divide them into a hundred thousand varieties; not only performing all the separate functions of all the separate species of animals, but thousands of functions which the lower beasts do not perform, and have no trace of any power by which they might be taught to perform them. So, too, all the functions which beasts have in a higher degree than man, are by him made use of for his purposes: the fleetness of the horse, the keen scent of the hound, the strength of the elephant, are made by man his servants; and he engrosses to himself the functions of the animal kingdom—nay, it may be said those of the vegetable and mineral kingdoms. In all this complexity of functions, says the writer, man is still one genus, and for all practical purposes only one species; and it is this unity in multiplicity, and multiplicity in unity, which gives him his infinite power over the material universe.

The writer asserts the will and the power to influence the animal and material world; to alter the breeds of the horse, the dog, or the sheep; to change the courses of rivers; to remove forests; to modify climate. The division of employment and the tendency to progress, are only resultants of the original power and organization which we have defined.

Mr. Fergusson, in contradistinction to many of the modern schools, holds the essential inequality of men, in their physical, mental, and psychological organization, resulting in an essential inequality of all men in power and position. He allows, however, of a real and essential equality of all men in means of enjoyment, and of free will and power to improve or deteriorate their conditions.

He opposes the morphological doctrine of Lamarck and his followers, that one species of animal can be developed out of another; and also that* which says that the more perfectly organised species were developed out of those less organised, as the world became fitted for their reception. Upon this Mr. Fergusson remarks, that if it prove anything, it proves too much; for in that case, when the world arrived at that state that the amphibia were developed out of the fishes, or the birds out of the amphibia, all the fishes or reptiles ought to have given birth to the more perfect kinds, and perished themselves. So, too, when man was developed, the female monkeys having given birth to him, their own race should have become extinct. There is not, therefore, one fact to support the doctrine.

Mr. Fergusson, by a single reference, which is all he has given to it, seems to advocate the doctrine of one pair only having given birth to man; and so with the other animals,—yet, on his own principles, without any sufficient reason. With regard to the human race, unless he adopts the morphological doctrines, which he repudiates elsewhere, he cannot conciliate existing facts. There

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* "Vestiges of the Natural History of Creation."

may be no specific anatomical difference between man and man, but as the writer himself shows (p. 59), this is no reason for identity when other and higher marks of distiuction exist. How he is to account morphologically for the negro, for instance, appears inexplicable, for we find the negro on Egyptian monuments three thousand years old exactly as he is now; whereas, adopting any given quantity as expressing the tendency to change, the specific relationship of the members of that race would have passed away. Morphology admits of an arithmetical analysis being applied, and the result is that it fails before the test. Morphology is inconsistent with a limited number of species; for carried out arithmetically, it must be constantly producing new species within the old ones, and thereby breaking up the old ones; so that, arithmetically, a species of negroes existing three thousand years ago, could not now exist in mass.

This is the arithmetical working of the doctrine in question; while tested by historical results, we find at any time when we can apply the test, ethnographic characteristics were the same as now, and there are no sufficient means to deduce all the varieties from one pair. Admitting, too, the identity of the human race, it does not follow that it should be an identity of blood, but it may be an identity of type.

Indeed, the same causes which have smothered other branches of science, have smothered this; and each party has been anxious to set up a theory and fashion the facts to it, instead of studying the facts. The field for investigation is wide, but hitherto investigation has been cautiously eluded. If, instead of searching for facts favouring morphology—and all parties hitherto, whether advocates of one pair or of many, have been morphologists—the whole facts had been investigated, we should now be better able to form a judgment. However many may be the facts brought forward by morphologists, the one fact of continuous identity is one worth them all. The identity of the Syrian and Negro of three thousand years ago with him of the present day is undeniable; but the facts on this question of continuous identity have not yet been gathered together. The fact of the continuous identity of other animals has been proved over as long a period.

A remarkable class of phenomena, which have led to the confused views which prevail, are in a similar condition. These are the phenomena consequent on assimilation and association, and which, if at all adverted to, have been only misunderstood by the morphologists. First, there is the disposition in individuals associating together to acquire a likeness in countenance, as between husband and wife, and as in the negroes of the United States towards the Americo-English. The next are the changes which take place in different ages in the *physique* of the same nation. In this country, collections of portraits will show very curious results as affecting the countenance of the English of the higher classes, from the time of Queen Elizabeth to the present day. A third are the changes which take place consequent on the removal of a race to another soil: thus the English born in the United States or Australia, are tall, slim, sallow, and lose most of their teeth before the age of thirty. This is only one of an extensive series of facts.

The adoption of identity of type, instead of identity of blood, is calculated to simplify the discussion, and is consistent with the other facts. There is a relationship between the members of the feline tribe, but no one has imagined that the lion and the cat are of the same blood: neither is it necessary that the lion of Asia and that of South Africa, though nearer in relationship, should be any nearer in blood.

The assumption of the contrary, and the doctrine as to in-breeding, have had much influence in producing confused ideas. The endeavour to derive each class of animals from one stock, has caused violent attempts to twist facts. This is because no distinction is made between those operations which are temporary and those which are permanent. While it is impossible to make a Negro into a Syrian, it is quite possible to modify either: it is possible, likewise, to produce cross-breeds between the two,—but if they are cross-bred for ever, they will never yield an Indo-European.

It is because we can produce many varieties of dogs, and make the animals larger or smaller, that it is assumed all dogs are originally from one stock; though the least consideration will show that we cannot make all the varieties from any given pair, which we ought to be able to do if all had the same origin. All that the breeders in this country could do, they could never make a dingo; nor before they had the variety in the country, could they have made a newfoundland.

Indeed, so averse is nature to these artificial varieties, whether of animals or plants, that it is only by constantly bringing fresh stock that the varieties can be kept up. Hence has arisen the doctrine, that in-breeding causes deterioration and extinction; whereas the truth is, that it is only in-breeding of artificial varieties which produces such results, for natural varieties may be in-bred for ever. Had not in-breeding been a law of nature, the offspring of the first pairs or individuals of animals and plants could not have propagated, and could not now have existed.

The breeder has nature always to thwart him: instead of giving the expected half-blood, she will often repeat the grandsire; and if the attempt be persevered in, the Bakewell sheep become extinct or degenerate, the dahlia becomes single, and the cyder graft unproductive. Porcupine men, albinos, spotted Africans, dwarfs, giants, and six-fingered people, have been known for several generations, but they have never become permanent varieties; nor have all or a majority of each generation, even when in-bred, been endowed with the parental abnormity.

When properly examined, there is no scientific evidence to show that an Indo-European and a Negro have any identity of blood.

On the speculation whether man, being the last created animal, must remain so, Mr. Fergusson inclines to give an answer in the affirmative; but we do not perceive the relevance of his remarks, except that in which he says that it does not appear necessary that a new animal should be created, because man being endowed with the functions of progress, he is enabled to do what in all other instances it required a distinctly new species to effect.

Upon the question of progress, Mr. Fergusson admits of a progressive tendency, though not a uniform one; and he gives a diagram, in which in a curved and knotted line one end is in advance of the other, though some intermediate points are retrograde from others. Adopting this progress in the creation of animals, he considers it as particularly developed in the history of mankind, because man possesses within himself the power of progress.

By explaining himself in this way, the writer guards against the idea that progress being continuous is uniform, and is prepared to admit, in history for instance, that very advanced periods may have been succeeded by others in which society has been in a very low state, until another rally has taken place. This will be found very important in the ethnographical discussions.

Mr. Fergusson applies to art his two attributes of the division of employment and progress. The first, he insists, is not only the means by which anything in art can be accomplished, but it is, at the same time, the cause why there should be not only two or three arts or forms of art, but thousands, to suit the various idiosyncracies to which they must adapt themselves, to fulfil the purposes for which they were given to man. Their aim, he says, may be, and perhaps should be, only one; but to accomplish this object, their forms must be as various as the intellects to which they address themselves. The one only means, he holds, by which man ever did anything great, either in the useful or fine arts, is by this aggregation of experiences.

In his Sixth Section, the writer comes to the classification of arts. His introduction describes mankind as capable of becoming one vast animal, extending over the whole globe of the earth, and living for an indefinite period of time. Hitherto, men have lived only in detached fellowships of a few hundreds of thousands or millions, and with an average political life of not more than a thousand years; but Mr. Fergusson asserts that the tendency now is to larger commonwealths, and consequently longer periods, with of course corresponding accessions of greatness and power. Of this the present movement of races—the English, the French, the High Dutch, the Slavonic, the Italian, and the Scandinavian—are strong and undeniable indications; and they must result in commonwealths, as much beyond the mighty states of modern Europe with their ten, twenty, or thirty millions, as these are beyond the townships or shires which achieved fame in the brightest days of Greece. It is to this tendency that we are to look as giving a stimulus to the artist, and a field for the exertion of his powers.

Mr. Fergusson divides the arts into those which may be exercised by any one individual, which he names Anthropics: and those which have reference only to great bodies of men, and which he names Politics. In the latter he puts Medicine, or medical police; Morals, or moral police or government; and Religion, or ecclesiastical police.

Anthropics are divided thus: first, those resulting from muscular power—Technics; next, those from the developments of sense—Æsthetics; and third, those dependent on the power of speech—Phonetics. Mr. Fergusson here purposely uses the term Æsthetics in a special sense.

In defining the Technic arts, the writer says they arise from the peculiarity that man, though he has all the limbs and organs of other beasts, seldom uses them for any useful purpose without the intervention of a tool of some sort. All other beasts can only do what their own claws, teeth, or tails can effect, or what the organic tools with which they are furnished, as the trunk of the elephant, is specially intended to perform. The powers and tools being detached, man can do more, for he has the command of all; whereas the elephant is bounded by what his trunk can do for him. If all men had to do the same thing, those who did not would possess a vast quantity of unemployed and useless power: but as it is, man may choose what tools he pleases, use them as he likes, and lay them aside when he no longer wants them (p. 74).

Of the Æsthetic arts, Mr. Fergusson rightly says that the senses on which they depend are capable of an extension, which, except in the sense of sight by the invention of the telescope and microscope, they have not received, and certainly not to the extent of the technic and phonetic arts.

Speech the writer treats as the reflex of intellect, and as a distinguishing characteristic of man, from which result a number of arts.

Having laid down these three groups, he does not require that they should be accepted as strict classes, but as forming combinations and modifications, and he arranges them thus, so as to make seven groups:

Technic	———	———	1
———	Æsthetic	———	2
Technic	Æsthetic	———	3
Technic	Æsthetic	Phonetic	4
Technic	———	Phonetic	5
———	Æsthetic	Phonetic	6
———	———	Phonetic	7

In carrying out this classification, Mr. Fergusson would have benefitted by the application of the principles he laid down in his previous classifications, for the tables he has given are meagre and imperfect. It would take up too much room to give them in this *Journal*, although such a conspectus is well calculated to show how many branches of art are left uncultivated.

The Technic arts are considered under the heads of Powers, Applied Powers, Primary Arts, Applied Arts, and Refined Arts.

In summing up the sources of Power, the writer has omitted many which result from the consideration of the several branches of creation. The light, heat, and actinism of the sun are used by us as powers; in the case of daguerreotypes, even the light of the moon has been made available; and we do not even yet know what resources may be obtained from without this world. The recent applications of electricity are among the most promising contributions to science; but the powers derived from Etherology are still undeveloped. The enumeration, as powers, of chemical attraction and repulsion, gases, steam, elasticity, air, and water, is imperfect and confused: but Mr. Fergusson was too anxious to proceed with his subject to elaborate these.

If the muscle of man and the allied power of animals are to be recorded, we should not leave out associated men, vital power, mental power, and moral power, for all these are necessary to be considered in the practical determination of the question. Indeed, the determination of these several powers requires to be closely investigated; for the mere consideration of physical strength throws no light on most human operations.

Under the head of Applied Powers, the writer enrols tools, engines, processes, and machinery.

The Primary Arts, Mr. Fergusson calls those for obtaining raw materials; but here again the classification is imperfect.

The Applied Arts are those by which raw materials are worked up and combined.

The Refined Arts are those in which, by the addition of the element of "beauty," a higher character is given. While carpentry and weaving are called applied arts, upholstery and tailoring are called refined arts.

Mr. Fergusson asserts that the existence of the fine arts depends on a great primary law of human nature (p. 94), which he thus gives:—To every function of which man is capable, there is attached a use, and that function is necessary for his existence, or for performing that part in the great drama of the world for which he was created; while, to urge him to the performance of this, severe pains and penalties are attached to the non-performance which he cannot escape, such as hunger, cold, misery, and disease. On the other hand, there is attached to the exercise of every function, a certain inducement or gratification to its exercise, which he thinks may be in man greater than the compulsory force. To this inducement or attraction, the writer gives the name of "beauty" or "sense of beauty," meaning thereby the gratification we are able to extract out of every useful function we perform, and which is necessarily attached to it. He therefore considers that all the useful arts are capable of becoming fine arts,—or, in other words, besides ministering to our necessities, they may become sources of pleasure and gratification; of course, in several degrees, for some only minister to our sensual appetites, while others tax to the utmost our intellectual powers. Thus, however far removed, gastronomy and lyric poetry may equally be classed as fine arts. All common and useful things may be refined into objects of beauty, and all that is beautiful or high in art is merely an elaboration and refinement of what is *fundamentally* a useful and a necessary art.

This leads the writer to a review of the refined arts and lower fine arts, after asserting that the taste of each man is unlike, and that there is no mind so lowly that beauty may not creep into it, if only through the song of the bird, the sight of the wide fields, or the glow of the setting sun. Each, too, can feel beauty in his own trade or calling, or in his own round of life. For each, then, must some provision be made; and if only the lower arts are felt, the lower arts must not be set aside. Gastronomy, tailoring, millinery, floriculture, and landscape gardening, are brought first before us, and the writer has a word for each. Of the two latter, he says, if we were to foster all the arts with the same singleness as we have these two, they would not stand so forward in the list as they now do.

It is to be observed of floriculture, that no art is under a system more likely to foster it. In the metropolis, 1,200*l.* is yearly given in rewards by the Horticultural Society, 1,000*l.* by the Royal Botanic Society, and further rewards by others,—about 3,000*l.* yearly, which is applied solely in the reward of merit. This sum is competed for by private growers and by nurserymen; and to gain the prizes, the most skilful gardeners are employed, and great emulation created. The nurseryman obtains, too, a further reward in the sale of plants, which earn rewards. At the Royal Botanic Gardens, in the Regent's Park, the judges of the rewards are named by the votes of the growers in each class. It is to be wished that rewards should be given specifically for plants of fine form, colour, and smell. The cultivation of the two latter properties would open new branches of study. The Royal Botanic Society have devoted some attention to artistic botany, but not of late years. It should be further said, that the expenses of the exhibitors for conveyance of subjects are paid, and that refreshments are given to them on the day of exhibition. Every facility is likewise given in the public gardens for the studies of the florist. The public taste and public sympathies are largely enlisted in the pursuits of the florist.

If the same sum were devoted yearly to the reward of painting, sculpture, architecture, or engraving, the same facilities given, and the same mode of choosing judges adopted, a much better result would be obtained than as matters are now conducted. There is no similar reward of merit for painting, sculpture, architecture, or engraving, and there is no freedom for the artist. It may, too, be said, that a much larger sum is spent on flowers than on paintings. Many a man spends two or three hundred pounds a-year on his greenhouse, who never buys a picture, a cast, or an engraving, which will last, and which can be handed down to his children; whereas his flowers soon fade.

If an exhibition of architecture, sculpture, or engraving, should be set up, as has been talked of, the best way to make it successful will be to set aside the profits as rewards of works in several classes; for thereby a direct stimulus is given to the artists in each department, and the public take an interest in the race.

Mr. Fergusson says, if any Englishman abroad thinks of what he left in his home which is most beautiful, it is not of our painting, or sculpture, nor of our architecture, nor of anything commonly called fine art; but between the great man's park, and the little cottage garden, he will remember many scenes and objects of beauty, which, if he have any artistic feelings, will not soon be driven from his mind.

Of course, jewellery, plating, ironmongery, carriages, ships, glass, porcelain, mosaic, paving, and upholstery, come in for their share of attention, and they receive a few remarks well worthy of being read.

Architecture, the writer says, arises out of the useful art of building by such slow steps that it is hard to draw the line between them, or to say whether some buildings should be set down as utilitarian, or take a higher rank. He says rightly, that even of those warehouses which lay no claim to high art, a few dressings to the windows, and grouping these slightly together, and a little attention in the arrangement of the several parts, might often give a higher and pleasing character.

While classing architecture in the same list as cookery and tailoring, he says of its works, that it has some adventitious advantages, which apply to others only in a small degree. First, it has size; next, it has durability beyond almost any other of man's works, except perhaps the lay of the poet; and third, in its dedication to worship, to halls of meeting, to schools, to tombs, it has a hallowed influence from the associations connected with it. Beyond this, it admits and requires the adaptation of painting and carving.

Thus, a perfect building, such as Karnac, the Parthenon, or a middle age cathedral, becomes the exponent of the principal technic, æsthetic, and phonetic arts of the age in which it was erected. Architecture alone has hitherto been able to attract to itself so many arts in a permanent form, and hand them down to after ages; and it is for those reasons that Mr. Fergusson has adopted it as the web on which to embroider the story of his pages.

Before leaving this subject, the writer remarks that many of the works of the engineer admit of a higher artistic treatment than they have received; though he admits that they are free from the affectation and servility which characterise those of our architects. He regrets, however, that works unrivalled in the world for magnitude and magnificence, should not have been transmitted to posterity with some better testimony of the public taste.

He does not even let the military engineer alone, for he says that it is no reason against artistic treatment, that if a place should be beseiged the works will be destroyed; and he alludes to some of the fortifications lately erected in Germany, as having masonry well executed, the embrasures and openings surrounded by bold and appropriate mouldings, and the bastions and curtains surmounted by a bold cornice of machiocolations. These, with their size and massive solidity, are held forth as making them nobler buildings than those of almost any modern architect.

The Seventh Section is for the Æsthetic Arts. These, Mr. Fergusson very fairly arranges under the senses from which they arise, and as Useful and Refined Arts. He considers, likewise, the Tools used to produce the results, but does not include the consideration of the Powers which contribute to them.

Under the head of Taste, Mr. Fegusson names only Gastronomy. This is a sense, though much used, little cultivated; and the only scientific recognition we know of it is by the Horticultural Societies, who require fruits exhibited to have a good taste, as well as size. Perhaps we may name the galvanic effects on the taste. The practical application of Taste would, no doubt, if its functions were better understood, be widely extended; as it is, although there are numerous classes of what may be called gastronomic tasters for teas, wines, brandies, ales, &c., the only non-gastronomic pursuit of tasting, is that of tasting whale and other oils, though metals are sometimes tasted. The medical relations of taste have likewise been little cultivated.

Mr. Fergusson dwells at some length on the neglect of the sense of smell, though if carefully considered its functions are most important,—indeed, they are essential to the human economy, and it may be questioned whether the operations of electricity and chemistry are ever unattended with the phenomena of smell. At present, there is no good observation or classification of phenomena, so that the technical or æsthetic uses are not developed. It has been too much the custom to consider smell and sound as dependent on the perception of man, instead of independent of him. In our last,* we extended Mr. Fergusson's theory (p. 44) as to the imponderables, to actinism, colour, and sound, and we here add smell; and we repeat, that the best mode of studying them is by carefully marking every distinction, and classing apart every form which is not in all things identical with any other. At the same time, the study of each of these is calculated to throw light on the laws which govern the others, and to suggest new modes of observation.

The coincidences in the laws which respectively govern sound and light are most remarkable; but they are explainable, because there must be *à priori* laws and principles common to both. Thus, the cultivation of one branch of little importance in itself, may point out or corroborate some phenomenon in relation to another branch of immediate and practical application. We are acquainted with the existence of low degrees of electricity, with rays of the spectrum which cannot be seen, with manifestations of electric light too weak for our sight: we know that there are sounds which we do not hear. Everything attests that there are phenomena existing of which we have not yet attained the development.

In the consideration of the imponderables, no distinction has hitherto been drawn between those which are naturally or organically, and those which are artificially developed. We are familiar with the distinction between the light of gas or a candle and that of the sun, but we are prone to assume that there is no difference in other cases between an organised and artificial imponderable; yet the same relations may exist between organised and artificial electricity or magnetism, as between the two classes of lights. Indeed, the principle of organization, fundamental in Mr. Fergusson's system of philosophy, is ignored elsewhere. There must, however, be a great distinction: we see it in the colours of nature and in those of art—the greatest painter can never give the freshness of the former: we feel it in the odour of the free-blowing violet, and in the faintness of the manufactured perfume. Life is wanting. If we are to apply the teachings of science to physiology, we must bear this broad fact in mind; the more particularly at a time when so strong a desire is shown to explain all the functions of life by the chemist's workshop, and the galvanic battery. In vain shall we strive to restore the impaired functions of an organ, or to give motion to the animal machine, if our instruments are dead instead of living. That there are such distinctions, we may see again; for the electric currents of our machines do not exhibit the periodic phenomena of the free electricity of the globe. We have dead blood, as against a throbbing pulse. This may suggest the consideration of applying the free electricity and imponderables of the globe, as powers distinct from their artificial representatives.

The fine art which Mr. Fergusson ranges under that of Smell, [illegible] perfumery; but gastronomy also partakes of this sense. Mr. Fergusson is inclined to recommend the greater cultivation of perfumes, as among the ancients.

Of the sense of Touch, Mr. Fergusson has nothing to say, though he places Eumorphics within its range. Bathing is an act which certainly belongs to this art.

For the Sight, the writer provides the fine arts of Eumorphics and Euchromatics, or beauty of form and beauty of colour; the former of which he thinks is not studied enough, though most important in architecture and in all the technic arts, as in pottery, glass-blowing, upholstery, &c.,—as indeed is likewise the other art of the arrangement of colour.

In this place, Mr. Fergusson advocates the restoration of colour in sculpture; and, as we think, with great propriety. No good reason was used against its application in Gibson's statue of the Queen, and those who did not pretend to be classicists, were pleased with it.

Under this head, as a useful art, the writer names only Optics; but we think he should have added Telegraphing, unless he considers it a phonetic art, and perhaps Illumination, or the preparation of artificial lights. The preparation of coloured lights and fireworks are fine arts, producing good scenic effects. Testing bodies by polarised light may come in here as a useful art.

While upon the subject of illumination, we may observe that the science of it is in a very low state; for the endeavours of inventors have been—rather to produce a substance for light, than to produce the greatest light. The quantity of light seen has no relation to the quantity of light existing in the substance, and which may be obtained: nor have quantity and intensity any correlation. Light is mostly attendant on the operations of electricity, but in so low a state that it is not always observable by our organs, but can only be seen by increasing its intensity, or by forming new combinations with it. Indeed, no consideration has been bestowed on the media by which it can best be manifested. Light is light, and air is air, and it is supposed that light and sound cannot exist independently of the laws which are usually considered as regulating the atmosphere and our organs. It is, however, easy to conceive, and perhaps to prove, that the gaslight of London might be doubled or multiplied in intensity, without requiring any increase of material.

The sense of Hearing comes next, and the arts which belong to it, which Mr. Fergusson puts down as neglected, though he names acoustics and music, and to which we add acoustic telegraphing.

A great deal has been written on acoustics, as on optics, and much mathematical learning expended; but this, as already hinted, has been in one direction, and thereby has tended to throw enquirers into a single, and in so far the wrong path. It has been pointed out in a late writing on this subject in the *Mechanics' Magazine* (September, 1848), that the investigation of the transmission of sound in air, gives very little idea of its capabilities for transmission in other media; and this is applied to the conveyance of sound to a distance—holding forth that the voice and tone of a speaker may be communicated from London to Liverpool, and perhaps further, by mechanical resources already existing. A distinction is there drawn between the processes of generating, conducting, and diffusing sound, which may be very usefully applied in the consideration of the adaptation of light to purposes of illumination.

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* C.E. and A. Journal, ante p. 22.

Mr. Fergusson, before dismissing music, suggests that with the resources of phonetic art, it has capabilities not yet brought out in modern times; and that the sublimer passages of Shakspeare and Milton may be made to receive a higher expression, by being sung in recitative, by one or more voices. In this case, however, he considers music should be subordinate, and not as in the opera or oratorio, preponderant.

The Eighth Section is for the Phonetic Arts. The introduction to this, however, shows much less information, and much less accuracy than we have found in other parts of the work. In this introduction, he traces the means adopted for giving wider expression to words by hieroglyphics and alphabetic characters, down to the printing press and electric telegraph. He indulges, too, in the hope and belief, for which we have already given assurance, that other tools and engines will be invented, by which the natural powers of man's voice may be extended as much or more than the powers of his muscles have been; and, he says, not only in loudness, so as to be heard almost instantaneously at the furthest corner of the earth, but in durability, so as to last longer than the pyramids of Egypt.

Mr. Fergusson says, let those who deny the progress and despair of the perfectibility of mankind, look attentively at the two inventions of the steam-engine and electric telegraph. "Is it nothing," says he, "within the last hundred years, to have gained for man the hundred arms of Briareus, and the seven-league boots of the nursery tale, and to enable him to make his speech known to any human being on the face of the earth, not only now, but echoing to all after ages?"

The Ninth Section takes up the subject of Politic Arts, but we do not intend to enter upon it here; and the more so, as considering that Mr. Fergusson is weaker here in carrying out his own principles, we should be led into longer explanations than is justified by the space at our command.

(To be continued.)

Account of some Recent Improvements in the System of Navigating the Ganges by Iron Steam-Vessels. By Albert Robinson, C.E. London: Weale, 1848.

What this book is, is an account by Mr. Albert Robinson of the steamboats built for the Ganges by Messrs. H. O. & A. Robinson, of Millwall,—a very unpromising announcement to many, for it suggests the idea of a mere prospectus or advertisement. Such a publication would come within the views of many firms, and is a legitimate mode of pushing business; but there is, however, a higher duty on the part of those engaged in a professional pursuit, and that is to give some account of the works they perform. A man who makes a coat after the received fashion would not be thanked if he published its cut; even in the case of a new paletôt, he would be exempt from any public communication: but men who are engaged in more liberal pursuits, as they have largely benefitted by the diffusion of information, are expected to contribute to it in their turn. This duty, then, constitutes a valuable privilege, a compliance with which is nevertheless too often neglected from self-interested motives. Those, however, who have shown a better feeling, have had no reason to regret their exertions, while they have very usefully contributed to the annals of engineering literature. The compiler and the scientific historian may at some time undertake the task, but no one can so well describe a work as those who have been actively engaged in its execution; and a short pamphlet, or even a few lines, from them is worth the big volume of strangers. Many valuable contributions will suggest themselves to our readers, and we shall only name a few of those which first occur to us, as Rennie's Breakwater, Mr. Edwin Clarke's account of the Tubular Bridge, Mr. Alan Stevenson's Skerryvore Lighthouse, the account of the Thames Tunnel, and Mr. Alexander Gordon's Iron Lighthouses; to say nothing of Smeaton's Edystone Lighthouse and Ramsgate Harbour, and Watt's directions for putting up Steam Engines.

A man who publishes such a work, does not only a service to himself, but is deserving of thanks for the service he renders his profession, and we shall always welcome even the slightest attempt in this way. Mr. Albert Robinson has, however, produced a very useful book, in which he has gone to some expense, and has shown much care, in order to give every information on the subject. We do not think this liberality misplaced on any occasion, for whatever information may be given to others, the successful completion of an undertaking is always a guarantee and an advantage to the first promoters; and the Messrs. Robinson and Russell are much more likely to get further orders for India, Russia, and the West Indies, than they are to awaken rivals. Still, there is everything that the manufacturer, the projector, or the student requires, to give a detailed and accurate view of the whole undertaking, the drawings and text being fully sufficient for all purposes.

The circumstances which led Mr. Albert Robinson to this undertaking are stated by himself. He had had some experience on the great rivers of America, and being led into communication with capitalists here on the mode of improving the steam navigation of India, he proceeded there in 1843, and surveyed the Ganges from Allahabad to Calcutta. The result was the formation of the Ganges Steam Navigation Company, and the building of a fleet of steamboats by Messrs. H. O. & A. Robinson. These proceedings Mr. Albert Robinson relates.

The Ganges is the natural channel for the commerce of northern India, but it is distinguished by such natural peculiarities that hitherto its resources have not been adequately developed. Mr. Robinson thus describes it:—

> The country through which it flows may be said to be one immense plain, the soil of which contains a very large portion of sand, and is of course easily acted on by running waters. The bed which the river has formed for itself in such a soil is, as might be expected, tortuous or devious in its course, and of very irregular breadth and depth: being composed of loose sand, it is kept in constant motion, and the changes which occur in the depth and locality of the channels are incessant. The banks too are continually undergoing change through the action of the water undermining them at one place, and forming new banks at another. Flats or shallows intervene with deep narrow channels throughout the greater part of its course; and when the river is low, small shallow channels or runs are formed through or across the flats or sand-bars; and in one of these channels frequently is to be found the only passage for the navigation. The width of the river is so various that it is impossible to give more than an idea of it. When low, it is from ¾ mile to 1½ mile; when high, from 1 to 3 miles, and in some places it extends over 20 or 30 miles of the flat country. The depth, when high, is in the channels between 35 and 75 feet; and when low, between 3½ and 10 feet. The perpendicular rise of water in the wet season at Jellinghee is about 32 feet. The Bhaugruttee, though called a river, is a side channel or mouth of the Ganges, and through which the navigation is performed in the high-water season: the width varies from a furlong to a quarter of a mile, and during the navigable season the least depth is from 3 feet to 22 feet. For some months of the year it is not navigable for large vessels. The Hooghly, which is a continuation of the Bhaugruttee, and through which the navigation is continued to Calcutta, although resembling in its general features the great Ganges, is less irregular and of easier navigation; its depth is generally greater than the Ganges, and the width of the channel is satisfactory: at Calcutta, where it is a tidal river, it is nearly as wide as the Thames at Gravesend. The Sooderbunds, through which the navigation to Calcutta has to pass in the low-water season, are, in fact, small mouths of the Ganges, flowing to the sea through a delta of fine sandy alluvial deposit, covered with a rank vegetation and jungle. These channels are very numerous, and reticulate with each other in the most extraordinary manner, like a labyrinth. Their width varies from only 50 feet to ½ mile, and being within the tidal action, their depth is much the same at all seasons of the year; and at low water is probably not less in the channels used by vessels than 5 feet: their chief peculiarity is their extreme crookedness and sharp bends.

In the low-water season, the length of the navigation between Allahabad and Calcutta is 1,147 miles; in the high-water season, 787 miles: either length far beyond our English experience in river navigation, but familiar to our brethren beyond the Atlantic, whose system, as developed on the Mississippi, Mr. Robinson has applied to the Ganges.

The rise of steam navigation on the Ganges is thus stated:—

> Under the administration of Lord William Bentinck, in 1834, the steam traffic of the river was greatly developed by the establishment of a regular line of steamers for the conveyance of government stores, troops, passengers, and merchandise. But although the government of India thus led the way, it was understood that it was not intended to discourage or restrict private enterprise.
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> Fortunately for the advent of steam navigation in India, *coal* had then been discovered in several places; and at Burdwan, 63 miles from Calcutta, mines had been opened and worked. This coal is, however, not so good as British coal, the estimation being that it is only equal to 75 per cent. of Newcastle coal; but it is highly probable that as the pits are deepened the quality will improve. The Burdwan coal is now brought to Calcutta by the Damoodie river, at a cost of 20*s.* per ton, and to other places on the river at prices varying from 18*s.* to 27*s.* per ton. The price of English coals at Calcutta is from 30*s.* to 33*s.* per ton.
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> The system of steam navigation introduced by the Indian goverment, and which is continued to the present time, is that of placing the goods or passengers in small separate vessels, and the steam-engine and coals in another, which tugs or tows the cargo-boat or passenger-boat, as the case may be. The steamers or 'steam-tugs' are generally of iron, and about 120 feet long, 22 feet breadth of beam, 8 feet deep, and draw, when fully coaled, from

3 to 4 feet water. The engines are of from 40 to 90 nominal horse power, and of excellent workmanship. The steamers are in fact similar to what were used on the Thames a few years ago, only shallower, and of fuller build. The vessel in which the passengers are placed is termed an '*accommodation-boat*.' It is of similar dimensions with the steam-tug, and is fitted up with passengers' cabins, and a 'cuddy' athwartships dividing them; it carries only passengers and specie, and light packages and parcels. The freight-boat or '*flat*' is also of the same dimensions as the steam-tug, viz. 120 feet long and 22 feet beam, and draws when loaded about 3 feet; it has cabins for the captain and ship's officers only, and takes no passengers.

One only of these vessels is tugged or drawn by the steamer at a time, so that the freight and the passengers are never conveyed together by the same steamer.

The twin vessels are linked to each other at the bows and stern by a flat beam of wood, which acts as a hinge, and serves also the purpose of a plank for the crew to pass from one vessel to the other.

Like the native boats, steamers are obliged to stop running during the dark of night. In the dry season, the average passage up is twenty-four days, and down fifteen days. In the rains, the average passage up is twenty days, and down eight days. The number of voyages made annually by each steamer is nearly six. In 1844, there were seven government steamers, with their accompanying vessels, all of which were kept in activity. This number has since been increased by two more, specially adapted for troops.

Besides these boats are those of another private company:—

The agitation of the question about the same time by other parties had the effect of drawing the attention of some of the Calcutta merchants to the subject, who got up another steamboat company, raised a capital, and ordered their steamers from London. It was named the *General Inland Steam Navigation Company*, and is perfectly distinct from the association whose steamers form the subject of this paper. This company's steamers are upon the tug system, but differ from those of the Government in being of greater power, and being intended to tug or tow *two* small cargo-vessels at once, the passenger cabins being on board the steamer. The names of those which have been put on the line are, the *Sir Herbert Maddock*, the *General McLeod*, and the *Sir Frederick Currie*; the second of these was, however, unfortunately lost in the Hooghly, and the company have recently purchased the Assam Tea Company's steamer, *Assam*.

Mr. Robinson's system is distinguished from these by using only one vessel for steamer, passengers, and cargo.

The hull below the main deck is appropriated to cargo, with the exception of the space occupied by the boilers, and the condensers and air-pumps of the engines. The main deck projects over the sides all round, tapering in at the bows, forming 'guards' which increase the room on deck. The engine cylinders lie horizontally on the main deck. The saloon and cabins are also placed upon it, 'forward' of the engines and boilers. Over the cabins, and extending nearly to the stern, is a light promenade deck, and the part of it or cabin passengers is covered by an awning.

The frame and deck beams and paddle-box frames are of *iron*, and the shell of *iron plates*. The main deck is of wood. The cabins and the promenade deck over are entirely of wood. The length is, at load water-line, 195 feet. The beam or breadth of hull is 28 feet. The extreme breadth over paddles is 46 ft. 9 in. The depth of iron hull is 10 ft. 3 in. at the engine-room; and the rest of the hull, 7 ft. 9 in.

The bottom or floor is nearly flat, rising on each side only sufficient to throw the bilge-water towards the keel. The bows are full, but with a good and fine entrance. The stern is as full as was considered admissible, and is in character with the bows. The tonnage of the hull, exclusive of cabins and upper deck, builders' measurement, is 400 tons.

The engines are medium-pressure condensing, unconnected, and of the nominal power of 120 horses. The cylinders are two in number and are horizontal, are of 30 inches diameter, and the stroke is 7 feet. The boilers supply steam of an elasticity of 20 lb. pressure per inch above the atmosphere. The steam is worked expansively. The speed of the piston is 280 feet per minute. Each engine has a separate condenser of large size, and an air-pump worked by a bell-crank motion taken from the cross-head: they are placed upon the floor of the vessel under the cylinders. The diameter of air-pump is 2 ft. 4 in, and the stroke 2 ft. 6 in. The vacuum kept up in condenser, with water of the temperature of 80°, is 28 inches on the barometer. The *mean effective pressure* upon each square inch of the piston resulting from both the pressure of the steam and the vacuum is, when the steam is cut off at two-thirds the stroke, 27 inches per indicator.

The boilers, four in number, are single-storied and tubular. The external shell of each is curved at the fire-boxes, and cylindrical at the tubes. The grates or furnaces are adapted for either wood or inferior coal.

The power of the engine is made available for hauling off the steamer when she grounds upon the sand-banks or shoals by the very simple contrivance of a 'whelp' barrel, similar to that of the windlass, securely put upon the main crank-shaft of the engine, where it crosses the deck. The chain cable, which is connected at one end to the anchor, laid out sternward or abaft, is by the other end wound round the whelp barrel; the engine is then started, and exerts such a prodigious force that the vessel is speedily drawn off the sand-bank and afloat again.

The weight of the vessel and paddle-boxes has been stated to be 142 tons—the engines, boilers, and propelling machinery and engine-bearers, 106 tons—and the cabins and upper deck, 12 tons,—making a total of 260 tons. In addition there is to be taken into calculation the water in boilers, 21 tons; fuel for 12 hours' steaming, 10 tons; sundries, furniture, stores, &c., 15 tons, making the working weight 306 tons. This weight requires an equal displacement, and which is obtained by an immersion of the hull to 2 ft. 10 in. All above this will be the carrying power for cargo. Thus at 3 ft. 6 in. she carries 85 tons; at 4 feet, 149 tons; and at 4 ft. 6 in., 213 tons dead weight of cargo. The carrying power for cargo is of course diminished by the passenger carrying accommodation to the extent of the weight of the cabins and stores, shown above to be 27 tons; and without these the working draught of the steamer would be only a fraction above 2 ft. 7 in.

The difficulty of getting the vessels out to India was thus mastered:—

The iron vessel and the engines, which together form one of these steamers, are both designed in all their details by the same firm, who, being *iron* ship-builders as well as engineers, were enabled to produce a combination of the nature described. Each vessel and pair of engines were constructed simultaneously at their establishment; and when completed, the engines were fitted on board the vessel on the stocks; everything was put in place, and the engines worked, to make sure that there would be nothing to fit or do to them abroad. The parts of the engines where they were joined to each other and to the iron vessel were then marked, taken asunder, and packed up for the voyage. The whole work of the vessel was then painted in the inside four different colours, each quarter being of one colour; and the plates of the shell and the ribs, as well as every piece, were marked with paint, and stamped with letters and numbers, to facilitate and insure the correct putting together in India. The vessel was then taken in pieces, and the whole carefully shipped and stowed on board a ship of the ordinary size, bound for Calcutta. Accompanying the parts was sent accurate drawings of the whole, and a model of the vessel, painted and marked exactly like the original. Upon arrival, after only a four months' voyage, the parts were landed at the establishment of the Ganges Steam Navigation Company, near Calcutta, the iron vessel put together in a dry dock, decked and floated out. The work was performed chiefly by native mechanics, under the superintendence of the writer; and the first steamer was put together in only nine weeks from the day of landing. The engines were then fitted in, and the cabins put up, of teak wood, to the working drawings. The whole was completely finished and the steamer fitted out and started on the trial trip in a little more than four months.

The success of these steamers is complete, and the river passage has been already greatly reduced,—in one case to five days, as against the eleven and thirteen days of the other steamers.

The following is the present state of the enterprise:—

The new steamers put upon the Ganges up to the present time consist of
Two of 120 horse power each for passengers and cargo,
One of 140 ditto for cargo only,
Two of 250 ditto each for cargo only,

In all, five steamers, aggregating 880-horse power. Their cost is made up of—1st, the price of the vessels and engines in London;—2ndly, the expense of transporting them in parts and pieces to Calcutta;—and 3rdly, the charges of re-constructing in India.

Owing to the constructors in London having kept in view in their design of the engines and boilers, that the parts were required to be adapted for *shipment*,—to the preparations made by them for facilitating the business of putting together the parts abroad,—and to economical and active measures in executing the work in India,—the total cost of the whole five steamers completed and started on the Ganges, exclusive of *spare* boilers, &c., and of interest upon the capital employed prior to the steamers coming into activity, does not exceed the sum of 96,000*l*., which is made up thus:

Steam-engines (880-horse power)	£41,800
Vessels, cabins, &c.	39,686
Cost in London	81,486
Transportation to India	5,875
Re-construction and equipment	9,199
Cost on the Ganges	£96,560

To which perhaps should be added interest for an average period of eighteen months upon a part of the sum, say upon 55,000*l*., at 7½ per cent. per annum, 6,187*l*. This would make up a sum of 102,747*l*. No preliminary expenses or charges for the 'Direction' were incurred. Be it observed this is no mere 'estimate,' but the actual cost of the thing done. They only who have *carried out* a similar operation connected with a foreign country at a great distance, can correctly understand the difference.

The item of fuel is at present a heavy one (about 350*l*. each voyage of the *Patna*); there is, however, little doubt that in another year or two coals will be delivered on board at a lower price. The cost of the personal establishment of each steamer is, even at its present high amount (about 148*l*. each voyage of the *Patna*), much less than the steamers on the tug system.

As an appropriate finish to this exposition of the question, we shall give Mr. Robinson's views on the improvement of the River Ganges.

It has been already stated that the bed of the river is composed of sand;

the exceptions (of which there are a few) do not affect the question, because there is abundance of depth over the hard parts of its bed. This sandy formation, which is the cause of the evil of the extreme shallowness, affords facilities for remedying it; and the deepening of the channel where necessary, *without* permanent or costly engineering works, is a task which the author believes to be perfectly practicable. All that is wanted is, to aid the slow but certain powers of Nature by the application of scientific skill and practical experience, combined with the cheap labour and the simple 'means and appliances' already in existence in India, and with, in some places, the steam-engine applied to machinery afloat. In some places the improvements might be effected in a single season, whilst in other cases years of steady perseverance in the necessary measures would be required; and even when the deepening is accomplished, the same measures must be continued in a lesser degree, in order to secure what may have been gained.

The principles upon which these views are based, are.—1st, that the water of the Ganges holds in suspension the fine sand with which it forms the shallows, the bars, and the banks. 2nd, that just in the measure that the water is kept in agitation (whether by the natural action of the current or other means, (will it hold more or less of this fine sand in suspension. 3rd, that wherevever the agitation exceeds a certain degree at any spot, there the water is deepening; and wherever at any spot it is minus this degree of agitation, there the water is shoaling. This is aptly illustrated by a circumstance of common occurrence to the new steamers. From the great length of one of these vessels, when it gets aground upon a shallow in an oblique position with respect to the direction of the current, the water on the side where the velocity is increased by the obstruction of the vessel becomes in a little time deeper, and a channel is formed which generally enables her to be got off; and on the other, or lee side, where the velocity of the current is diminished, it shoals up so that in a few hours (should the vessel remain fast so long) a sand-bank makes its appearance above the surface of the water, upon which one may jump out.

But an example of what was done by very small means, in an instance that came within the author's knowledge, will serve to show more definitely what might be done to improve the navigation by adequate measures. In the month of April (the worst part of the dry season) in 1847, at a place a few miles above Benares, the water had gradually shallowed to 2 ft. 6 in. Upon this shoal several of the government steamers, as well as the new steamer *Benares*, stuck fast, and met with much detention before getting over. Being near a military station, the officer in command of it took great interest in the proceedings of getting off the *Benares*; and after she had passed down, he in the most spirited manner (acting upon the writer's suggestion, that some good result might be produced by manual interposition), collected a number of natives, whom he directed so skilfully to disturb the sand at the bottom of the water with pointed poles or bamboos, that, in a few days, so much of the sand had been carried away by the current, that a channel through the *shoal* of 4½ feet deep, and amply wide enough for a steamer, was thus formed. This channel then remained open during the rest of the dry season, and the steamers passed through it without once grounding.

A Treatise on Public Slaughter-Houses. By Richard B. Grantham, C.E., M. Inst. C.E. London: Weale, 1848.

While other engineers have devoted themselves to several branches of sanitary improvement, as the sewer system and the supply of water, Mr. Grantham has very usefully taken up the subject of slaughter-houses, basing his work principally on the operations of the Parisian abattoirs. This is, of course, familiar to our readers, having been so often published; but it is so far in an original form, that Mr. Grantham has made personal observation of the establishments at Paris. He attacks the nuisance of Smithfield, but without advocating the Islington cattle-market, which has been lately opened with the view of mitigating the evil.

It is difficult to select anything from such a book which is not trite, but the whole subject is of importance. Mr. Grantham's practical remarks on the French system may however be usefully referred to.

I consider that, holding the opinions I do, I am bound at once to deprecate the attempt of any private company, formed of persons wholly unconnected with the butchers' trade, making it compulsory on the trade to slaughter cattle in abattoirs remote from the great masses of the population, and those only few in number.

I object to it upon the principle that no trade ought to be interfered with to this extent by any party not connected with that trade, and that it ought not to be confined to certain localities, and I do not believe that the public will be better served by being subject to the control of an independent body; at the same time, if the trade will not or cannot see that it is incumbent upon them to meet the demands of the times, and endeavour themselves to abate the nuisance of the badly-conducted slaughter-houses, some one must take up the matter, and they must be subject to their rules; but it ought to be some constituted body already in existence.

It is preposterous to take the Paris abattoirs as a precedent for the circumstances of London. In Paris, as I have elsewhere stated, the number of butchers does not exceed 500 in a population of nearly a million; and the French citizens are not in the habit of consuming nearly the quantity of meat per head that the English do; whereas in London alone, there are about 4,000 butchers in a population of above two millions, and the consumption, probably, four times greater in proportion. And although the five Parisian abattoirs may not at all times be over-crowded, particularly some of them, it forms no argument that six or seven public slaughter-houses, placed round about this metropolis, will be sufficient, nor that the distances at which they would probably be located prove the greatest possible injury to the trade and inconvenience to the public. Unfortunately in this country, particularly in London, we have no means by which we can, with any confidence as to the correctness, estimate the amount of the consumption of meat, but we have been informed by a good authority, that it may be considered to be nearly double of that which is slaughtered in London. I have before alluded, at some length, to the laws and restrictions to which the butchers' trade, in all its branches, is subjected in France; but that system is totally inapplicable to this country. The surveillance and control would not be submitted to here,—every man has always been accustomed to conduct his own affairs in his own way; and so long as he does not interfere with, or prejudice, the public welfare, or violate the laws, he has a prescribed right to perfect freedom. In France they have been taught to respect that kind of control, not only by habit confirmed for a long period in the general government of the country, but in the details of their trade, ever since that trade assumed any importance in the internal economy of the country. We cannot help fearing for the trade here, that should public companies, not being butchers, establish public slaughter-houses, that it will be reduced very nearly to the same state as the trade is in France, and that of the most disagreeable description—namely, of a power which will have only its own private ends to gain.

THE DISTANCE OF THE SUN FROM THE EARTH DETERMINED INDEPENDENTLY OF PARALLAX.

(Reprinted from the *Ipswich Chronicle*, of December 23rd, 1848.)

To the Mathematicians of the Nineteenth Century.

Gentlemen—The under-mentioned equations demonstrate and prove the distance of that beautiful luminary the sun (independently of parallax or transitorial phenomena), and will, I hope, set at rest all mistrust upon this grand and sublime question, which has engaged the attention of all lovers of astronomy, ever since the cultivation of science began. The data which I employ are the lengths of the apparent day and night on the longest and shortest days of the year, the radius of the globe we inhabit, and the versed sine of the obliquity of the ecliptic.

$$\frac{(\infty - y)s^2}{4\infty y(\infty + y) + (\infty - y)^2 z} = \frac{\sqrt{4\infty^2 y^2 + (\infty - y)^2 s^2} - 2\infty y}{(\infty - y)^2}$$

$$b\infty = ay$$

Seconds.

Data
a = the length of the day on 21st Dec. = 86430·04
b = the length of the day on 21st June = 86412·93
s = the earth's equatorial radius = 3962·5 miles
z = versed sine 23 deg. 27 min. 22·81 sec. = ·0826363238
∞ = the distance of the sun on the longest day.
y = the distance of the sun on the shortest day.

With this data, and the known fact that the earth moves nearly in an elliptical orbit, I deduce two independent equations, and having the same number of unknown quantities, their respective values are truly limited to a known, definite, and satisfactory result. The absolute values of the required quantities, will prove the nice accuracy of the distance (obtained by a transit of Venus over the sun's disc), but they will also demonstrate an error, respecting the eccentricity of the earth's orbit, or half-distance between the foci; consequently the ellipse will be much nearer to a circle than astronomers have hitherto considered it to be,

I am well aware that by making these remarks I place myself antagonistical with mathematicians upon this subject, but truth and demonstration will ultimately prevail over authority and unintentional error. In conclusion, and for the sake of publicity, I intreat all gentlemen who are willing to aid pure algebra, to make these equations as public as they possibly can,—for I wish them to stand the test of the learned; by so doing, they will succour the cause of science in one of the noblest, grandest, most sublime of all questions that ever came under the cognisance of erring man.

I remain, Yours, &c.,

John King,

Upper Brook-street, Ipswich,
Dec. 20, 1848.

IMPROVED STEAM-VALVE.

Registered by Mr. Josiah Evans, *of Haydock Colliery, near Warrington, Engineer.*

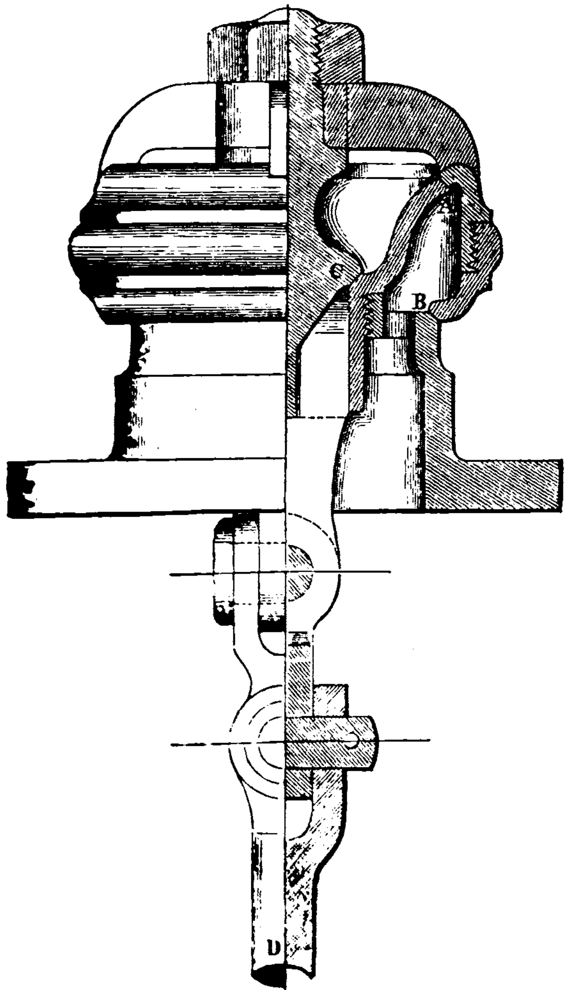
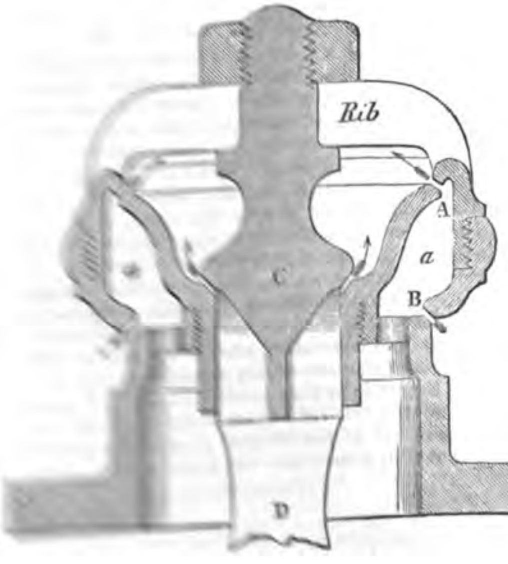


Fig. 1

Fig. 2.

Fig. 3.



[illegible] is to make the area of the centre [illegible] than the difference of the area of the lid of the valve at B, and the area of the lid of the valve at A, or in such other proportion. By this arrangement, when used as a safety-valve, and when the difference is only one inch in area, and the steam at a pressure of 60 lb. per square inch, the actual weight to be suspended to the rod D will be only 60 lb.; or when used for the working valves of a steam-engine without the centre part C, the area of the seatings A and B can be so proportioned that only the weight of the valve-lid will have to be lifted.

Fig. 1 is a vertical view of one-half of the valve; fig. 2, a vertical section, showing the valve closed; and fig. 3, a vertical section, showing the valve open. The arrows indicate the flow of the steam through the openings when it is admitted into the spaces, *a*, *a*.

ON THE PRINCIPLE OF RAILWAYS.

(From the *Railway Chronicle.*)

The most important step in attaining a sound knowledge of any subject is to obtain a clear view of the "*principle*" on which it is based.

Railways, in common with all other results of human intelligence and skill, have their A B C, or elementary principles; and were it not that I am deeply impressed with the conviction that a considerable portion of the railway public (both professional and shareholding) require to be brought back again to school for the purpose of learning the very first lesson on this important subject, I would not have presumed to beg for a corner in your valuable pages, in order that I might have an opportunity of repeating the elementary lesson which, through your indulgence, some four years ago I attempted to give on the A B C of what I term the "principle of railways." But judging from the increasing number and *weight* of those monster rail-crushing, permanent-way-destroying, dividend-absorbing, Brobdignag engines, which are now, from morning until night, making havoc with the 4,000 miles of railway which branch to nearly every part of Great Britain, I am fain to repeat my A B C, in the hope that I may make one or two apt scholars, and, peradventure, reclaim some who ought to have known better than to subject good honest wrought-iron rails to a crushing treatment which neither art nor nature ever fitted them to sustain.

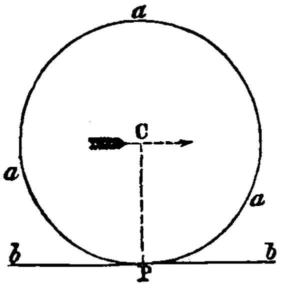
Were any apology required for intruding the subject on the attention of your readers, it would be found in the fact, that such is the havoc which these monster engines are making with the rails, that by their "bills of mortality" their longevity is now reduced to under eight years at the very outside, especially on those lines where the traffic is considerable.

Now, when we commercialise this fact in its most simple form, and bring the result to a focus in plain £. *s.* *d.* upon 4,000 miles of rail "used up" every eight years, to say nothing of the destruction of other portions of permanent way, and the increased deterioration of the rolling stock pacing over rails in bad condition, we may indeed say, "that's the way the *dividends* go."

Were this subject gone into and looked at in its proper light, all other reforms would sink, on comparison, into insignificance. But as "it is best in all things to begin at the beginning," permit me to mount the desk and hold forth "for a brief while" on my A B C, or principle of railways.

Lesson 1. To what circumstance is it we owe the low amount of tractive force requisite to move heavy bodies on a railway?

Answer. Simply to the impenetrability or hardness of the surfaces, namely, of the rail and the wheel.



Demonstration. Let *a a a* represent a wheel of perfectly hard and impenetrable substance, and let *b b* represent a rail of the same material; it is evident that the contact of such a wheel with such a rail will be an absolute point, P. It also follows that the force required in moving forward the centre or axle, C, will be infinitely small.

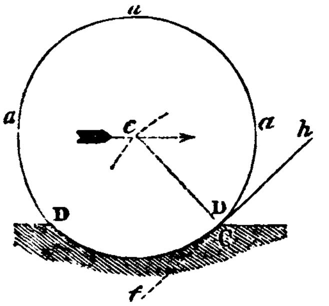
This, then, is not only the principle, but also the perfection of a railroad—namely, the least possible mutual penetration of the wheel and rail, so as to (under all circumstances) maintain the absolute point-like contact between the wheel and the rail.

Now, let us take another example—namely, the same demonstration applied to a case where the rail and the wheel are not of perfectly hard, impenetrable substances.

Lesson 2. To what circumstance are we to ascribe the great amount of tractive force required in dragging a wagon along a soft or sandy road?

Answer. To the penetrability or softness of the road.

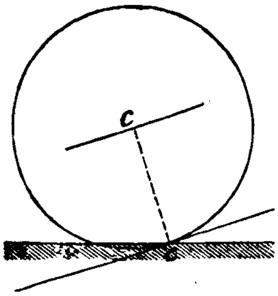
Demonstration. Let *a a a* represent a wheel rolling along a sandy or penetrable soft road, into which the wheel sinks from D to D. In moving forward the axle, *c*, of such a wheel, we shall find, that as the wheel is, as it were, in the act of mounting an everlasting hill, whose declivity is represented by a tangent to the circle at the point C, as great an expenditure of force will be required to move such a wheel along a level plain of such a degree of softness or penetrability, as would be required to roll the same wheel up a perfectly hard inclined plane of the declivity represented by the line *fh*.



Now, let us examine in what respect the preceding demonstration has reference to railways in general, and the action of heavy engines in particular.

Hardness or impenetrability is a relative term. A rail which is not sensibly penetrable to the action of the wheel of an empty wagon, is quite penetrable to that of a monster locomotive, whose driving-wheels are loaded with some eight tons.

In the case of the action of the wheel of an empty wagon, the contact of the tyre of the wheel with the rail is very nearly an absolute point; but load that wheel with eight tons, and we shall find that we cause it to sink into "the sandy road" condition of things; in other words, we cause such a wheel and rail to mutually compress or penetrate each other; and instead of the contact being *a point*, it becomes *a line*, like the side of a polygon, as here shown; and the force requisite to produce motion will be equal to that which would be required to roll such a wheel and its load up a perfectly hard incline equal in declivity to the tangent of the circle of the wheel, drawn from the point *c*, or its parallel C.



Hence the vast importance of departing as little as the nature of things will permit from the absolute hard-surface-state of affairs, as indicated in the first demonstration. The way to do this is so to arrange our system of traffic on railways, as that no one engine will ever be required with a load on any of its wheels of more than four tons at the utmost. Were this carefully attended to, the saving of coke expended in perpetually ascending the hill of iron they create before them would be vast; while the saving in wear and tear, or more properly speaking, destruction of permanent way, would pay many times over for the wages and capital expended in the increased number of engine-drivers, and of lighter locomotives required to perform the same traffic duty, which in every respect they would perform with more economy, as so much of the apparent or ostensible power of the present monster engines is actually absorbed in their own efforts to maintain motion, and roll continuously up a self-created hill of iron.

If there be one subject more than another that calls for the most careful and searching investigation, it is the commercial results, for good or evil, which issue from the employment of heavy engines; and when we have such startling facts as that, on the average of some of our lines of best traffic, we employ upwards of eighteen tons of rolling plant, in the form of engines and carriages, to convey one ton of passengers, it ought to prove to us that we are on a very wrong system; and when we add to the extravagance of so disproportionate an expenditure of means to the end, the rapid and wholesale destruction of permanent way, which inseparably attends the heavy-engine system, we shall do well to look to that question as a most certain cause of decreased profit, and in returning to the employment of light engines as more certain to bring back the days of good *bonâ fide* dividends, than all the petty diplomacy in which the railway interest have squandered their means and attention during the last three or four years.

The system which Messrs. Adams and Samuel are bringing before the public in the form of light passenger engines and carriages combined, in which they have so admirably united the minimum of non-paying weight to the maximum of paying weight, contains within it, so far as I am able to judge, the very salvation of dividends, and the railway interest at large, together with the utmost accommodation to the public. Besides the important results which are likely to attend the employment of the system of engine just alluded to, the influence they will have in converting our branch lines from suckers into feeders, in the most substantial sense of the term, is a subject that holds out the brightest hopes for the profitable extension of the benefits of railway communication into every corner of the land, and so diffusing happiness and wealth through the length and breadth of our beautiful country.

Patricroft, near Manchester, JAMES NASMYTH.
Jan. 9, 1849.

REGISTER OF NEW PATENTS.

GALVANIC BATTERIES AND MAGNETS.

WILLIAM EDWARDS STAITE, of Lombard-street, City, gentleman, for "*improvements in the construction of galvanic batteries, in the formation of magnets, and in the application of electricity and magnetism for the purpose of lighting and signalizing; as also a mode or modes of employing the said galvanic batteries, or some of them, for the purpose of obtaining chemical products.*" (Partly a communication.)—Granted July 12, 1848; Enrolled January 12, 1849. [Reported in the *Patent Journal.*]

The great leading feature of this invention being the batteries, they obviously form the first part of the specification; the system pursued throughout being what he terms the "perfluent" system, in contradistinction to the percolating batteries—the unequal reduction of the plates by these (as well as every other kind of battery) besides the constant attention required, rendering them all more or less troublesome and expensive in their action. Now, by the proposed system, the consumption of the metal is equalised, and the exciting fluids may be regulated so as to effect the necessary change to ensure the continued action of the battery, without other attention than may be periodically determined, and which may be extended to a considerable time. These batteries are, in their general arrangements, very similar to the ordinary acid battery; each separate cell is furnished with two openings at bottom, at opposite ends of the cell, which communicate with short longitudinal channels under the battery, which connect one cell with that next it on one side, while the opening or channel at the other end of the cell communicates with the adjoining cell on the other side; and in this order the whole series are in communication. The under channels, leading to the end cells of the battery, have a hose attached thereto, which are carried up to the level at which the liquid is to stand in the battery, and terminate in two funnel-heads—the one having a spout to run off the excess of the liquid into a suitable receiver, while the other is being continually replenished from the supply-cistern; the height of this funnel being sufficient to cause the liquid to flow through the battery, passing first to the cell next that end in which it circulates, then to the next in succession by channels before mentioned, and so on through the whole series. Modifications of this battery are represented, in which only one opening is made in the bottom of each cell, and all communicating with one channel. A hose-pipe is attached to this, the funnel-head of which is raised and lowered at intervals of about 20 minutes, for the purpose of running off or replenishing the liquid, which is thus equalised throughout the whole number of cells. Instead of the cells being connected at alternate ends, as first described, syphons may be employed for passing the fluid from one to the other. In another arrangement of the perfluent system is shown, in connection with a double or porous cell battery (the inner cell being a porous jar) supported in the centre of the outer cell on a pipe passing through the bottom of the battery, and furnished with washers of india-rubber, to prevent the liquid escaping from one cell to the other; or at the bottom this pipe forms a communication with an under supply-channel, in which the proper feed is maintained in a hose and funnel-head, at the proper level; and supposing the exciting liquid to be a solution of sulphate of lead, it becomes specifically lighter while it remains in the jar, and becomes a clear solution of dilute sulphuric acid. This is allowed to flow over the edge of the porous jar into the outer cell, or zinc compartment of the battery;

here it escapes by an aperture in the bottom to a channel common to all these cells, and from thence carried away by it at a height suitable for maintaining the proper level in the cells.

The second part of the invention alludes to an apparatus for regulating the supply of the exciting fluids to galvanic batteries. The liquid is contained in a cask or other suitable cistern, enclosed at top to prevent the pressure of the atmosphere acting on the surface of the liquid, which is drawn off at an opening at the bottom, and received into a small open cistern, the level of the liquid in which, when above the opening in the cask, prevents any further escape; from this small cistern the liquid is drawn by means of a syphon; the end pendant thereon is a flexible hose: while the other, or long end, is a metal tube, which delivers the liquid into a glass tube or vessel, from which it escapes by a small aperture at the bottom, which is regulated to pass about the necessary quantity; when the liquid rises to a higher level in the glass tube, and consequently covering the long end of the syphon, which passes down to the bottom, the flow will be diminished, at the same time the higher level attained will indicate a greater outflow at the bottom; the outer side of the glass being graduated accordingly. The syphon is suspended by a cord, by which the relative proportion of the legs may be varied by elevating or depressing the level thereof, the long end always remaining the same, while the flexible material of the other adapts itself to the required height at which the apparatus may be suspended.

Thirdly, this invention relates to combination of lead as the positive element with nitric or acetic acids, instead of zinc, and having any suitable negative element; the plates for which purpose may advantageously consist of surfaces of platinum.

Fourthly, to the employment of an amalgam of zinc, inclosed in a bag, as a substitute for the amalgamated zinc plates or rods used in galvanic batteries. For this purpose he employs a bag of linen, hair, cloth, or any finely reticulated fabric not metallic, in which the amalgam (in a liquid state) is placed, in which state it is used in lieu of the plates before mentioned.

Fifthly, to improvements in the formation of magnets, which consist—first, in the hardening such articles by heating them in a bath of hot metal, instead of subjecting the magnet to the heat of a furnace, and afterwards plunging them in water—lead being employed as the heating medium.

The metal he uses in the formation of magnets for electrical purposes he prepares as follows:—he takes the best Swedish iron, and, instead of converting the whole into steel, as usual, he only partially converts it to the thickness of the scale on the outside; this scale is removed, and afterwards fused and the ingot obtained, and then rolled out into thick sheets, from which the magnets are cut.

The sixth part relates to an improved galvanometer; in the galvanometers hitherto employed, they have been useless when the electrical apparatus has been in action, as they cannot be used during that time, while the present improved galvanometer is included in the circuit, and shows at all times the intensity of electricity passing. It consists of a thick wire coiled round a hollow wood centre, in which a glass tube is fixed, in the centre of which is placed a rod of soft iron, so as to slide freely up and down in the centre. This is surmounted by a small stem of brass; the passage of the current through the coil tends to draw the soft iron rod upwards, the height to which it is elevated depending on the intensity of the current; the glass tube is graduated to show in units the number of grains of pure zinc consumed, which may be effected by the actual experiment, or it may be graduated according to one of Petrie's galvanometers.

The seventh part relates to an amalgam consisting of zinc and mercury, in the proportion of five parts of the former to one of the latter, when employed as plates or rods in galvanic batteries.

The eighth part of this invention has reference to improvements in effecting the motion of the electrodes in electric lamps, employed for the purpose of producing a continuous light for illuminating purposes, or for the production of a regular intermittent light, applicable to lighthouses. The improvements in this particular consist of an apparatus for elevating the electrode as it is consumed or transferred to the opposing electrode by the passage of the electricity, and is an improvement on a former patent, dated July 3, 1841, and described in the *Journal*, Vol. XI., p. 49. In this case, the supporting stem of the lower electrode terminates at the lower end in a rack, which gears into a pinion, on the axis of which is placed an escapement-wheel, worked by means of a double pall, one of which drives the wheel in one direction, while the other propels it in the opposite direction.

This double pall is pivoted in the centre (the opposite ends being the parts that fall into the teeth) to a lever, one end of which has a slow oscillatory motion communicated to it from a crank, actuated by a train of wheel-work, the motion of which is maintained by springs, or some suitable maintaining power, and the direction of motion given to the wheel will depend upon the pall in gear; this is determined by what he terms a regulator-coil; this regulator-coil is placed in the circuit producing the light. A rod of soft iron is placed in a vertical position in the coil, the upper part of which terminates in a wooden top attached to a long lever, which is elevated or depressed by the vertical rod, according to the intensity of the current of electricity. The long lever has near its fulcrum a small stirrup, embracing one of the palls, so that when it is elevated, it withdraws that pall from the wheel, and throws the other into gear; this will take effect when the lower electrode has been elevated too far, or brought into too close contact with the opposing electrode, and will, consequently, reverse the direction of motion of the wheels, and lower the electrode; and, again, when it sinks too low, the palls will be reversed, and thereby raising the electrode to a position more compatible with the production of light. When the electrodes are in a position the best suited for the production of light, a small catch on the regulator-rod lever comes in contact with the crank-movement, and prevents the further action thereof; but so soon as this lever is elevated or depressed by the regulator-coil, so will an upward or downward motion be imparted to the electrode. Suitable counter-balances are attached to the several parts, to ensure their proper action. By this means, a continuous and uniform light is obtained, applicable for general purposes of illumination. The upper electrode is secured in a tripod, one of the legs of which forms the conducting-link, and is immediately connected with the regulator-coil before-mentioned, and forming the eduction for the electric current, the induction being effected through the rack to the lower electrode.

In the production of an intermittent light, the supporting stem of the electrode is furnished with a rack, gearing into a pinion, in connection with a train of wheel-work and a suitable flyer, to regulate the motion; this pinion is so fitted as to have about one-tenth of an inch of back-lash, and is free to receive an impulse from the rack. The lower end of the stem terminates in a rod of soft iron, surrounded by a helix-coil contained in the electric circuit. This is influenced by the current so as to draw down the electrode, the wheel-work before-mentioned giving way thereto, and allowing it to be slowly withdrawn, so that when the electrodes are at too great a distance apart, the light becomes extinguished, and the influence of the coil ceases. A weight hung over a pulley is suspended by a cord from the rack or support-bar of the electrode, which—so soon as the influence of the coil ceases—begins to elevate the lower electrode, until it comes in contact with the upper electrode, and thereby establishing the electric circuit; and the influence of the coil being again brought into action, the rack-bar is slowly drawn downwards, as before explained, till the light becomes extinct—the flyer in gear with the rack limiting the speed of either movement, producing thereby a regularly intermittent light, the duration of the light and the succeeding intervals of darkness depending upon the apparatus employed. A chain is attached to the raising weight, one end of which rests on the pedestal of the apparatus; and as the electrode is reduced, a greater portion thereof is deposited on the resting place, and so keeps the whole in a proper state of equilibrium. Other arrangements are represented for producing an intermittent light, in which the rack and wheel-work is omitted, thereby allowing the flashes of light to be produced in rapid succession; but this may be readily arranged to limit the duration of light or darkness, as may be required. In one of the lamps shown the upper electrode consists of a rotating disc, having an angular periphery, the apex of which forms, as it were, the point of the electrode. This is connected with suitable wheel-work, which causes it to rotate slowly, or about one revolution an hour. A scraper is placed in contact with the periphery of this disc, which removes at each revolution the particles of matter transferred from the lower electrode, and by this means maintaining a permanent point to the electrode.

The eighth part has reference to the making of electrodes of electric lamps of iridium, the hardest of all known metals; or of alloys thereof. For this purpose he fuses the oxide iridium by enclosing it in a cupel of bone-ash under the influence of the voltaic arc, which produces the most intense heat known. The resulting ingot is afterwards subjected to heat for a considerable time, and hammered for the purpose of annealing it and forming as near the shape as possible, when it is completed in the manner of cutting precious stones by the lapidary's wheel. These electrodes are shown in a shape assimilated to that of a horse-shoe, and mounted on two glass supports from the base of the lamp, with which the current wires are in suitable connection; the whole is under a glass shade, the light being produced by the passage of the electric fluid through the iridium. Combinations of these electrodes are represented under the same shade for the production of a more intense light.

The ninth part refers to the encasing of electrodes in supporting tubes, by which the electrode is protected from fracture, and also admitting of the electrodes being made of several pieces, and joined end to end. This supporting tube rises nearly to the top of the electrode, and is surmounted by a number of erect springs, which surround the electrode, and hold it firmly after it passes out of the tube end; these springs are fitted to the top of the tube by a sort of a bayonet-joint. The electrode—or pieces forming the electrode—are joined by insertion the one into the other, and secured by a suitable cement, the top of the under one forming a cup for the reception of a pin formed on the lower end of the upper portion.

The tenth part relates to the introduction of an intensity-coil in the electric circuit of galvanic batteries, for the purpose of increasing the intensity of the fluid. This consists of a copper-wire ribbon, wound and retained in a suitable coiled form, through which the current is passed when applied to the purposes of lighting, or for motive purposes. This copper ribbon should be a cross section of an area of one-tenth of an inch for every forty yards in length.

The last part of this invention relates to the production of chemical products from galvanic batteries, either used for the production of light or heat, for motive power, or for the production of such chemical products only. For this purpose, one or other of the perfluent systems of battery should be employed, from the facilities afforded for drawing off the products. In the case of zinc being used as the positive element, the sulphate of zinc will be the result; but as the sulphate of zinc is of little or no commercial value, he further prepares it by adding thereto a solution of the sesqui-carbonate of ammonia, which will precipitate the oxide of zinc, and the acid, being thus freed from the zinc, may be used again in the batteries, while the oxide of zinc may be employed in place of the carbonate of lead, so extensively used as a pigment. Various other results may be obtained, according to the metals and acids employed in the batteries, several of which are given in illustration, but which it will be unnecessary to enter into.

First—the construction of galvanic batteries on the perfluent principle, before explained; whether the perfluence of the liquid is effected by inter-communicating channels at the bottom of the trough, or by syphons at the top, or by any other equivalent means.

Secondly—the employment in galvanic batteries of flexible hose, with funnels attached thereto, for the purpose of charging and discharging the cells.

Thirdly—the construction of the double fluid battery, before described, so as to cause the perfluence of two separate and distinct exciting fluids.

Fourthly—the graduated meter attached to the supply-tub or cistern, in order to regulate the quantity of the exciting fluid which may be required to pass through the battery.

Fifthly—the equilibriated hydrostatic supply-cistern, as adapted to galvanic batteries.

Sixthly—the combination of lead (instead of zinc), as the positive element, with any suitable negative element having nitric acid as the exciting fluid, in galvanic batteries.

Seventhly—the mode described of enclosing a liquid mercurial amalgam of zinc in a bag of linen, horse-hair, cloth, or other finely reticulated fabrics, and to be used instead of the amalgamated zinc-plates, or rods of galvanic batteries.

Eighthly—the employment of an amalgam of zinc and mercury, in the proportion of five of zinc to one of mercury, in galvanic batteries.

Ninthly—the several improvements described in the formation of magnets.

Tenthly—the improved regulator for electric lamps, as described.

Eleventhly—the improved galvanometer and graduated scale, before described.

Twelfthly—the several improved modes of actuating the electrodes in electric lamps, before described.

Thirteenthly—the method described of making the electrodes of iridium, or alloys of iridium, and used for the purpose of producing electric light.

Fourteenthly—the encasing the electrodes of electric lamps in tubes, for their support, and the making them in pieces, as before explained.

Fifteenthly—the insulation of the said electrode tubes from the metal stand which supports the lamp, so as to allow of two or more separate lights being worked with separate currents of electricity, independently of each other; but sufficiently near to be worked under one glass shade.

Sixteenthly—the revolving circular electrode, with conical edges, in combination with a scraper, for removing the particles of matter transferred from the one electrode to the other.

Seventeenthly—the employment in electric lamps of glass, or some similar imperfect conductor of heat, to envelope the metallic apparatus for holding the electrode.

Eighteenthly—the combination of an intensity-coil with a galvanic battery, as before described.

Nineteenthly—the several arrangements for producing the regularly intermittent light from electricity, for the purposes of illumination in lighthouses, together with the various modifications by which the same may be adapted to the production of a permanent light, as described.

Twentieth, and lastly—the formation of galvanic batteries, for the purpose of obtaining chemical products from the several combinations of galvanic elements and exciting liquids, herein mentioned.

PAPIER-MACHE ARTICLES.

William Brindley, of Twickenham, Middlesex, manufacturer, for "*improvements in the manufacture of articles of papier maché.*" —Granted June 6; Enrolled December 6, 1848.

The improvements relate—First, to a mode of producing ornamental and other surfaces in relief, on trays and other articles of papier maché. Secondly, to a mode of manufacturing hollow articles of papier mache, such as basins for holding water, so as to produce wash-hand basins, suitable for camp furniture, and such like purposes. And thirdly, to making hats of papier maché.

The first part of the invention consists in employing moulds with sunk or hollow parts according to design, so as to obtain articles of papier maché from sheets, made with designs in relief. For this purpose, metal moulds are used; but in place of their being plain, and producing plain surfaces, they are made with engraved or other sunk surfaces, so that when the sheet of pulp is compressed between moulds, one or other, or both of which having recesses in pattern, those will produce the article of papier maché with surfaces in relief; and as it would be expensive to make a number of moulds of the same pattern, if of metal, papier maché is employed in making numerous patterns from one pattern; and this is done by placing a succession of sheets between the moulds, and then to dress up such moulded articles as if they were to be japanned; but in place thereof they are only saturated with oil, and stoved; and then they are used in obtaining a series of moulds for making trays and other articles of papier maché, according as the moulds are made suitable for one article or another; and in order to give them strength, the ordinary moulds of sheet metal are used; or in place of making the papier maché moulds from sheets, as above described, papier maché articles may be moulded and dried between the ordinary moulds; the parts where surfaces in relief are to be obtained to the articles of papier maché can be cut out with a sharp knife. The second part of the invention consists of making basins of papier maché, so that they may be used to contain water; and this is done by causing sheets of pulp made by sieves from pulp, as above explained, to be pressed between two moulds. The third part of the invention consists of applying a like means of operation in the manufacture of hats.

MOULDING BRICKS.

Joseph Skertchly, of Anstey, Leicester, gentleman, for "*improvements in bricks and in the manufacture of tobacco pipes and other like articles.*"—Granted June 30; Enrolled December 30, 1848.

The improvements are—Firstly, for making bricks used for building, and when required to be covered on either or both of their faces with plaster, cement, stucco, or other like coating, such coating shall be so dovetailed into the subjacent bricks as to be afterwards detachable therefrom only with great difficulty. With this view, each brick is moulded on the face or faces to be plastered or coated, with an under-cut groove, the form of which may be varied at pleasure, so long as it is made broader at the base, or internally, than at the top.—Secondly, the invention relates to making tobacco pipes and other like articles from clay or other suitable substance.

STOVES AND FURNACES.

William Edward Newton, of Chancery-lane, Middlesex, for "*improvements in the construction of stoves, grates, furnaces, or fire-places, for various useful purposes.*" (A communication.)—Granted July 6th, 1848; Enrolled January 6th, 1849.

The improvements relate to the construction of stoves and other closed furnaces, for the more perfect development of the heat produced by the combustion of fuel, and the prevention of smoke. The fire-place containing the fuel is either completely surrounded by an outer case, forming a chamber within which the atmospheric air is heated, or only partially closed, leaving the front of the fire exposed. In either case means are provided for replenishing the fire. The atmospheric air passes through holes in the sides, and is regulated by registers over the holes. The outer case which incloses the fire-place is not the shell of the stove, but there is another, partially inclosing both the fire-place and the case immediately surrounding it: this case may be ornamented in any tasteful manner. Above the stove just described there is another chamber, into which the products of the combustion in the fire-place, and the heated atmospheric air from the chamber surrounding the fire-place, are conveyed, by means of a conical-shaped pipe, called a throat; the area of which where it is connected to the fire-place, is larger than the upper end, where there is a plate which divides the lower portion of the stove from the upper chamber; the products of combustion in the fire-place, pass through this throat from the fire to the upper heating chamber, at the same time the heated air in the chamber, surrounding the fire-place, is also passed into the throat at its lowest part, and consequently ensures an admixture of the heated atmospheric air with the inflammable products from the fire-place. The heated products pass and circulate round the interior of the upper chamber, and then pass downward through a vertical pipe, into the outer chamber of the lower part of the stove, by which the external case of it is heated; thence by a pipe to the chimney. The heated air from the chamber immediately surrounding the fire-place, in passing into the throat, intimately mixes with the inflammable products from the fire-place, and is thereby consumed.

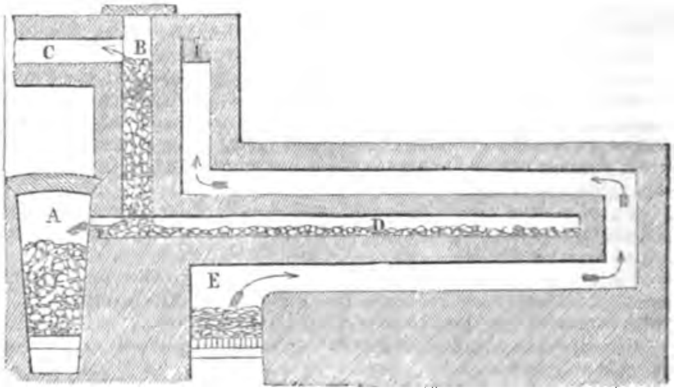
The improvements are also applicable to furnaces for puddling and making iron. The atmospheric air may be admitted to the throat direct from without, in its natural state of temperature, instead of passing it to the chamber, and thereby heating it. Steam, as well as the atmospheric air, may be admitted to the throat; the mode also of applying the atmospheric air to the throat may be varied, as it may be admitted at the sides, by several openings, or by one opening, or in the middle of the throat; the object being to intimately mix the atmospheric air and the inflammable matters from the fire-place together; the throat may also be increased in size between the upper and lower apertures, for the purpose of giving longer time for the air and products to mix, previous to passing into the heating chamber.

EXTRACTION OF METALS.

William Hunt, of Dodder-hill, Worcester, chemist, for "*improvements in obtaining certain metals from certain compounds containing those metals; and in obtaining other products by the use of certain compounds containing metal.*"—Granted June 24; Enrolled December 22, 1848.

The improvements relate to the extraction of certain metals from compounds containing them, and also to the manufacture of sulphate of soda and carbonate of soda from common salt. The first improvement, relating to the extraction of metals, consists in obtaining in a metallic state, from iron slag of iron furnaces, the iron contained therein; and obtaining in a metallic state the copper and tin from the slags containing those metals. The iron is extracted from the slag in the following manner:—First, the iron slag from puddling and refining furnaces is (instead of being allowed to run from the furnace, and cooled in masses) granulated by running it from the furnace into a vessel of water; or, if more convenient, the slag may be crushed by proper machinery; the object being to reduce the slag into very small pieces. The granulated or crushed slag is then mixed with small coal, in the proportion of about $\frac{1}{4}$th of the slag. This mixture is then placed in a reverberatory furnace, and covered with a thin layer of small coal, and exposed to a full red heat for about 24 hours, at the end of which time the iron will be produced from the slag. It should be then taken from the furnace, and cooled quickly in water. Tl metallic iron thus obtained may be used for the production of pi iron (by mixing it with the ordinary burden of the blast furnace) or for bar-iron, in which case it is charged into the puddling or refining furnaces with the ordinary metal.—For extracting the copper contained in the slags of copper, the slag is granulated or crushed, as in the case of iron slags, and mixed with raw sulphurous ores and small coal, in the proportion of 30 lb. of sulphur contained in the raw ores, 40 lb. of lime, and 20 lb. of small coal, to one ton of the granulated slag. These are mixed together with water, to form a paste, and submitted to operation in a reverberatory furnace, as in the former case, the resulting products being a regulus of copper and a slag. In the ordinary copper slags the quantity of copper contained therein is about one-half per cent., and the regulus contains about 35 per cent. of copper, in consequence of the process of calcination of the ore being only carried a certain height; but the patentee proposes to carry it so far that the regulus shall contain about 60 per cent. of copper, and the slag about one per cent.

The second improvement is for obtaining sulphate of soda from common salt; and also in obtaining from the sulphate of soda thus produced, carbonate of soda. In the process, for the purpose of decomposing the salt, artificial sulphuret of iron or artificial sulphuret of manganese is used. The quantity of sulphur and of iron contained in the artificial sulphuret is first ascertained, and should the proportion of iron to the sulphur therein not be equal to about three of iron to one of sulphur, then about that proportion is to be made up by the addition of a proper quantity of oxide of iron, in a powdered state. It is then mixed with common salt, in the proportion of about two parts of salt to one of sulphur contained in the compound. When mixed, it is to be placed in a furnace, and subjected to a transmitted heat; atmospheric air being at the same time admitted into the furnace, by which chlorine gas and a small quantity of hydrochloric acid are evolved. If it is not desirable to collect the chlorine gas for any subsequent purpose, then steam is passed into the furnace, which has the effect of facilitating the operation, but converts nearly all the chlorine gas into hydrochloric acid. The chlorine gas being now present only in small quantity, the products from this operation are sulphate of soda and oxide of iron, which may be separated in any ordinary manner.



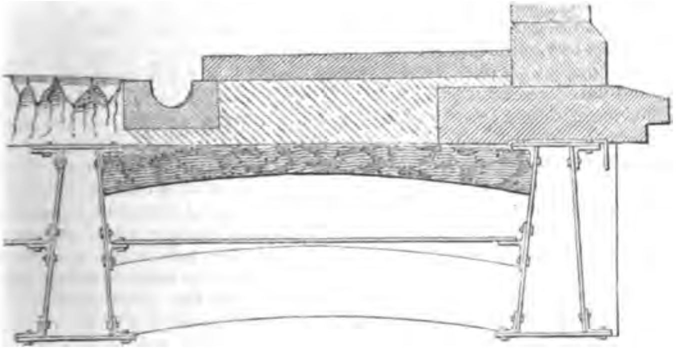
The annexed engraving is a section of the furnace. A, is a chamber for iron pyrites, the gaseous products from which pass through an opening near the top, and through the vertical chamber B, and then through the horizontal passage C; the vertical chamber B being charged with a quantity of the compound of the artificial sulphuret of iron and common salt, through which the products from the pyrites in their passage pass. When exposed in this chamber a sufficient length of time, it is raked and spread over the bottom of the chamber D, where being exposed to an increased temperature, the process is completed; the resultants being, as before stated, sulphate of soda and oxide of iron. E, the fire-grate of the furnace; the products of combustion passing from thence through the flues in the direction indicated by the arrows, and finally through the flue F, to the chimney. The obtaining carbonate of soda from the sulphate of soda thus produced, is effected by following nearly the same process as that described with respect to the production of sulphate of soda.

TUBULAR BRIDGES.

Description of the Tubular Beam Bridge on the Carmunnock Road, over the Polloc and Govan Railway. Erected by **Andrew Thompson**, Esq., Engineer, of Glasgow, in 1840.—(Paper read by T. L. **Donaldson**, Esq., at the Royal Institute of British Architects, January 22nd.)

The Carmunnock Road, near Glasgow, passes over the Polloc and Govan Railway, askew, by means of a beam bridge. The width from outside to outside of parapet is 25 ft. 6 in.; the total length from one extreme to the other of the abutment-walls about 93 feet. The aperture for the railroad is 30 feet in the clear, taken at right-angles to the axis of the railroad ; but taken on the face of the bridge is 31 ft. 6 in. The walls which support the iron girders are 3 ft. 6 in. thick, constructed of stonework, faced with fair ashlar of hammer-dressed course-work, ⅛th of the facework being headers. The ends of these walls are strengthened by the wing retaining-walls; and there are four intermediate abutments or counterforts, 2 feet wide, and projecting 3 ft. 3 in. One coming under each girder, these walls rise to a height of 18 feet; and immediately under the beams is a course of ashlar 3 feet broad in the bed, and 1 foot thick. There is a wrought-iron plate bolted down to the course of ashlar just mentioned, to receive the feet of the tubular beams, which are six in number, being 5 ft. 1¼ in. apart from centre to centre, and 35 ft. 3 in. long. They are constructed of the best boiler-plate, ⅜ inch thick, and measure 3¼ inches wide in the clear at top, and 6 inches in the clear at bottom, and are 18 inches deep (as shown in the annexed engraving, drawn to a scale of ¾ inch to a foot). The upper and lower plates are 6 inches wider than the beam, the 3-inch projection on each side being for the purpose of receiving the angle-irons of ⅜ plate, with a bearing width of 3 inches against the side and upper and lower plates, to which they are attached by rivets ¾ inch in diameter, square-headed on one side and rivetted over on the other, spreading to 1 inch in diameter. They are 1½ inch apart from centre to centre. The beams are filled in solid with concrete to render them unyielding and rigid, and are tied together by ⅝ cross-bars of Low-Moor iron, 3 inches wide, attached by bolts to T-irons, which are rivetted to the sides of the tubes.

Fig. 1.—Showing two of the Girders and Brick Arch between.



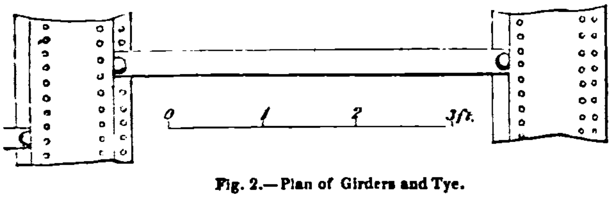


Fig. 2.—Plan of Girders and Tye.

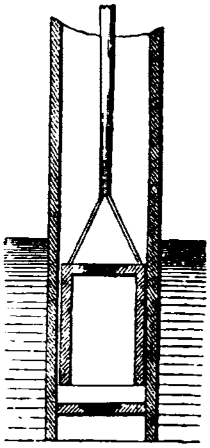
The beams being thus framed together, the spaces between them were filled in with two 9-inch courses of arched brickwork, having a rise of 1½ inch at the centre in a space of 3 ft. 2 in. The crown of the arches was paid over with hot tar, upon which was a layer of well-wrought clay puddle, well rammed down. Over the clay there was a coating of Whinstone metal, to form the road, covered with a binding course of engine-ashes, 2 inches thick. The horizontal rusticated arch-faces are of cast-iron plates, ¾ thick, bolted to the outside beams, and cast in three lengths. The parapets are of hammer-dressed stonework, each alternate course going through the whole thickness. There is a foot pavement on each side of the bridge, 4 feet wide, with gutters laid between it and the roadway.

This bridge was constructed for William Dixon, Esq., the eminent iron-master of Glasgow, to whom the railroad belonged. That gentleman has the most important foundry called the Govan Ironworks, at Glasgow. The communication between the furnaces is by means of platforms resting on tubular beams, slightly differing from those just described. The bearing between the furnaces is 33 feet. The beam is composed of ⅜ plate, the depth 19 inches in the clear; the width, which is the same at top as at bottom, is 7 inches in the clear. The bottom plate is secured to the side plates by inner angle-irons with ½ inch rivetted bolts, 2½ inches apart from centre to centre. The side plates rise 2½ inches above the top plate, for the purpose of receiving the outside angle-irons, which secure the top plate to the sides, and to which it is rivetted in the same manner as the bottom. Each side of the angle-irons is 2½ inches wide. Two or three of these beams form the supports for the platform, which connects the summit of one furnace with the other.

There have been recently brought before the notice of the profession so many schemes for the construction of beams for supporting floors, in order to avoid the various casualties to which cast-iron is liable, and at the same time to produce less depth in the flooring and greater lightness in the weight, that the consideration of the construction of the above-described bridge, which was erected nine years since, is at once instructive and interesting.

FREE-ACTION PUMP FOR COFFERDAMS.

We copy the following description of a pump from the *Railway Chronicle.* It has been tried lately in one of the cofferdams at the bridge over the Trent, now in the course of construction upon the Great Grimsby and Sheffield Junction. The principal features in the invention are—that the action of the pump is independent of the contact of any two solid rubbing substances:—that it is not subject to the derangement to which other pumps are liable, in which water-tight joints of one kind or another are required, and upon the perfection of which, universally, their effectual working, and in many cases, their actual working depends:—that it can be used in engineering works where ordinary pumps would be choked:—and that it can be constructed wholly of wood, in a short time and at a trifling cost. The accompanying sketch shows a section of the one that was tried, and which discharged as much water (working at fourteen strokes per minute) as a 12-inch circular suction-pump. The working part was below the surface of the water on starting the pump, although when once at work it would continue to draw water until the surface fell below the bottom of the main. The bucket, which was a square wooden tube, closed by a common flap-valve at the top, was suspended by a wooden rod connected with the rocker above, and worked within another wooden tube 10 inches square inside, open at the top and constituting a main 26 feet long. The bucket worked clear of this main, about 1-16th of an inch on every side, and was 3 feet long. About 8 inches or 10 inches from the bottom of the main, another valve was inserted, which, together with that in the bucket, opened upwards. The stroke of the pump was 4 feet. The mode of action is clear. As the bucket rose, the water rushed in at the lower valve, and by this means every up-stroke raised the surface within the main, a certain amount—the motion of the bucket and the supply through the lower valve being too rapid to admit of the escape of any significant quantity of water between the bucket and the main. The experiment was exceedingly satisfactory. The pump lifted sand and gravel in considerable quantities, and though scored by the same in the immediate neighbourhood of the bucket, its action was not in the least impaired.



SUPPLY OF WATER TO LONDON.

Another scheme is brought forward for supplying the metropolis with water. It is proposed to take the supply from the river Thames, near Henley, at an elevation of 106 feet above low-water mark at London-bridge, and convey it in a canal, 19 miles in length, until it reaches the Grand Junction Canal at West Drayton, whence it will be conveyed a distance of 15 miles to Paddington, in the bed of that and the Paddington Canal, or in a separate channel alongside of those navigations. A reservoir is to be formed at Paddington, 103 feet above *low*-water mark of the Thames; and another high-service reservoir is to be formed on Primrose Hill, 190 feet above low-water, or 172 feet above high-water mark, which the promoters state will be supplied by *a very simple hydraulic power obtained from the fall of the water to the lower parts of London.*

The quantity of water intended to be supplied is 100 million gallons daily.

The cost of the undertaking is estimated at 750,000*l.*; but if a separate channel should be made for the water for the whole distance, 250,000*l.* is to be added to the expense—making in all a million.

This is an outline of the promoters' scheme, which appears to us has not received that mature consideration it deserves before it is brought into Parliament: in consequence, it will, we fear, break down in committee. There cannot be a doubt that the source of the supply is good, and that an ample quantity of water for the wants of London may be procured, and that there would not be any very great objection to bringing the supply by a navigable canal from Henley as far as Drayton, as the navigation through this distance of 19 miles would not be more objectionable than taking the supply from the Thames at Staines, a place about the same distance below Henley as West Drayton. But we have a strong objection to the course of the Grand Junction and Paddington Canals, as they are fed by large reservoirs of stagnant water collected during the winter months, and let down for the lockage through the summer months. These reservoirs receive the land drainage of a vast tract of country: one is at the head of the river Brent, near Edgware-road; another at Elstree; another at Ruislip; and one or two others between the latter place and Tring; and, besides, those canals coming within the range of the metropolis, are liable to be polluted by a variety of objectionable matters. The size of the canal, with an inch fall only per mile, requisite to carry 100 million gallons daily, is a much larger work than we anticipate the estimates will cover—when is included the settling, filtering, and delivering reservoirs: for enormous as the quantity is, it will not do to allow the water to pass into the mains without undergoing the process of filtration, as in rainy seasons the river Thames is in a very turbid state.

If the companies' mains and pipes are to remain the same as they now are, it will be requisite to lift 10 to 15 million gallons of the water for the supply of London to the upper reservoir at Primrose hill, or the water will not pass through the mains with a sufficient velocity to supply the eastern parts of London, from five to seven miles distance. How this quantity is to be lifted "by a very simple hydraulic power," the promoters do not tell us

Unless, indeed, half of the 100 million gallons be allowed to run to waste, to raise the 10 or 15 million gallons to the upper reservoir, by an overshot-wheel of 30 feet diameter, by such an arrangement one-half of the water would be discharged at an elevation of only 55 feet above *high*-water mark, an elevation that cannot be of much service in flashing the sewers; as for the latter purpose, the main quantity of water should be discharged at the head of the sewers throughout London. The waste water might very advantageously be used for supplying the Serpentine—much needed, and which is about 40 feet above high-water mark, and also the ornamental water in the Green Park and St. James's Park; but it would be discharged too low for Regent's Park, as the lake there is on about the same level as the intended Paddington reservoir, unless it be raised by an additional water-wheel kept for that purpose.

After all, the main consideration is, can so large a quantity as 100 million gallons daily be diverted from the river Thames in the summer time without being detrimental to the river between Henley and Brentford? And can that quantity be brought to London with a fall of only an inch per mile? If this really can be done, or even 50 million gallons, then it will unquestionably be of great value to the metropolis, provided the water be properly distributed; for this purpose it will be indispensably necessary to have another reservoir at Hampstead, with a large main for supplying it, in addition to the reservoirs belonging to the present water companies, so as to ensure a constant supply at all times to the top of the highest house within the district to be supplied! In such case, can all this be done within the capital of one million sterling? We think not; nor for half as much more, particularly if the water-course of the Grand Junction and Paddington Canals be abandoned.

It is very evident, as we said at first, the scheme has been hastily brought forward, and assertions made that will be difficult to support. Instead of 100 million gallons, let the promoters be content with 10 million gallons daily: that supply will be ample when we take into consideration the present supply of the New River;—and instead of trusting to "a simple hydraulic power," let them calculate for steam power to lift the water up to Hampstead, which would be a more central and elevated spot to distribute it throughout the metropolis.

PORTER'S PATENT CORRUGATED IRON BEAMS.

Mr. Porter, of the Iron-roofing Works, at the Grove, Southwark, has recently taken out a patent for the employment of corrugated iron in the construction of beams; and for the purpose of testing the strength some experiments were made, of which the following is an account. Two beams made on this plan were submitted to the test; the extreme length of each 22 feet, and span between supports 20 ft. 6 in.; depth of beam, 18 in.; weight of beam, 8½ cwt.; the top and bottom frames were of 4 inches × 4 inches T-iron, and the base ½ inch thick; the plates of corrugated iron forming the beam being of No. 16 gauge, and the bands 1½ inches × ½ inch thick. The two beams were placed 9 feet apart, and across these were laid two large oak blocks, weighing 1 ton 3 cwt., and supporting the further load. These blocks, or bearers (the one 19 inches and the other 24 inches wide), were 4 ft. 3 in. apart from centre to centre, and equidistant from their centres to the centre of the beam, 25½ inches; upon these were laid cast-iron blocks, weighing 6 tons 17 cwt. This weight was put on on Saturday and remained till Tuesday, without causing any deflection. On Tuesday, in the course of an hour-and-a-half, an additional load was applied of 121 bundles of plate-iron, weighing 7 tons 3 cwt. 0 qr. 16 lb., producing a deflection of $\frac{9}{16}$ths inch. This load was allowed to remain from 1 p.m. on Tuesday until 10 a.m. on Wednesday, in course of which time the deflection had increased $\frac{1}{16}$th inch. Fifty-one bundles of plate-iron, weighing 3 tons 9 cwt. 1 qr. 2 lb., were now added, which caused a total deflection of 1 inch bare; rested a quarter of an hour, when 32 bundles of plate-iron, weighing 1 ton 18 cwt. 0 qr. 12 lb. were added, which increased the deflection to 1⅜ inch and 1 $\frac{3}{16}$ inch respectively; the difference being evidently occasioned by the settling down of the piers, giving a greater load to one beam. A further load, weighing 2 tons 8 cwt. 3 qrs., brought the deflections to 1⅝ inch and 1¼ inch. This loading was proceeded with gradually during three hours, when the load was left for an hour. In the meantime a slight noise called attention to a partial dividing of the bottom flange of T-iron, in the beam which hitherto appeared the least strained: upon examination, it was found to have originated in a flaw near a "shut" in the T-iron, distant 6 ft. 3 in. from the point of support; this caused a further deflection of $\frac{1}{16}$ inch, but the fracture did not appear to increase during half-an-hour. The deflection of the beams increased to 2 inches and 1¾ inch with an additional load of 2 tons 6 cwt. 2 qrs. 22 lb. load, applied gradually during three quarters of an hour. After a further lapse of 10 minutes, a further load of 7 cwt. caused a rapid deflection in the already-weakened beam, the corrugated iron giving way at the same time to the strain of the rivets longitudinally. The beams were now blocked up to prevent any accident from the sudden falling of the load. The corrugated iron of the other beam was also found to have yielded in several places to the longitudinal strain of the rivets, principally in the lower part of the beam.

The breaking weight is, therefore, considered to be about 25 tons, exclusive of the weight of the beams.

The inventor considers that his beams will not weigh more than one-half, or five-eighths, of the weight of cast-iron beams to carry the same load, and that they may be made for 21*l.* per ton.

ON THE DRAINAGE OF LAND.

[We give the following interesting account of Land Drainage, from an "Essay on Land Drainage, &c.," by Mr. WILLIAMS, acting engineer to the Severn Commission.]

The great advantages resulting from the application of drainage water to mill-power, is no matter of mere theory. They have been practically illustrated, in the most conclusive manner, upon the estate of Lord Hatherton, at Teddesley, Staffordshire, and the illustration there afforded is so forcible, that a treatise on the subject of drainage would be incomplete without a description of the highly effective mode in which the greatest enemy upon his lordship's estate has been converted into one of the most effective agents in its improvement.

Having frequently heard of the great simplicity and practical utility of the system adopted upon Lord Hatherton's farm, I visited Teddesley for the purpose of inspecting the whole of the arrangements, and acquiring such information upon all the details as would enable me to give a concise description of them. Upon my visit, I found that they had been inspected by many scientific agriculturists, and amongst others, by Mr. French Burke, who had noticed them in a pamphlet upon Land Drainage and Irrigation, published in 1841; but as they have been considerably extended and improved since that time, and as they are of greater importance to the illustration of the object to which this chapter is devoted, than to an essay confined to the subject of draining and irrigation, I offer no apology for going into a detailed account of the results now attained, and which are both novel and highly instructive.

A large proportion of Teddesley Hay, which is a manor extending over 2,586 acres of land, was originally part of the forest or chase of Cannock, and covers the height, seen to the eastward of the Penkridge Station of the London and North-Western Railway. From these heights the lands slope gradually, with slight undulations, to the river Penk, a distance of about three miles. The domain was originally of much smaller dimensions than at present, and comprised two anciently enclosed parks, one containing 589, the other 200 acres. The larger park, previous to Lord Hatherton's coming to the estate, was in the lowest state of cultivation, and much of the smaller was little more than a swamp. The circumjacent common lands were also covered with heath or rushes. On his lordship's entering upon the estate in 1820, his attention was at once directed to its improvement, and he has since that time been constantly engaged in extending and bringing it into its present high state of cultivation. The old park fences have been thrown down, large plantations made, and the home park laid out in a manner suited to the neighbourhood of a nobleman's residence; an extensive farm has been built, and the lands subjected to a new arrangement. The extent of land which did not require draining was comparatively small; and the whole, which consisted generally of a light soil, rather inclined to peat, the subsoil being chiefly clay, has since been subjected to a regular course of thorough draining, and the water collected into two main channels, by which it is first conveyed to an extensive reservoir, which has been constructed for its reception, and from which the water flows underground for a distance of nearly half-a-mile, in a culvert fifteen inches in diameter, to the farm buildings, where it is discharged upon an overshot wheel, and thus furnishes mill-power for the various purposes connected with the estate.

The wheel originally used was constructed of timber, and was thirty feet in diameter; from the want of sufficient natural fall in the surface of the land, between the reservoir and the farm, no little ingenuity and contrivance were required in the arrangement of the details for using the water in the most efficient manner, and for afterwards getting rid of it. Much talent has been displayed in overcoming these difficulties, which has been done in a way which proves how completely this system of converting the water obtained from the drainage of the land to the purpose of motive power, is applicable to the great majority of estates of any magnitude in the kingdom.

The original timber mill-wheel has recently been replaced by one built of wrought-iron, of thirty-eight feet in diameter, which is a model of lightness, combined with strength. This wheel is let into a chase cut into the red sandstone rock, which here underlies the surface to the depth of its entire height of thirty-eight feet, by which means the upper part of the wheel is brought below the level of the bottom of the reservoir, and a sufficient fall to the water in its course to the mill is secured. Having performed its work, the tail water is discharged from the bottom of the wheel by a head-way, which is driven through the rock, for a distance of some 500 yards, where it is discharged into a lower level of the estate, and made available for the purposes of irrigation to a large extent of upland water meadows. In the recent alterations, iron has been substituted for wood throughout the whole machinery. The extension of the radius of the wheel would alone have enabled the mill to do more work with the same supply of water; but additional water has also been obtained, and the power of the water-wheel is now equal to twelve horses. A comparatively small portion of the water which is now derived from the drains is required for the purposes of the mill, but, being soft, it is all used for the purpose of irrigation.

The mode by which the additional supply has been obtained is worthy of notice. A piece of bog of thirty acres, covered with rushes and deep moss, in the centre of a large plantation, had been left unplanted. It was formerly a part of the extensive heath now enclosed, and had been considered irreclaimable. The surface soil was very poor, and overlaid a bed of clayey gravel of three feet thick, the under-stratum being a bed of strong clay of twelve feet thick, resting upon a bed of strong gravel; the whole formed part of an inclined plane, which terminated in a deep quaking bog, partially covered and surrounded with alder; below this spot were farm lands, recently enclosed, imperfectly drained, the bottom being cold, notwithstanding the surface had been dried. The mode adopted in draining these thirty acres, was bringing levels up from the main drains, which fed the mill pool, and which, on reaching the lower part of the land, were twelve feet deep. Drains of the same depth were then cut through the clay, on each side and up the centre of the thirty acres. The bottoms of these drains were bored at distances of five or six yards apart, the boring-rods passing through the clay to the bed of gravel beneath, from which the water in the stratum of gravel gushed in abundance into the drains: by these means the bog in the wood below has been effectually dried, and the cold bottom of the farm lands, still lower down, has been greatly improved. The surface of the thirty acres was afterwards close drained, at distances of twenty feet apart, and three feet deep. The whole surface, which was originally impassable by man or beast, is now sound and hard, and is valued at 30*s.* per acre. From the additional supply of water thus obtained, the mill can work night and day during the winter months, and for sixteen hours per day in the driest season. Thus at a comparatively trifling cost, by the application of ordinary skill and judgment, has a noxious waste been converted into valuable land, and furnished water power, which well warrants the saying of Lord Hatherton's agent (Mr. Bright), that "that bog was the best bit of land upon his lordship's estate." A similar application of the same principle would be equally valuable upon every estate where equal facilities exist.

The whole of the work connected with the drainage of the land and the mill, both in its conception and execution, does infinite credit to all concerned, and Lord Hatherton has been fortunate in having, in Mr. Bright, the assistance of a most intelligent land-agent, to whose contrivance he is mainly indebted for the acquisition of this great power, and under whose superintendence the whole was executed.

The water-wheel works a thrashing machine, cuts hay and straw, and kibbles oats and barley for a stock consisting of about 250 horses and cattle, grinds wheat and malt, and drives circular saws, by which the sawing of all the smaller scantlings for the use of the estate is executed. At my request, Mr. Bright has kindly furnished me with the following tables, showing the cost of the whole of these works, and an estimate of the saving effected by them, and which will at once prove the value of the principle which they have so successfully established.

The following is a statement of the number of acres of land under-drained, the amount expended thereon, and the increase in the annual value produced by the process:—

Quantities.			Value of the lands in their original state.				Amount expended in under draining.			Value of the lands in their present state.			
			Per Acre.	Annual value.						Per Acre.	Annual value.		
A.	R.	P.	s.	£	s.	d.	£	s.	d.	s.	£	s.	d.
78	1	36	10	39	4	9	262	15	0	27	105	18	9
19	1	2	10	9	14	6	74	9	8	35	34	0	9
38	0	3	16	38	8	3	52	14	2	40	76	0	9
82	2	2	15	61	17	8	346	15	4	30	123	15	4
30	3	24	10	15	9	0	121	3	8	35	54	1	6
81	1	34	8	32	11	8	153	16	4	22	89	12	2
36	3	16	10	18	8	6	142	8	0	30	55	5	6
33	0	0	8	13	4	0	80	5	2	26	42	18	0
10	2	33	..	....			90	8	0	50	26	15	3
10	0	8	..	....						21	10	11	0
9	0	0	12	5	8	0	76	9	8	30	13	10	0
15	0	11	16	12	1	0	41	9	4	33	24	17	8
21	2	10	15	16	3	5	66	0	0	30	32	6	10
15	3	13	15	11	17	5	40	2	7	30	23	14	11
39	0	2	14	27	6	0	175	9	4	27	52	13	2
521	3	24		293	14	3	1,724	9	3		766	1	2

Total Expenditure.

	£	s.	d.
Under-draining as per statement	1,724	9	3
For erecting Water-Wheel and Machinery	1,850	0	0
Irrigation	224	4	10
Total outlay........................	£3,298	14	1

Increased Revenue.

	£	s.	d.	£	s.	d.
Present annual value of lands under-drained	766	1	2			
Original value of the same land	293	14	3			
				472	6	11
Estimated annual saving by the Mill				550	0	0
Increased annual value of Water Meadows				178	0	0
Total increased revenue				£1,200	6	11

Resulting from the drainage of 521 acres, and the employment of drain-water over eighty-nine acres of land, and the saving effected by the employment of mill power, together affording a clear annual interest on the outlay of upwards of thirty-six per cent.

The tenants upon Lord Hatherton's estate are, as may be expected, quite alive to the great value of mill-power for agricultural purposes, and his lordship has erected a water-mill, similar in most of its leading features to that which has been described, upon one of his farms in the neighbourhood. In this case, the drainage water of the farm is collected into a reservoir, sufficiently above the farm buildings to obviate the necessity of sinking the wheel so deeply below the surface of the ground as was necessary in the former instance; the water is brought from the reservoir in cast-iron pipes, laid underground until they approach the mill-wheel, when they rise in a crane-neck, and discharge the water upon its upper surface; the tail water is got rid of by a culvert discharging into a lower level, as in the former instance. I found, on going over the estate that other of his lordship's tenants were desirous of making arrangements with the agent for similar erections, being evidently anxious to secure to themselves the same advantages as were enjoyed by their neighbours, and quite willing to pay an additional rent, equivalent to the advantages conferred.

The spirit of improvement exhibited on the estate is very gratifying, and presents great inducements to the capitalists and landowners of this kingdom to turn their attention to like improvements. In point of remuneration, the profits to be thus realised throw all other investments with which I am acquainted far into the shade, and the encouragement they afford is most important in a national point of view.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

Jan. 8.—Sydney Smirke, Esq., V.P., in the Chair.

A paper was read "*On the various Qualities of Caen Stone*," by Mr. C. H. Smith.—It explained various analyses of the stone, and experiments on different beds as to resistance and compression, and also on the absorbent character of each variety of the stone.

The Chairman stated that in one building erected under his direction the use of Caen stone instead of Portland saved near 14,000*l.*

Jan. 22.—T. Bellamy, Esq., V.P., in the Chair.

A paper "*On the Girder-Bridge over the Polloc and Govan Railway*," was read by Mr. Donaldson. It is given in another part of the *Journal* (p. 57.)

Mr. Jennings described a new water-closet invented by him, which consists of the ordinary basin. The trap is formed of a tube of vulcanised india-rubber, compressed by two clips close together when not in use, and forms an air-tight joint.

SOCIETY OF ARTS, LONDON.

Jan. 24.—T. Winkworth, Esq., in the Chair.

The Secretary read a paper, by Professor B. Woodcroft, "*On Steam Navigation.*"

Steam in its present practical state owes its origin and progress to the improvements recently made in the steam-engine in this country. The employment of animal power in the propulsion of vessels by means of paddle-wheels is of very ancient date; and the substitution of steam for the same purpose was suggested as soon as the steam-engine was rendered effective in pumping water from mines, long before it was found capable, from its then imperfect state, of propelling a vessel advantageously.

In 1472, Robert Valturius gave a view of two galleys, moved by wheels.—In 1543, Blasco de Garay, a Spanish sea-captain, is said to have exhibited an engine by which vessels and ships of large size could be propelled.—In 1705, John Bramah, the inventor of the hydraulic press, of a lock, &c., obtained a patent under the following title:—"His new invented Hydrostatical Machine and a Boiler, on a more peculiar principle than any yet made known to the public;" and one of the inventions described in his specification is a "mode of propelling vessels by the improved rotatory-engine therein described and claimed (which will act as a pump), by means of a paddle-wheel or what may be called a screw-propeller."—On January 5, 1769, James Watt obtained a patent for improvements in the steam-engine, one of which was for causing the steam to act above the piston as well as below, and this was called the "double-impulse" or double-acting engine. This was the first step towards the practical application of the steam-engine to propelling steamboats.—In 1785, a patent was granted to William Symington for "his new invented steam-engine on principles entirely new;" and in 1787, Patrick Miller published a pamphlet on the subject of propelling boats by paddle-wheels moved by men. The vessels to which they were applied were called Triple Vessels, the deck being constructed so as to cover three small vessels, and the two paddle-wheels being fixed in the space between the vessels.

The first boat which the steam-engine was used for the purpose of propelling was constructed by Mr. Symington, at the suggestion of Mr. Taylor, a person to whom Mr. Miller had made known his views as to the possibility of propelling vessels by means of paddle-wheels. From the experience which Mr. Symington gained in the construction of Mr. Miller's boat, and the circumstance that in 1780, the crank had been discovered by Pickard, and at this time the double-acting cylinder and crank were being used for stationary engines, he abandoned his own old engine, and obtained a patent for applying a double-acting reciprocating engine to a boat, and for placing his crank on the axis of the paddle-wheel. This was a very important discovery.

The name of the vessel in which Symington combined the double-acting engine of Watt, the crank and fly-wheel of Pickard, and the improved wheel of Miller, was the *Charlotte Dundas*. This combination of machinery constituted the system of steam navigation now used, and this vessel was the parent steamboat of its race. Mr. Fulton, the American engineer, and Mr. Bell, the Scotch engineer, were on board the *Charlotte Dundas*, and acquired a knowledge of the machinery used by Symington. Mr. Fulton subsequently introduced this system of propelling in America, and he was the first person to establish steamboats for practical purposes.—Mr. Bell was the first person in Europe who established practical steamboats.

From the establishment of practical steam navigation, in 1807, to the year 1837, the paddle-wheel was the only instrument used to react against the water; but in the latter year, an instrument, now generally termed the screw-propeller, was practically introduced by Captain Ericsson. Although almost innumerable modes of propelling vessels have from time to time been suggested and patented, the only instruments that have hitherto been found of practical benefit are the paddle-wheel and screw-propeller, each under various modifications:—The varieties of paddle-wheels as improved by Miller; the Morgan paddle-wheel, invented by Mr. E. Galloway, and the split paddle-wheel, invented by Mr. Field. The varieties of the propeller, are portions of an uniform pitch-screw, patented by Captain Ericsson; or the increasing pitch-screw, patented by Mr. Woodcroft.

INSTITUTION OF CIVIL ENGINEERS.

Jan. 9.—J. Field, Esq, President in the Chair.

The paper read was "*A Description of the improved Forms of Water Wheels.*" By Mr. W. Fairbairn, M. Inst. C.E.

After noticing the opportunity for improvement afforded by the substitution of cast and wrought iron for timber, in the construction of hydraulic machines, the author pointed out the disadvantages and loss of power attending the principle and the form of the old water-wheels. He quoted Dr. Robison's "Mechanical Philosophy," for the numerous disadvantages of the old form of bucket, and the difficulties arising from the attempts of the old millwrights to design a shape which should retain the water for a greater length of time in it, and thus give out more power. The chief difficulty was the opposition of the air to the entrance of the water; and numerous contrivances, such as boring holes in the starts, making the spout much narrower than the face of the bucket, &c., were tried; but still the difficulties existed, and induced Mr. Fairbairn to adopt the construction described in the paper, and which he termed "the Ventilating Water-Wheel." The general object of these modifications was to prevent the condensation of the air, and to permit its escape during the filling of the bucket with water, as also its re-admission during the discharge of the water into the lower mill-race.

The paper then described minutely the principles and construction of the large wheels erected for the Catrine and Deanston Works; for Mr. Brown, of Linwood, near Paisley; for Mr. Duckworth, of Handforth; for Mr. Ainsworth, of Cleator; and for others; and showed that in all cases the system had proved eminently successful. These wheels were all on the suspension principle, with wrought-iron arms, radiating from cast-iron centres to the periphery, and so placed that the whole structure was in tension, the motion being communicated from internal toothed-wheels, fixed to the shrouding. The various modifications of the forms best adapted for different heights of fall were described; but it will suffice to give that for breast-wheels for high falls, as it appeared the most complete. These wheels were described to possess many advantages beyond the overshot, the undershot, or the common breast-wheels, and were best adapted for falls not exceeding 18 feet or 20 feet, and where at times there was a considerable depth of back water; and such was the improvement caused by this system, that the wheel at Mr. Ainsworth's mill was frequently plunged from 5 feet to 6 feet in the back water, without its uniform speed being impeded. The wheel had a close sole; the tail end of the buckets were turned up at a distance of two inches from the back of the sole-plate, and running parallel with it, terminated within about two inches of the bend of the bucket, immediately above it. The water, in entering the bucket, drove the air out by the aperture into the space behind, and thence into the bucket above, and so on in succession. The converse occurred when the buckets were emptied, as the air was enabled to flow in as fast as the wheel arrived at such a position as to permit the water to escape. It appeared to be allowed that this system had been very generally successful, and that the results obtained had approached, very nearly, to the stated duty of the Turbine, whose powers had, however, been much exaggerated, and had been allowed recently by M. Fourneyron not to have obtained more than about 72 per cent. as a mean duty.

Jan. 16.—The annual meeting was held this evening.

The following gentlemen were elected to form the Council for the ensuing year:—*President:* J. Field. *Vice-Presidents:* W. Cubitt, J. M. Rendel, J. Simpson, and R. Stephenson, M.P. *Council:* J. F. Bateman,

G. P. Bidder, I. K. Brunel, J. Cubitt, J. Fowler, C. H. Gregory, J. Locke, M.P., J R. M'Clean, C. May, and J. Miller, members; and W. Harding and T. Piper, associates.

The report of the Council was next read. Satisfactory reasons were given for the unusual delay in the publication of the minutes of proceedings, and a plan was detailed for paying off the debt incurred for the alterations of the house of the Institution.

Telford medals were presented to the right hon. the Earl of Lovelace, Messrs. Harrison, Mitchell, and Ransome.

Council premium of books, to Messrs. Harrison and Jackson.

Telford premium of books, to Messrs. Redman, Green, and Rankine.

Memoirs were read of the deceased members:—Messrs. B. Cubitt, T. Hopkins, S. Fowles, members; Lieut-Col. Brandreth, P. L. Campbell, F. Carlton, and T. E. Steele, associates; and J. Pope, graduate. Votes of thanks were passed unanimously to the President, Vice-Presidents, Members, and Associates of the Council, and to the Secretary; and the President, in returning thanks, gave a memoir of the late George Stephenson, and his connection with the combination of the fire-tubes and the blast pipe in the locomotive, which constituted it the life of the present railway system.

ROYAL SCOTTISH SOCIETY OF ARTS.

Dec. 11, 1848.—John Cay, Esq., F.R.S.E., President, in the Chair.

The following communications were made:—

1. "*Description of Harbour Screw Cramps, designed for temporary use in binding together the Stones in the construction of Harbour and other Marine Works.*" By Thomas Stevenson, Esq., F.R.S.E., civil engineer.

This paper states that the great majority of instances of damage to harbours from gales occur during construction, or from neglect in repairing, and shows the almost total dependence of a whole pier on the stability of each stone in the structure. Many instances are adduced of harbours suffering great damage during construction, which, after being "*closed in*" and completed, have withstood the assaults of after storms. The principle on which these screw cramps have been designed is that of coupling stones together in such a manner that the outermost cannot be removed without dragging the adjoining stones along with it. The first of these implements is adapted for a vertical wall, and consists of a cross-rod of iron inserted diagonally between two of the stones of the works, and on either end of this rod chains are slipped (one set being at the front of the wall, and the other at the back). These pass through openings in an abutment-plate placed diagonally across the last stone, and are tightened up by means of capstan-headed screws. The second of these implements is designed more particularly for a talus, or sloping wall, and consists of a kneed abutment-plate (placed upon the last or outermost stone of the unfinished work), connected by chains to a ring-bolt, fixed in any stone at a sufficient distance from the open end of the work, or even to a crow-bar driven down between any open joint in the masonry. These chains are tightened up by means of a draw-screw. This apparatus, in the event of a storm coming on suddenly, could be applied in the course of a few minutes.

2. "*Description of a Fire-Engine on a new principle.*" By Mr. John White, engineer.

This fire-engine is patented for England, but not for Scotland. It was stated that it differs in principle from all others hitherto made, and that the following are some of the advantages obtained:—First, from the number of pumps employed, and their great power, each producing a pressure of 60 lb. upon the square inch of water, which is as much as twenty men on the average can exert in the common fire-engines by their united power. Secondly, the men at the common engine may either help or hinder, at their pleasure, without the possibility of detection. This, however, is impossible in this new engine, for as each man has his own pump, he must either do his duty or stand still. Besides, as each pump is a perfect fire-engine of itself, the machine can be worked from one man up to its full complement, while the common engines cannot be worked at all until a sufficient number of hands be put on. That it is evident that the pumps of the common engines must pass their centres at the same moment, which, but for the air-vessel, would render them of little use as fire-engines, and even with its aid the column of water rises and falls at every stroke of the pumps, as may be seen, occasioning a great waste of power to recover it at every alternate movement of the levers. This evil was stated to be almost entirely overcome by the twelve or more pumps Mr. White employs, one half of which being in full power while the others are receiving their water, a uniform pressure is maintained upon the jet, which renders the air-vessel less needful, but with it, nearly as steady as the jet from a fountain.

The third thing Mr. White noticed was his method of preventing the air from mixing with the water and escaping with a crackling noise as it issues from the jet, breaking the column, and consequently preventing it from reaching the altitude it would otherwise attain. This is accomplished by an improvement in the top of the air-vessel, which has a vulcanised india-rubber cap, supported by a pierced metal shield or diaphragm, through the holes of which the water acts upon the elastic substances, over which is an air-tight dome, and the space between is charged with the compressed air to about 30 lb. upon the square inch, which is further compressed when the pumps or engine is at work; thus producing an uniform elastic spring that equalises the flow of the water from the jet,—which leaving no air beyond what is naturally in the water, rises unbroken to a much higher elevation than is reached by the common engine.

Mr. White read certificates from Salford, Manchester, and Glasgow, as to the superiority of his engine to those of the common construction. At Manchester, where a comparative trial was made, Mr. White's engine, with twelve men, sent more water, and to a greater altitude, than the *Ganges* engine, belonging to the Town Council, worked by twenty-four men; and at Salford, Mr. White's engine, with twelve men, threw the water several feet above the top of a chimney 129 feet high, while the *Deluge* engine of the old construction, worked by the same number of men, could not throw the water more than half the height; and when the number was afterwards increased to thirty-eight men, they were not able to make the water reach to the top of the chimney.

3. "*Description of a Cross-Cut Sawing Machine for sawing Fire-wood, &c.*" By Mr. William Douglas, carpenter.

This machine consists of a two-handed saw, freely slung in a frame, and moved by a crank at the end of a long bar, having a fly-wheel to turn the centres. Trees, logs, &c., being fixed and adjusted to suit, this simple contrivance cross-cuts them; and it is stated that a man can by its means cut double the quantity he could do by hand, and that the machine can be made complete for 5*l.*

INSTITUTION OF MECHANICAL ENGINEERS.

The annual meeting of the Institution of Mechanical Engineers took place on Wednesday, the 24th of January, at the Queen's Hotel, Birmingham.

In the absence of the President, Mr. R. M'Connell was called to the Chair, and read the report of the Council, which congratulated the members on the successful progress of the Institution, which now numbered 189 members, of whom sixteen are honorary members. The council deeply regretted the death of the late President, Robert Stephenson, Esq., who was the first president of the Institution. The rules of the society had been revised, and would be submitted to the meeting. The council congratulated the meeting on the readiness with which Robert Stephenson, Esq., had consented to take the Chair vacated by the death of his father, and which he had been filling *pro tem.* The financial report showed a balance in hand of 147*l.* 9*s.* 1*d.* The report was unanimously adopted. R. Stephenson, Esq., was then formally constituted president, and a vote of thanks was passed to Alderman Geach, for his services as treasurer, and that gentleman was re-appointed to the office. Mr. E. Marshall was elected secretary for the ensuing year. The rules, as amended, were also put and carried; after which, the officers and council for the ensuing year, elected by ballot, were announced. A vote of thanks was then passed to the council, for their services during the year.

A paper on the subject of a collision-apparatus, with a supplementary one on a station-buffer, for effecting an improved break for stations, written by Mr. C. de Bergue, of London, was read by the Secretary, and illustrated with plans and a model.

Mr. John Richmond, of Middlesex, exhibited an improved locomotive-engine counter, for registering the strokes of railway-engines at a high velocity. It was remarkable for the simplicity of its movement, and elicited a favourable expression, although the principle of its construction was not new.

A paper on a patent disengaging-apparatus for disconnecting steam-engines, and diminishing the shock of the disconnection, written by Mr. Hick, of Bolton, was read by the Secretary. The apparatus was intended to prevent frightful accidents, and might be worked with safety by any one.

The model of an improved patent railway-chair and switch, manufactured by Mr. Baines, of Norwich, was explained by the Secretary. It was highly approved, but as the inventor was absent the discussion upon it was postponed to the next meeting, to give him an opportunity of explaining its merits and stating the cost.

SUBMARINE TELEGRAPHIC COMMUNICATION WITH FRANCE.

Some interesting experiments were made on Wednesday the 10th ult., at Folkstone, as to the practicability of carrying electric lines of communication over great widths of sea channel. The experiments were conducted under the direction of Mr. Walker, superintendent of the telegraphic system of the South-Eastern Company. They were undertaken to test the possibility of establishing an electro-telegraphic communication with France, by a wire carried over the depths of the Straits of Dover; and it was intended to have taken the wire two miles out to sea, on board the *Princess Clementine* steamer (one of the company's ships), uncoiling and dropping it in the water as she proceeded. The night previous, however, had given token of breezy weather, and on the morning of Wednesday the wind was high; and the waters of the channel being agitated by a considerable swell, it was feared the vessel would roll and toss to such an extent, as to prevent the proper management of the instruments, or keep the needles in their necessary vertical position. It was, therefore, decided on to pay out 3,600 ft. of insulated wire along the mouth of the harbour and the side of the pier—one end being connected with the telegraphic arrangements at the Folkstone station, thus being in direct communicaiion with London, and the other attached to an instrument on board the *Clementine*, at anchor in the harbour. All the arrangements having been completed by half-past 12 o'clock, a message was sent to London, to apprise that all was in readiness, after which a continuous correspondence was kept up between the *Clementine* and the stations of London, Ashford, Tonbridge, and Folkstone. At four o'clock the submerged wire was drawn in and coiled up, and was found not to have sustained the slightest injury. The experiments were, it is stated, in every respect highly successful; the length of wire in the sea forming apparently not the slightest impediment to the perfect and free transit of the galvanic current.

The wire employed was not made expressly for the occasion, but had been constructed for the Merstham Tunnel, where it was found that not only the damp on the wires affected the galvanic current, but was still further interrupted by the steam from the engines, impregnated with acid and earthy matters. Its size is No. 16 copper wire, covered to a thickness of about ¼ inch diameter with gutta-percha, under a patent by Mr. Foster, of the gutta-percha manufactory, Streatham, and similar wires will in future be employed in all the tunnels on the lines, which places have been found to cause the only obstructions which present themselves to the free working of the system.

The telegraphic instrument employed was one constructed by Mr. Walker, on a plan to avoid any action from atmospheric electricity. The galvanic coils are mounted on wheels, and the needle is brought to a perpendicular with the greatest facility by turning a stud, which causes the coil to pass in a direction opposite to that to which the needles had been deflected. The conductor for the atmospheric electricity consists of a vertical wire, furnished with radiating points, and a bobbin of wire of a much finer texture than any other in the instrument. This is surrounded by a small brass cylinder, connected with the earth, and any overcharge of electricity burns the fine wire and escapes. This occurred in one instance at Tunbridge Wells, during a thunderstorm, a short time since.

FORCE OF SCREW-DRIVERS.

Sir—Will you oblige me by answering the following questions in your next number? We will suppose, for instance, a screw of a certain size is to be driven: with a short driver you are obliged to use great force to accomplish it—but with a long screw-driver there is less force required. You will perhaps, therefore, explain why millwrights and engineers use a short shaft, or endeavour to get the power to act upon the resistance as close as possible. It appears that these cases are exactly opposite. I hope this is sufficiently plain for you to understand what I want.

A Constant Reader.

London, Jan. 6th, 1849.

[The force required to turn a screw does not depend on the length of the screw-driver. In supposing that a screw may be driven more easily by a long screw-driver than by a short one, the very common error is involved by which a *sensation of exertion* is mistaken for force. Let the actual force required to drive screws of the same size and kind into a certain piece of uniformly compact wood be measured—not roughly, by the fatigue of the arm—but accurately in pounds and ounces—by means of a dynamometer, and it will be found that, allowing for slight irregularities which are unavoidable in such experiments, the force required is the same whether the screw-driver be six inches or eighteen inches in length. The reason why the longer driver requires less exertion in turning large screws is, that it can be more firmly grasped, and allows the workman to bring his muscles more easily into play than is practicable with the shorter instrument. The investigation of the power required in turning screws resembles the mechanical principles of the wheel and axle, where a weight suspended from a rope coiled round the wheel in one direction resists the rotative power of a weight attached to a rope coiled round the axle in the opposite direction. When the wheel is just on the point of turning, the weight applied to it is to the other weight as the radius of the axle to that of the wheel. In the same way, when the screw is just on the point of turning, the tangential force resisting its rotation is to the external turning force applied tangentially to a round handle as the radius of the handle to the radius of the screw.

The reason why engineers make driving-shafts as short as possible, is because short shafts are *cæteris paribus* less likely to be twisted by torsional strains than long shafts.—Editor.]

NOTES OF THE MONTH.

Ammonia Destructive to Leather.—Ammoniacal emanations from manure in stables are most pernicious to leather, it being rendered quite brittle and useless in a very short period; consequently, harness ought never be allowed to hang up in stables.

The appearance of Old Oak may be obtained by exposing any article of new oak to the vapours of ammonia. Every variety of tint may be obtained according to the duration and temperature of the volatile compounds. A new oak carved arm-chair exposed to the vapours of ammonia, will in about twelve hours have all the appearance of its being made 200 years since; and any other wood similarly exposed, will obtain the appearance of oak.

Cast Iron Pipes Enamelled would be a valuable acquisition in obtaining pure water. A correspondent inquires whether pipes have been so prepared: an answer from any of our readers will be acceptable.

Earthenware Piping.—Mr. Murray, in the *Mining Journal*, in answer to a correspondent, considers an internal glaze for the earthenware pipes altogether unnecessary. Earthenware pipes for the conveyance of water should be so deeply laid in the earth as to be unaffected by the agency of frost, lest the water absorbed by the porous earthenware in the act of expansion by freezing should rend the pipe. The application of *gas tar* to the pipes, when imbedded, as an external coating, would act as an insulator in reference to external temperature, and operate as a defence against the influence of frost.

Zinc Paint.—Some experiments were recently made at the Veille Montagne Zinc Company's Offices, on zinc and white-lead paint, by submitting them to a stream of sulphuretted-hydrogen gas, when the white-zinc paint remained unchanged and the white-lead paint was turned quite black. Some specimens of external painting were also shown of both zinc and lead, which had been painted for some months: the zinc paint still retained its whiteness, whilst that of the lead had very much changed.

Wrought Iron Cofferdam.—Last month the experiments undertaken by Mr. Brunel, at the instance of the Admiralty, for carrying the railway bridge across at Saltash, for the Cornwall Railway, were brought to a successful close. For the purpose two old gun-brigs, purchased of the government, were moored over the spot, and a wrought-iron cylinder, of ⅝ inch boiler plates, strongly rivetted together, 85 feet high, and 6 feet diameter, and of 28 tons weight, was sunk *in profundis*. The necessary apparatus for pumping out the water was then applied, and the experimenters, who afterwards descended to the bottom of the cylinder, had the satisfaction of finding that at 11 or 12 feet below the mud, there was a foundation of solid rock for the piers. The bridge will be of large dimensions, the Admiralty requiring that it shall have a clear width of 300 feet between the piers, and a clear height of 180 feet above high-water mark. Over it will pass the entire passenger traffic from Plymouth to the Land's End.

Dover Harbour of Refuge.—We have again, says the *Dover Chronicle*, much pleasure in recording the successful prosecution of this great maritime undertaking of the present age. On visiting the works the other day we were quite astonished at the remarkable extent of progress made since we last noticed them. The works are certainly conducted with an extraordinary spirit of industry. This is evidenced by the fact that the timber framework of this great sea barrier has been carried out upwards of 260 feet from the point of shore at the Old Cheeseman's Head; and by the aid of several diving-bells, helmets, &c., and a most masterly arrangement of travelling cranes, the ponderous stonework has been securely bedded in the chalk rock to a similar distance, and brought up almost to the level of high-water, within eight months. This compact body of beautiful masonry contains, we believe, no less than 150,000 cubic feet of stone of large dimensions, and of the finest quality that this country can produce, and gives good evidence of the ultimate stability of a structure, the beneficial effects of which are already very apparent, inasmuch as the frequent heavy sea caused by the prevailing south-west winds is materially checked at the harbour mouth, and the entrance of vessels into this desirable haven during a gale is now rendered almost a matter of ease and certainty. In addition to the extraordinary appliances already referred to, there is a fine steam-engine at work, driving several sets of mortar and cement mills, and a remarkable crane for unloading vessels. This engine is worked with all the docility of a child, and has within these few months discharged about 15,000 tons of stone, and all too with the most careful and steady results. Altogether, the works present the appearance of a more successful contending against the destructive action of the sea at this much exposed portion of the coast, than has ever been before attempted here. The operations have been inspected by engineers, royal, civil, and practical, all of whom have expressed their entire confidence in the speedy and satisfactory completion of a work so gigantic and so eminently calculated to save hundreds of lives, and thousands of pounds' worth of property. Several very high gales, with tremendous seas from the Atlantic, have lately waged their fury upon it, but no damage has been sustained further than occasional interruption to the working of the machinery upon which so many of the operations depend. The successful results here shown are no doubt to be attributed to the high standing of the engineers, and the spirited enterprise of Messrs. Lee, the contractors, who always avail themselves of the most valued expedients that science and practice can provide, and which are so highly calculated to bring this great monument of human skill and of a nation's resources to a satisfactory conclusion.

On Chemical Processes for the Boring of Rocks, &c., to be Blasted.—M. Courbebaisse having stated that calcareous rocks only could be acted upon by hydrochloric acid for blasting purposes, and that the silicious rocks, quartz, granite, &c., required the employment of another agent—most probably hydrofluoric acid, which it would be necessary to make on the spot; and having also stated that he had not been able to undertake any experiments on the subject, with a view to save miners and engineers from useless and expensive experiments, a civil engineer of Nantes, M. Emeril, determined to experimentise on the subject, and he therefore directed a large quantity of hydrofluoric acid to be used both in a liquid and gaseous state. The result of these experiments proved the impracticability of the process for mining purposes, for the gelatinous layer formed by the action of the acid on the rock effectually prevented the application of another portion of acid. Notwithstanding all endeavours, most carefully and assiduously made, there was not obtained the slightest benefit from the application of this process. Besides, the tediousness of the operation would prevent its practical adoption.

Peat Charcoal, prepared on the principle patented by Mr. Jasper Rogers, is a complete *disinfectant* when applied to offensive matter, the noxious effluvia being entirely destroyed by it. A manufactory for it has been erected in the forest of Dartmoor. It is cut out in cubes of 8 to 10 inches diameter, and immediately carried to a powerful press, where it is reduced about two-thirds in bulk, and nearly deprived of its water. It is then loaded in the trucks, and is conveyed to the works, where it is boiled in a mixture of coal-tar, pitch, peat naphtha, and other hydrocarbons. After saturation and drainage, the peat is fit for charging the retorts, composed of fire-clay, 9 feet long, and 5 feet in diameter, holding two tons of saturated peat each, and capable, when in full operation, of working 8 tons each in 24 hours. The gaseous products from these retorts pass much after the mode adopted in ordinary coal-gas works, along a hydraulic main, and through a long set of condensers, whence, after being deprived of all its condensable adjuncts, the purified gas is brought, by means of pipes, beneath the retorts, where it serves as a very powerful fuel. The condensed matter from the peat contains an immense proportion of stearine or vegetable tallow, oil, and naphtha. When the retorts are discharged, the charge requires to be drawn into a close iron chest on wheels, with a tightly fitting lid, which must be immersed in water, as the charcoal retains its heat for a very long time; and if quenched with water, as is the case with gas-coke, it imbibes so much of that fluid as very materially to deteriorate its quality. The extraordinay effects it has had upon smiths' work in particular, chiefly from the total absence of sulphur—has been such, that it has acquired the concurrent testimony of several intelligent smiths. The absence of clinker at the nozzle of the bellows, the perfect freedom from scale on the iron, so that an iron horse-shoe looks like one of steel, and that delicate instrument, the weaver's pick, when broken, is welded together with ease.

Valuable Products of Peat.—At a recent meeting of the Royal Society, for the promotion and improvement of the growth of flax in Ireland (the Marquis of Downshire in the Chair), Mr. Owen, of London, referred to a discovery which his friend Dr. Hodges would say, was worthy of the deepest consideration of every one present. Having heard, some time since, that from peat there could be produced ammonia, naphtha, soda ash, oil, spermaceti, and some other substances, he left London for Paris, and called on an eminent chemist there. He had been previously speaking on the subject with a Mr. Reece, also an eminent chemist, who told him that for the expense of 30*l*., he could produce from 100 lb. of peat, chemical results to the value of 148*l*. It was Mr. Reece who referred him to the Paris chemist, and when he (Mr. Owen) produced to the Paris chemist the statement of Mr. Reece, as to what he could do with the peat, the former assured him (Mr. Owen) that he could really do all that he had stated in the document. He then rang a bell, and ordered the results of his experiments to be brought up from his own laboratory, and then he (Mr. Owen) saw with his own eyes the sperm candles made, the ammonia, the oil, and the soda ash produced from peat; and that chemist thought this was the greatest discovery of the age, and one which would eventually convert the greatest obstacle to improvement into the greatest blessings, and double the fertility of the soil, to an extent that none could estimate. Well, he (Mr. Owen) being a man of business, declined to take any of these statements for granted, and consequently he had got a great number of experiments made by Dr. Hodges and his friend Mr. Reece, which were entirely confirmatory of all the statements made by his friend Mr. Reece. But still, not to deceive himself or others, he was determined to have an experiment made on a large scale, and had employed the largest apparatus in use for that purpose; and he rejoiced to tell this meeting that his great experiments had commenced, and the results were beyond all expectations for everything had succeeded to his utmost wishes. Mr. Owen here handed to the Chairman a sample of the spermaceti so prepared by him, which was minutely examined by his lordship, and a great number of other gentlemen in the room. He came there as a friend of Ireland, and he would return to England in a few days highly gratified with the result of this meeting, and with his love and admiration of Ireland greatly increased. It was expected that, according to Mr. Reece's system, they might be able to work 100 tons of peat per day: this would, in a short time, clear the land of the peat, and thus produce one of the greatest possible blessings to Ireland, in clearing the land, and making it fit for agricultural purposes.—The Chairman said that peat was of considerable value in the north of Ireland, but in the south it was going to waste.

Splitting a Bank-Note.—The governor and directors of the Bank of England, having been informed of the extraordinary ingenuity of Mr. Baldwin, and that he was able to split not only a newspaper, but a bank-note, sent for him in order to test his skill. That his task might be as difficult as possible, they picked him out one of the old 1*l*. notes, which are printed on paper much thinner than the notes of the present day, and told him to split it if he could. Mr. Baldwin took the note home with him, and returned it the next day, in the state he had promised. The paper was not in the slightest degree torn, and seemed as though it had just come from the manufactory, so little was its appearance affected by the operation. The directors remunerated Mr. Baldwin for his trouble, but could not elicit from him the means he employed. The discovery is considered of much importance in connection with the paper currency of the country.

Conway Tubular Bridge.—The deflection which lately took place, at the testing of the second tube over the river Conway, by Captain Symonds, the government inspector, was very slight, and the result is stated to be highly satisfactory. Before any of the testing weights were drawn into the tunnel, it was ascertained that the deflection then existing was 1·86 inch. The testing ballast amounting to 235 tons 14 cwt. 2 qrs., caused an additional deflection of 1·56 inch only, thereby showing that, with the whole of the above superimposed weight, the departure from a straight line was only to the extent of 3·42 inch. The load having been withdrawn, in less than 10 minutes the whole structure regained its former deflection. The variation in the adjoining tube, which has now been in use for so many months, does not, it is reported, extend even to the $\frac{1}{16}$ part of an inch.

Ornamental Cast-Iron Windows.—The Messrs. M'Adam, of Soho Foundry, Belfast, have recently completed a number of ornamental windows for the new palace of the Pacha of Egypt: they are of cast-iron, and of very large dimensions, being 20 feet high and 8 wide—each window weighing five tons. They are to be bronzed and gilt after being erected. The same firm have also erected on the banks of the Nile, for the Egyptian government, a number of very large steam pumping-engines, to raise the water of the river for the purpose of irrigation.

Gold Mines in Wales.—The *Mining Journal* gives an account of two mines which have been opened in the Cwm-heisian Valley, called the East and West Cwm-heisian Mines respectively. The West Cwm-heisian Mine is pitched upon a group of five lodes, one only of which has been explored to the depth of 40 yards. Two rich courses of lead ore have been found therein, and continue in depth. The lead ores are accompanied by blende and sulphur ores, which, as well as the lead ores, contain a sufficient quantity of gold to pay the cost of extraction. About 900 yards north-east of the West Cwm-heisian is the East Cwm-heisian Mine, situate on a group of 14 large and powerful lodes, or veins, having many different bearings—the prevailing one being north-west and south-east, which intersect each other within a distance of about 200 yards. As might be expected, under such favourable circumstances, very rich results have been obtained; the veins contain highly argentiferous lead ores, potter's lead, blende, iron, and arsenical pyrites, all of which are mixed with gold. The mine was originally opened as a lead mine, but a small quantity of very rich auriferous ore being found within a few feet of the surface, yielding from 7 to 16 ozs. of gold per ton of ore, induced an inquiry whether the present intention of working for *lead* should not be abandoned. At first the discovery of gold was considered to be more curious than valuable; but, on further examination, large quantities of the tinstone, and ores taken from the veins at distant points, gave valuable results in gold. The owner then determined to have the mine opened to an extent which should set the question at rest, as to whether it were really to be considered a gold or a lead mine. To this end, a shaft was sunk to the depth of 30 yards, many fathoms of levels were driven, and several hundred tons of ore raised from the workings. For a distance of 200 yards which has been explored, *the masses of mineral, formed by the falling together of so many veins, is upwards of* 40 *feet in width, and is found to be of equal dimensions in depth.* Beyond the intersection, both east and west, the veins radiate, and are from 3 to 20 feet in width, extending from three-quarters to one mile in length, within the limits of the setts. The result of the foregoing operations has been, to prove that wherever the veins have been opened, they are found to contain gold, both in *depth* and *length*, and that every kind of mineral contained in them is mixed with gold. The whole mass of the veins must be wrought for gold as the primary object, and the lead and silver-lead ores will be obtained at the same time, without extra cost. The gold is remarkably pure, and free from alloy, and will average in value 4*l*. per oz., or 2*d*. per grain. In order to prove the value of the ore raised, an experiment was tried on 300 tons of it, fairly broken from all parts of the mines. The whole quantity was concentrated into 10¾ tons of washed ore, containing 84,487 grains of gold, or 176 ozs. troy, giving an average of 16 ozs. and a fraction per ton of washed ore, or 281 grains of gold per ton of raw ore; and by carefully picking out the waste and slate from the raw ore, before it was pulverised, it was found that the average might be raised to more than 350 grains per ton. The mines being situate in the bottom of a deep valley, where there is an abundant supply of water, it is estimated that the cost of raising the auriferous ore, and extracting the gold from it, will not exceed, on an average, 72 grains of gold, or 12*s*. per ton of rough ore; and it is very probable that the amount of the cost will be reduced, when the work-people employed become more experienced in the manipulation of the ore.

Suspension Bridge at Pesth.—The Pesth Suspension Bridge, which is erected over the Danube at Pesth, was commenced in 1840, according to the designs and under the direction of William Tierney Clark, civil engineer, and has just been completed at a cost of £650,000. This bridge, which for magnitude of design and beauty of proportions stands first among suspension bridges, has a clear waterway of 1,250 feet, the centre span or opening being 670 feet. The height of the suspension towers from the foundation is 200 feet, being founded in 50 feet of water. The sectional area of the suspending chains is 520 square inches of wrought-iron, and the total weight of the same, 1,300 tons. This is the first permanent bridge since the time of the Romans which has been erected over the Danube below Vienna, it having been considered impossible to fix the foundations in so rapid a river, subject to such extensive floods, and exposed to the enormous force of the ice in the winter season. It now, however, stands as another monument of the skill and perseverance of our countrymen. The bridge was opened for the first time, not to an ordinary public, but to a retreating army, on the 5th of January, 1849, by which the stability of the structure was put to the most severe test, which cannot be better described than by referring to the letter of a correspondent, who writes—"First came the Hungarians in full retreat and in the greatest disorder, hotly pursued by the victorious Imperialists; squadrons of cavalry and artillery in full gallop, backed by thousands of infantry—in fact, the whole platform was one mass of moving soldiers; and during the first two days, 60,000 Imperial troops, with 270 pieces of cannon passed over the bridge." This fact cannot but be of importance to the scientific world, since it proves that suspension bridges, when properly constructed and trussed according to the design of Mr. Clark, may be erected in the most exposed places, while their cost in comparison with stone bridges is insignificant.

New Railways Opened in the Year 1848.—The aggregate length of new railways opened in England during the year 1848 was 750 miles, consisting of branches and portions of main lines belonging to the following railways:—Bristol and Exeter, 5 miles; Blackburn, Bolton, and West Yorkshire, 9; Chester and Holyhead, 80; East Anglian, 21; East Lancashire, 20; East Lincolnshire, 48; East and West Yorkshire, 16; Eastern Counties, 30; Eastern Union, 3; Great Northern, 69; Great Western, 31; Lancashire and Yorkshire, 84½; Leeds and Thirsk, 10; Leeds and Dewsbury, 20; Liverpool, Crosby, and Southport, 14; London and Brighton, 10; London and South-Western, 24½; London and North-Western, 7; Newmarket, 18; North-Western, 6; Manchester, Sheffield, and Lincolnshire, 57; Midland, 57; North Staffordshire, 29; Shrewsbury and Chester, 28; South Devon, 27; York, Newcastle, and Berwick, 7; York and North-Midland, 24½ miles.—The aggregate length of new railways opened in Scotland during the same period was 299 miles, belonging to the following railways:—Aberdeen, 17½; Caledonian, 84; Dumfries and Carlisle, 24; Edinburgh and Glasgow, 9½; Edinburgh and Northern, 40; Glasgow and Ayr, 36½; Glasgow, Barrhead, and Neilston, 8½; North British, 16; Scottish Central, 46; and the Scottish Midland, 33.—In Ireland the aggregate length of new railways opened in 1848 was 158 miles, belonging to the following railways:—Belfast and Ballymena, 38; Belfast and County Down, 4½; Great Southern and Western, 44; Irish South-Eastern, 10¾; Midland Great-Western, 14; Ulster, 11; Waterford and Kilkenny, 11; and Waterford and Limerick, 25.—It would appear, therefore, that the aggregate length of new lines opened for traffic in the United Kingdom during the past year was 1,207 miles.

Lime-Ash Floors.—This description of floor has been in use for many years in several parts of England, and is very durable: we have seen floors of it in Dorsetshire and Devonshire that have been made for upwards of forty or fifty years, and were then in a good state. They are made in the following manner:—The ground is first levelled, and on which is laid a mixture of lime ashes, with twice the quantity of fine grit sand, free from large stones or earthy matter. The lime and sand are well incorporated, and then allowed to remain in a heap from 10 to 12 days. The mixture is evenly spread over the surface of the ground about 2 to 2½ inches deep, and the surface trowelled over in the same way as trowelled stucco is done, and then allowed gradually to dry. Care must be taken that the surface is not damaged before it is perfectly dry, and it would be preferable if the sand were washed. The cost is about 1½d. per foot superficial.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM DECEMBER 21, 1848, TO JANUARY 25, 1849.

Six Months allowed for Enrolment, unless otherwise expressed.

William Baker, of Edgbaston, near Birmingham, civil engineer, and John Ramsbottom, of Longsight, near Manchester, engineer, for improvements in the construction of railway turn-tables, which latter improvements are applicable to certain shafts or axles driven by steam or other motive power.—Sealed Dec. 21, 1848.

William Riddle, of White Friar-street, London, gentleman, for improvements in the construction of ever-pointed pencils, writing and drawing instruments, and in inkstands or inkholders.—Dec. 21.

Charles Low, of Roseberry-place, Dalston, Middlesex, gentleman, for improvements in smelting copper ore.—Dec. 28.

George Fergusson Wilson, of Belmont, Vauxhall, Surrey, gentleman, and Charles Humfrey, of Manor-street, Old Kent-road, Surrey, merchant, for improvements in the production of light by burning oleic acid in lamps, and in the construction of lamps, and the manufacture or preparation of oleic acid for that purpose.—Dec. 28.

William Dingle Chowne, of Connaught-place West, doctor of medicine, for improvements in ventilating rooms and apartments.—Dec. 28

Moses Poole, of the Patent Office, London, gentleman, for improvements in the manufacture of heels for boots and shoes, of swivels, of bag fastenings, of revolving furniture, and of the connection of pipes for gas and other fluids. (A communication.)—Dec. 28.

John Mitchell, chemist, Henry Alderson, civil engineer, and Thomas Warriner Farmer, of Lyons-wharf, Upper Fore-street, Lambeth, for improvements in smelting copper.—Dec. 28.

Robert Jobson, of Holly-hall works, near Dudley, Staffordshire, engineer, for improvements in the manufacture of stoves.—Dec. 28.

Israel Kinsman, of Ludgate-hill, merchant, for improvements in the construction of rotary engines to be worked by steam, air, or other elastic fluid.—Dec. 28.

William Edward Newton, of Chancery-lane, civil engineer, for certain improvements in steam-engines. (A communication.)—Dec. 28.

William Gilmour Wilson, of Port Dundas, Glasgow, engineer, for improvements in the formation of moulds, and cores of moulds, for casting iron and other substances.—Dec. 30.

William Knapton, of the city of York, iron-founder, for certain improvements in the mode of manufacturing gasometers or gas-holders.—Jan. 3, 1849.

William Thomas, of Cheapside, London, merchant, for improvements in the maufacture of window blinds. (A communication.)—Jan. 4.

David Yoolow Stewart, of Montrose, Scotland, iron-founder, for improvements in the manufacture of moulds and cores for casting iron and other substances.—Jan. 4.

Henry Francis, of Chelsea, engineer, for improvements in sawing and cutting wood.—Jan. 4.

Robert Munn, of Starch-Head Mill, near Rochdale, Lancaster, cotton-spinner, for certain improvements in looms, and apparatus connected with looms, for weaving various descriptions of textile fabrics.—Jan. 4.

William Crofton Moat, of Upper Berkeley-street, Middlesex, surgeon, for improvements in engines to be worked by steam, air, or gas.—Jan. 4.

John Coope Haddan, of Bloomsbury-square, civil engineer, for an improvement or improvements in railway wheels.—Jan. 5.

Miles Wrigley, of Ashton-under-Lyne, architect, for certain improvements in the manufacture of yeast or barm.—Jan. 11.

William Edward Newton, of Chancery-lane, civil engineer, for a certain improvement or improvements in the construction of wheels. (A communication.)—Jan. 11.

James Castley, of Harpenden, Hertfordshire, manufacturing chemist, for improvements in the manufacture of varnishes from resinous substances.—Jan. 11.

Robert Urwin, of Ashford, Kent, engineer, for certain improvements in steam-engines, which may, in whole or in part, be applicable to pumps and other machines not worked by steam power.—Jan. 11.

Obed Blake, of the Thames Plate Glass Company, residing at 13, Southampton-street, Strand, gentleman, for certain improvements in ventilating; or ventilators, for ships, vehicles, houses, or other buildings.—Jan. 11.

Francis Hobler, of Bucklersbury, city of London, gentleman, for improvements in the construction of the cylinders or barrels of capstans and windlasses.—Jan. 11.

Michael Loam, of Treskerley, Cornwall, engineer, for improvements in the manufacture of fusees.—Jan. 11.

Christopher Nickels, of the Albany-road, Surrey, gentleman, for improvements in preparing and manufacturing india-rubber (caoutchouc).—Jan. 11.

William Rowe, of New-wharf, Whitefriars, city of London, carpenter and joiner, for certain improvements in the mode of uniting or combining pipes, or lengths of pipes, tubes, or channels formed of glass, earthenware, or other similar material.—Jan. 11.

William Walker, of Manchester, agent, for certain improvements in machinery or apparatus for cleaning roads or ways, which improvements are also applicable to other similar purposes.—Jan. 11.

Richard Laming, of Clichy la Garonne, near Paris, France, chemist, for improvements in the modes of obtaining or manufacturing sulphur and sulphuric acid.—Jan. 13. N.B.—This patent being opposed by caveat, lodged at the Great Seal Patent Office, was not sealed till Jan. 13th, 1849; but bears date Sept. 4th, 1848, the day it would have been sealed and dated had no opposition been entered. (By order of the Lord Chancellor.)

William Betts, of Smithfield Bars, London, distiller, for a new manufacture of capsules, and of a material to be employed therein, and for other purposes.—Jan. 13.

George Williams, of Tipton, Stafford, forge manager, for a certain improvement, or certain improvements in preparing puddling furnaces, used in the manufacture of iron.—Jan. 13.

Conrad Haverkam Greenhowe, of the city of London, civil engineer, for certain improvements in atmospheric railways.—Jan. 13.

Richard Dugdale, of Brompton, Middlesex, engineer, for improvements in hardening articles composed of iron.—Jan. 13.

Anthony Barberis, of Leicester-square, engineer, for improvements in spinning silk, and in the construction of swifts, and in the arrangement of apparatus for winding silk and other fibrous subtances.—Jan. 13.

Jean Baptiste Francois Mazeline Aine, of Havre, France, engineer, for improvements in steam-engines, and in the machinery for propelling vessels.—Jan. 16.

William Martin, of St. Pierre les Calais, France, machinist, for certain improvements in machinery for figuring textile fabrics, parts of which improvements are applicable to playing certain musical instruments, and also to printing, and other like purposes—Jan. 16.

Peter Augustine Godefroy, late of Shepton Mallett, Somersetshire, now of 31, Wilson-street, Flosbury, chemical colour manufacturer, for certain improvements in dressing and finishing woven fabrics.—Jan. 16.

Edward Buchler, of the city of London, merchant, for improvements in the manufacture of boots and shoes; also applicable to other fabrics.—Jan. 16.

Carey McClellan, of March Mount, Londonderry, Ireland, for an improved corn-mill. Jan. 16.

James Hamilton, of London, civil engineer, for certain improvements in cutting wood.—Jan. 18.

John Francis Bottom, of Nottingham Park, lace dresser, and John Dearman Dunnicliff, of Hyson Green, Nottingham, lace manufacturer, for improvements in dressing or getting up fabrics of cotton or silk, and of cotton and silk combined.—Jan. 18.

Francis Alton Calvert, of Manchester, machinist, for certain improvements in machinery for cleaning and preparing cotton, wool, and other fibrous substances.—Jan. 18.

Thomas Newcomb, of Bermondsey, machinist, for certain improvements in furnaces.—Jan. 18.

William Boggett, of St. Martin's-lane, Middlesex, manufacturer, for improvements in methods and machinery for obtaining and applying motive power.—Jan. 20.

Henry Bernoulli Barlow, of Manchester, consulting engineer, for improvements in the manufacture of cut piled fabrics, and in machinery or apparatus applicable thereto. (A communication.)—Jan. 20.

Samuel Brown, the younger, of Lambeth, Surrey, engineer, for improved apparatus for measuring and registering the flow of liquids, and of substances in a running state, which apparatus are in part also applicable to motive purposes.—Jan. 20.

Henry Needham, of Vine-street, Piccadilly, Westminster, gunmaker, for certain improvements in fire-arms.—Jan. 20.

Thomas Robinson, of Leeds, flax-dresser, for improvements in machinery for breaking, scutching, cutting, heckling, dressing, combing, carding, drawing, roving, and spinning flax, hemp, tow, wool, silk, and other fibrous substances, and in uniting fibrous substances.—Jan. 23.

Charles de Bergue, of Arthur-street west, in the city of London, engineer, for improvements in steam-engines, in pumps, and in springs for railway and other purposes.—Jan. 29.

Edward Slaughter, of the Avonside Iron Works, Bristol, engineer, for improvements in marine steam-engines.—Jan. 23.

Rees Reece, of London, chemist, for improvements in treating peat, and obtaining products therefrom.—Jan. 23.

Charles Henri Paris, of Paris, for improvements in preventing the oxidating of iron. (A communication.)—Jan. 23.

William Henry Barlow, of Derby, civil engineer, for improvements in the construction of permanent ways for railways.—Jan. 23.

Richard Johnson, of Blackburn, Lancaster, gentleman, for certain improvements in the manufacture of melted grain, and in vinous fermentation; also improvements in brewing, and in the machinery or apparatus connected with the above or similar processes.—Jan. 23.

Wakefield Pim, of Kingston-upon Hull, engine and boiler maker, for certain improvements in propelling ships and vessels—Jan 25.

Robert Shaw, of Portlaw, Waterford, cotton spinner, and Samuel Fletcher Cottam, of Manchester, machinist, for certain improvements in machinery for preparing, spinning, and doubling cotton, wool, flax, silk, and similar fibrous materials—Jan. 25.

John Talbot Tyler, of the firm of Ashm[illegible] Mount-street, Grosvenor-square, hatters, for certain improvements in hats [illegible] cases.—Jan. 25.

PULPIT OF SIENNA.

(With an Engraving, Plate IV.*)*

In the olden times it was asserted that the master-hand of the artist was to govern not merely the building but all its details; and we believe no mediæval cathedral was ever designed without the architect settling at the same time the fashion and the workmanship of all its fittings, so that a moveable belonging to the altar furniture is now as good a type of the mediæval styles as any of their architectural members. How times are changed! In these days, the moment an architect has finished the shell of a building he is turned out, and it is consigned to the house-painter and the upholsterer, who rule unfettered; and the architect may have the comfort of seeing a Greek building fitted with Elizabethan furniture—with Louis Quatorze, Louis Quinze, or anything but what is tasteful and appropriate. Mr. Pugin having laboured for what he calls a Christian building, laments to find it paganised, and his whole artistic aspirations frustrated and betrayed. Whatever may be done for the outside, however strictly it may be Doric or Ionic, Vitruvian or Palladian, however closely the authorities, legitimate or illegitimate, may have been followed, the Goths and Vandals are sure to reign inside. We will not take upon us to say that the architects, although so badly used, are altogether blameless. We believe they have given up more than the upholsterer, the paper-hanger, the house-painter, the ironmonger, the silversmith, and the carpet-weaver have usurped; and in particular, that having excluded colour from their own works, they have left those articles of furniture requiring the application of colour entirely in the hands of the artisans.

A better spirit is, it is true, now abroad; but the architect has to re-conquer his domain,—and we believe it will be well worth his while, for the superintendence of the minor works will give a considerable addition to his emoluments. We have often remonstrated against barn-door architecture for churches; but there has been great improvement for the better since we begun our complaints, though the clergy too often step into the place of the architect. Still it is something to see better designed pulpits, stalls, fonts, reading-desks, glass, tombs, and tiles. We do not, however, wish these improvements to be limited to works in the mediæval styles; for we fear it may lead to barren copying, while it hinders the progress of the other styles.

Whatever dispute there may be as to the responsibility of designing other articles of church furniture, there ought to be none as to the pulpit, for it is peculiarly a structural object; and in the great works of the middle ages it is treated as an independent design. It rises within the nave often to a greater height than many out-door monuments, so that on the plea of size the architect cannot say that it is beneath him. There is a staircase to the floor on which the preacher stands, and above all rises a high canopy. This may evidently be treated as a columnar or astylar composition, with a Greek peristyle, or Gothic pinnacles, while it allows of all the varied resources of art being applied for its adornment.

While there are particular objections to the adornment of the altar in the churches of the Establishment and of the dissenters, there cannot be so much objection to the decoration of the pulpit, as it is not supposed that any worship will be paid to it. If there should be any objection to statuary or painting, the decoration may be purely architectural; but there are many figures and emblems which have been allowed without objections in church decoration. The triangle, dove, I.H.S., angels' heads, cross, and even the figures of the four evangelists pass muster with very strict people. A well ornamented pulpit might, therefore be ventured upon as an architectural decoration of the interior, which would add pleasingly to its effect; and being the centre to which the eyes of the congregation are turned during much of the service, would not be censurable on the ground of unfitness or want of purpose.

Those of our readers who have been no further from home than Belgium, need scarcely be reminded of the wooden pulpits at Brussels, Antwerp, and elsewhere, and which present some of the finest specimens of wood-carving to be found. Those who have travelled further, know that Italy presents many beautiful examples in various styles. The one of which we now give an engraving, we thought worthy of the attention of our readers, though we do not present it as a type of a class so various, or as the greatest work of the kind. It is the pulpit, in white marble, in the cathedral of Sienna, in Tuscany.

This pulpit is a work of the thirteenth or fourteenth century, and is the production of Nicholas of Pisa, as the records of the cathedral show. They state, likewise, the amount of his remuneration, which was eight sols a-day, six shillings in silver of the present standard; equivalent, perhaps, to thirty or forty shillings in modern value. He was further paid four sols for his son John, and six for his pupils. The time employed was less than two years.

By some accident the original staircase was destroyed, and that now shown was executed three centuries later, by Balthazar Peruzzi.

CANDIDUS'S NOTE-BOOK,
FASCICULUS XCI.

> "I must have liberty
> Withal, as large a charter as the winds,
> To blow on whom I please."

I. One extraordinary merit of the mediæval architects has either been quite overlooked, or else purposely and very ungratefully kept out of sight even by their most mouthy admirers. That they planned and designed their buildings excellently, keeping the immediate purpose for which they were erected strictly in view, thereby securing for them appropriate character and natural emphasis of expression, is not only admitted, but dwelt upon with more of wonder than is called for; since more wonderful would it have been if, employing a vernacular style—the only medium of their architectural ideas—they expressed themselves naturally, unaffectedly, and I may say, *heartily*. Their style of building was almost as matter of course, racy and idiomatic, it being a living one, therefore capable of freely admitting new modes of treatment in order to meet circumstances not previously contemplated and provided for. In their success so far, there is then nothing very astonishing; but that they should have hit upon ideas so exactly suited also to our purposes at the present day, that architects have now only to copy them as literally as may be, is nothing less than marvellous,—equally marvellous whether it was through sheer accident, or through foresight, coupled with the good-natured intention of sparing us the trouble of thinking for ourselves. The same remark applies to the originators and elaborators of other styles, as well as to the architects of the so-called mediæval period. Sansovino, for instance, provided out of his own brains, designs for Pall-Mall clubhouses, as well as for buildings by himself at Venice. Lucky fellow! to be able to "kill two birds with one stone," after that fashion! Whether the same will have to be said of the *servum pecus*—I beg their pardon, the correct and orthodox *imitators* of the present day—admits of question; a question that may be left to the consideration of that priggish gentleman, Count D'Orsay, to whom we are indebted for a second infliction of Sansovino in Pall-Mall.

II. What has just been said leads naturally enough to another question—a somewhat delicate and ticklish one—viz., whether those who merely adopt a ready-made design from Sansovino, or San somebody-else, obtain the same remuneration, alias percentage, as is paid in the case of original or what passes for original design. If they do not, and remuneration is abated in proportion—for let us attend to "proportions,"—something may be said for the copying system on the score of economy. If, however, they have the face to claim, and actually do obtain, just as much for what is merely a leaf out of a book, as for a *bonâ fide* design, we must conclude that design is not supposed to be paid for at all, but something thrown in gratuitously by an architect to his customers. In many articles of manufacture, fashion is paid for as well as material and labour, since it has required some talent, and taken time and study to produce such pattern or fashion; but although architecture claims to be considered something infinitely more dignified than manufacture, no account is taken of quality of design,—be it bad or good, be it the produce of the architect's own thought and study, or an arrant plagiarism, —a tasteful artistic composition or a balaam medley of odds and ends, it makes no difference; bad and good being paid for exactly alike, and according to one invariable scale of remuneration. Which being the case, we ought perhaps to wonder that talent has not been altogether extinguished under the stupifying chloroform influence of such a Laputan system of encouragement.

III. What is called the Perpendicular might as well, or with still greater propriety, be termed the *Panelled* style of Gothic, it deriving its peculiar character most decidedly from a system of panelling. It is the division of surfaces into sunk moulded compartments, which is by far the more obvious and striking characteristic of that mode of Gothic. The name of Perpendicular, on the contrary, applies not so much to the general physiognomy as to the *lineation* or prevalence of upright lines in the tracery of the windows. In fact, *horizontality* expresses itself quite as much or even still more strongly than perpendicularity, owing to the openings, arches, as well as doors and windows, being framed into square-headed compartments forming panels upon a larger scale. As frequently as not, the windows themselves are actually square-headed; and whether so or not, their "lights" form a congeries of square-headed panels, differing from others only in being perforated and glazed. Horizontality, again, manifests itself plainly enough in the transoming of the windows; so that together with *square-headiness* and panelling, it characterises the style far more distinctly than perpendicularity does. Still, as "Perpendicular" is the designation which has now generally obtained in this country, it may as well be allowed to remain undisturbed, it being highly inconvenient to be always altering terms which, whether correct or not, answer the purpose of mere names. What is here said is chiefly intended to show how many other indicial and strongly-marked traits of style had been overlooked by those who brought up the term in question.

IV. With regard, too, to the Gothic style generally, many of its influential elements have been overlooked—at least, are not taken into account by those who pretend to trace its origin and development. It is usual to consider the Pointed Arch as the germ of the whole style in all its varieties, as the *punctum saliens*, out of which all the rest grew naturally. Now, in the first place, the Pointed Arch is in itself, and considered merely as a form, anything but beautiful; it being offensively harsh. Either a square or semicircular-headed opening, on the contrary, although it be left quite bare, and may so far be unsatisfactory, is not positively displeasing; but a pointed-arch one, forming a mere aperture in a wall, has a villainously barbarous look. Nevertheless, houses with such-shaped holes in the walls for doors and windows have ere now been erected, and have passed for "Gothic,"—at any rate, for *neat* Modern-Gothic. That there was a good deal of fancy exercised on such occasions is not to be denied, since it required a more than ordinary share of it to fancy that things of the kind had anything at all in common with the style which we call Gothic. People had got it into their heads, and some of them have it there still, that the Pointed Arch taken abstractedly and *per se* was the very essence, or rather quintessence of the Gothic style. Even granting it to be such, that essence was so diluted and wishy-washed as to bear the same resemblance to the original style as the nasty and nauseous rinsings of wine-bottles do to the generous beverage they once contained. The truth however is, that so far from constituting the essence of the style in question, the Pointed Arch is only one of its rudiments,—certainly the most obvious, and an exceedingly influential one. Still, the same form of arch might have been—in fact, has been employed without leading to the same style or anything like it. One highly important characteristic in it, is *diagonalism* or the employment of oblique planes and surfaces—for instance, in splays and the sloping "offsets" on the faces of walls or of buttresses. Another is, that with the exception of what are termed "weather-mouldings," the mouldings to apertures are recessed within the general plane or surface of the wall, instead of projecting out from it. Besides receding planes or surfaces connected by splays sloping upwards, one peculiarity of the style is, that it admits of what is precisely the reverse—namely, projecting surfaces or members supported upon *corbelling*, which alone constitutes a marked distinction of the style. The Pointed Arch is therefore only one element of it, and one which might have been adopted without the others resulting from it as of course. Supposing a person otherwise well-skilled in architecture, but ignorant of the existence of Gothic, to have the figure of a Pointed Arch shown him, we may safely say that it would be utterly impossible for him to form any idea from such sample of it what the style itself really was. In all probability, he would conclude it to be exceedingly dry and bald—exceedingly limited in expression, and exhibiting itself only in the forms of arches and openings in the wall.

V. In fact, the form of the arch goes but a very little way towards the system of the Gothic style, which derives its most characteristic motives of embellishment from windows, and the necessity for glazing them. In the earlier stages of mediæval architecture, and while windows were merely single apertures, they were small—at least narrow, insignificant, and more mean than beautiful features. Fortunately, they could not be greatly enlarged—certainly not to anything like the magnitude they afterwards frequently attained, except by combining two or more apertures framed together into one general composition, or what amounts to the same thing, by subdividing the entire general aperture into several lesser ones, in order that the glass and its leadding might be securely supported. Could intervening shafts or mullions have been dispensed with, or had they been so, instead of the admirable designs for windows we now see, we should have had merely large arches filled in with glazing. To the employment of mullions or intervening supports—a happy idea in itself—we are indebted for what may be called the efflorescence of decoration peculiar to the style—viz., TRACERY. Mullions being introduced, it became necessary to fill up the head of the arch by ribs in continuation of them, which being variously combined, become that peculiar species of decoration known by the name of TRACERY—a main and very fertile source of decoration, nothing corresponding to which exists in classical architecture or the styles copied from it. Yet, in estimating Gothic, its above-mentioned characteristics have been generally, if not entirely overlooked—certainly slighted, and treated as very secondary matters; while more than enough has been said on the subject of the Pointed Arch, and many absurdities uttered in the idle attempt to account for its origin. And if it could be accounted for conclusively, upon the very strongest evidence, all that would be gained would be the knowledge of an historic fact, without any further insight into or power over the style itself. We already know that it was evolved—whether partly through accident or not makes no difference—out of a few simple elements and circumstances. Yet what are we at all the better for knowing as much, when it does not enable us to work out by degrees a style for ourselves at the present day, by doing now what the mediæval architects did, in and for their own time. On the contrary, the knowledge of what has been done is now made a positive hindrance to anything further being done.

VI. However learned some of them may be, and thoroughly familiar with all that has been done before, not only in one, but in every style of the art, the architects of the present day seem to be visited by the curse—if curse it be—of impotence and sterility: they appear to have utterly lost all generative power, and to be incapable of producing new ideas. Can a single really new and fructifying idea—one that opens fresh ground, be pointed out in any work of the present century? Improvement there has been; but instead of being such as results from fresh artistic vigour and energy, it is of a kind which may be ascribed more to the extended employment and more numerous opportunities afforded to architects—in a word, to comparatively favourable matter-of-fact circumstances, than to any particular talent of their own displayed by the profession themselves. Be it ever so unbecoming or illiberal to say so, they do seem greatly at a loss for ideas; and accordingly contented to take up with and abide by those of other minds, who worked out theirs when architects were allowed the privilege of all other artists, and availed themselves of it by daring to think for themselves, and impress original mind upon their creations. Nor is it any wonder that by the utter disuse of it, the inventive faculty, which was wont in former times to be displayed, should now be paralysed. In fact, so far from their being encouraged, germinating ideas are repressed and stifled, as if absolutely noxious and dangerous.

VII. The toleration of every crude whim and sickly caprice is most assuredly to be deprecated. When we speak of new ideas being adopted, it is, of course, only worthy and meritorious ones that are meant—such as are the result of invention guided by study and reflection. And presumed it may be, that those who have really *studied* the style or styles they profess to follow, and have accordingly familiarised themselves with them, and imbibed their taste, do not require constant prompting from actual examples for every particular, but are so capable of entering into the general spirit of the original models, as to be able to modify them pertinently, and be faithful to their genius, although deviating from the exact letter of them. Hamlet's instructions to the players not to utter more than was actually set down for them, do not apply to architects. The observance of the mere letter of a style by no means ensures the spirit of it; the latter being something of so fine and volatile a nature, that it is apt to evaporate altogether while we are fumbling at rules, and poking after precedents.

VIII. Neither are my remarks to be understood too literally: by no means do I intend to say that the mere deviation from ordinary rules and practice will ensure some fresh and previously untried æsthetic beauty. It is not every idea which may chance to present itself that deserves to be adopted, or can be made anything of. Many may be dismissed forthwith; and even really good ideas require to be carefully considered, studied, and worked out. If it be asked what is to be understood by a really good idea, the answer is, one its author himself perceives the value of, and feels confident of being able to turn to useful account on more occasions than one. That those who have no ideas of their own, or power of invention, should protest against all attempt at originality, is not at all surprising; but that those who have, and who, were they to give their minds to it freely, might achieve originality more or less happy, should be deterred from doing so by the dread of being called innovators, and suffer mere rules and precedents to stand in the way of all further advance, is, if not particularly strange, particularly lamentable. Rash and fool-hardy innovation is, of course, to be discountenanced; and such unlucky and prodigiously queer *originality* as we have got in the new Coal Exchange, and in the new *hopeful* mansion in Piccadilly, is to be deprecated most earnestly; still such egregious monstrosities, in which it is difficult to decide whether dulness or fantasticality predominates, afford no more argument against freshness of design than the countless reams of printed prose in rhyme do against poetry.

IX. Were architects to attend more to *Effect* than they now do, they might produce equal results in point of finish and embellishment as at present, or perhaps even greater, with far less labour and cost. In his quality of artist the architect should work like the scene-painter, who calculates and makes proper allowance for the distance from which his *tableau* will be viewed, and finishes up no more than is sufficient to produce the appearance of finish. Architects, on the contrary, notwithstanding all the twaddling about proportions, seem to have no idea of proportioning the finish bestowed on detail and embellishment to their situation in the building itself, and also to the actual situation and aspect of the latter. Although it does not appear to be known, or if known is not attended to, it is an excellent maxim to work up carefully all the parts nearest the eye, and what may be called the "*foreground*" of an elevation, which being done, the appearance of equally careful execution will be secured for the rest; and no more than such appearance is wanted, because all that is more is entirely thrown away. It is by no means uncommon to find that details which show in drawings, in which the eye can take cognizance of the smallest minutiæ, all but entirely disappear in the executed structure, or as far as they produce effect at all, produce only a confused and *niggling* one. What, for instance, can possibly be made out of the figures on the frieze of the Athenæum Clubhouse, or of those on the attic over the centre arch in the screen-entrance to Hyde Park? A few bold, random touches of the mason's chisel might have been made to tell just as well, or perhaps better,—certainly would have had to the full as much meaning in them; for as to meaning, that sculpture may be all very classical and *comme-il-faut*, but has just the same degree of relationship to Hyde Park as I have to Sir Hyde Parker. Absurdity is increased when, while ornament is bestowed where it can be but imperfectly seen, it is withheld from parts that are exposed to the closest inspection. It is by no means uncommon, for instance, to find a chimney-piece of quite plain design in a room with a highly-wrought cornice. Besides the mere inconsistence itself, occasioned by the mixture of plainness and ornateness, the former is thrust prominently into view, while the latter is comparatively concealed. It is true, in such cases there may be a sort of a reason—a pounds, shillings, and pence one—for the sin against artistic effect and taste, inasmuch as the cornice being mere stucco, its richness is attended with comparatively trifling cost; whereas the chimney-piece being marble, carved mouldings and other workmanship becomes very expensive in such material. Still, that does not alter the principle of propriety and taste, which is to bestow ornament where it will display itself, and to finish up most carefully those parts which are nearest the eye. The contrary practice resembles that of a painter who should finish up his distances very elaborately and neglect his foregrounds.

X. If, as some seem to think, our architects have but a questionable claim to the title of artists, and certainly are not such generally, in the degree which they ought to be, it is not so much cause for surprise as for regret, since no provision seems to be made for an artistic education of them. Indispensable as it is in itself, "office"-education is a nullity in that respect; in regard to which, the most that it does for them is, that it initiates them into the means of artistic study, which, if they are to pursue it at all, they must pursue for themselves, should the proper stuff be in them; if not—why, they must Pecksniffise all their lives, consoling themselves with the reflection that—most unhappily for the public—there are Pecksniffs in high places as well as low, some of whom die rich, leaving their professional memories to be damned. A great deal of what passes for zealous study pursued out of sheer love of art, is very little better than busy idleness, and is utterly fruitless as regards any advancement in the practice of art. A man may be able to talk very learnedly, and to refer to almost every building of any note,—may be very conversant with nearly all the ideas that have from time to time been put forth in architecture by others, and yet have no ideas of his own to serve him on occasion, nor the talent for turning to account those with which he has encumbered, hoping thereby to enrich, himself. The study that is bestowed in loading the memory with ponderous trifles and other heavy lumber is naught; accordingly should be left by the architect to archæologists and similar heavy-h——d gentry. For him, one of the best of studies is to exercise his thinking faculties, his judgment, and his taste, with his pencil in hand; another is to scrutinise the buildings he sees, and then question himself rigorously to account for their beauties and defects, or what strike him as such. The habit of considerate and thoughtful examination so acquired, will stand him in good service in his own productions. Again, self-imposed tasks for working out any idea that may have struck the mind, are useful—indirectly, if not immediately. The idea itself is put to the proof as it were; for if capable of being made anything of, it will draw other ideas after it, and so become the nucleus of a growing mass of them. If not secured at the moment—secured at least by turning it over in the mind, a thought that might have been fixed, and afterwards returned to and matured, may pass away irrecoverably. After having become acquainted with routine and routine-design, let the student endeavour to guard himself against the enervating influence of the latter, by breaking away from it in his hours of relaxation—relaxation, consisting not in idleness, but in the free indulgence of his own fancies;—and though they may be mere crude fancies at first, something may possibly be made of some of them, and come of them in time. At any rate, so long as they are kept private studies, they are secure ftom reproach; and if occasion should present itself for adopting any of them, there will have been time for their ripening in their author's mind. Few, it is to be apprehended, take up the kind of study here hinted at, since we perceive very little evidence of it; on the contrary, see a great many things, both buildings and designs, which, as far as they do not consist of what is usual and hackneyed, rarely show more than some hasty first ideas,—good, perhaps, as hints and tendencies, and as capable of being worked-up satisfactorily, rather than satisfactory in themselves, or shown to sufficient advantage.

XI. Those who do not exercise their ideas, except when there is immediate occasion for so doing, are not likely to find them very prompt and active when wanted. Habitual inertness, or else habitual indolence of mind, can hardly be shaken off in an instant, or roused to much purpose, merely because an occasion presents itself; more especially if only a short notice be given, because then one's faculties are more likely to be bewildered than properly awakened. Did hurry always give a sufficient fillip to architects' powers and imagination, competition committees would deserve praise for their very "short-notice" policy, the time allowed by them to architects being barely sufficient to prepare drawings,—therefore wholly inadequate for careful study, or any study at all of the subject. In fact, they seem to have no idea that any previous study of the subject is required, but that there is merely to put it upon paper. That such is the case is almost certain, because they seldom pretend to pay for study, the premiums offered by them being, in many instances, not even more than would be paid by an architect to his clerks for the same amount of mere drawing.

XII. Were those who publish examples of architectural ornament and detail to accompany them with some critical remarks, specifying their particular merits, and also pointing out defects that detract from what may nevertheless be praiseworthy upon the whole, service would be rendered both to Art and to those who study it. Intelligent comment would, on the one hand, fix attention upon the more delicate beauties of such productions, and on the other, would warn against blemishes. It is an error to suppose that both beauties and blemishes must be sufficiently obvious at first sight to every one. Books of patterns are one thing, and books of artistic studies are another, although the latter are almost invariably treated as if they were nothing more than the former. Moreover, examples of such exceedingly opposite quality are so frequently introduced into the same publication, that it is impossible to understand upon what principle the "selection" or "collection" has been formed. The plates are left to speak for themselves—poor dumb devils!—and why? merely because those who ought to act as their interpreters are unable to speak for them.

GEORGE STEPHENSON.

(Continued from page 364, Vol. XI.)

[This sketch of the life of George Stephenson has been so long put off from a want of the needful books in the British Museum, and therefore we have had to apply elsewhere. We owe much to the kindness of several gentlemen, among whom we are bound to name Joseph Sandars, Esq., Father of the Liverpool and Manchester Railway; Henry Booth, Esq., Treasurer of the railway; Charles Manby, Esq., Secretary of the Institution of Civil Engineers; W. W. Collins, Esq., of Buckingham-street; and J. W. Brooke, Esq. Among the books we have are the following:—

1821. *Observations on a general Iron Railway; showing its great superiority over all the Present methods of Conveyance, and claiming the particular attention of Merchants, Manufacturers, Farmers, and indeed every class of Society.* Second Edition. London: Baldwin, 1821.—[Anonymous—written by Thomas Gray.]

1822. *Copy of Specification of Patent granted to* Benjamin Thompson. Newcastle.

1822. *Extracts from the 'Newcastle Magazine:' Controversy between* Benjamin Thompson *and* Nicholas Wood.

1822 & 1824. *Specification of* John Birkenshaw's *Patent.* Newcastle.

1823. *Notes, by* Mr. Stevenson, *in reference to the Essays on Railways presented to the Highland Society.*

1824. *A Letter on the subject of the projected Railroad between Liverpool and Manchester.* By Joseph Sandars. 1st, 2nd, 3rd, and 4th Editions. Liverpool, 1824-25.

1824. *Observations, &c., on the Communication between Newcastle and Carlisle.* By Wm. Chapman. Newcastle, 1824.

1824. *A Report on the same.* Second Edition. By Wm. Chapman, C.E. Newcastle, 1824.

1825. *Report on Railroads and Locomotive Engines.* By Charles Sylvester, C.E. Liverpool, 1825.

1825. *The Finger-Post; or Direct Road from John O'Groat's to the Land's End: being a Discussion of the Railway Question.* By ??? London: Cole.—[Anonymous—no date]

1825. *A Statement of the Claim of the Subscribers to the Birmingham and Liverpool Railroad to an Act of Parliament; in Reply to the Opposition of the Canal Proprietors.* London: Baldwin, 1825.—[Anonymous.]

1825. *The National Wagon-post, to Travel at the rate of Twenty Miles per Hour, carrying One Thousand Tons weight, all over the Kingdom of England, with Passengers, Goods, and Stock; also a Letter from the Chancellor of the Exchequer.* Paris: Didot, 1825.—[Written by C. M. George.]

1825. *Considerations on the Expedience of sinking Capital in Railways.* By John Vallance. London: Wightman, 1825.

Tacked to this is a reprint of another pamphlet by Mr. Vallance, called, '*On Facility of Intercourse.*'

1825. *Observations on the General Comparative Merits of Inland Communication by Navigations or Railroads, with particular reference to those projected or existing between Bath, Bristol, and London.* London: Hatchard, 1825.—[Anonymous.]

1825. *A Letter respecting the Projected Railways.* By **** ****. Sold by J. Nicholson, Rochdale.—[An attack on the Liverpool and Manchester Railway.]

1825. *Railways compared with Canals and common Roads, and their Uses and Advantages explained.* Edinburgh: Constable, 1825.—[Written by Charles Maclaren, and reprinted from the *Scotsman.*]

1826. *Sketches of our Information as to Railroads.* By the Rev. James Adamson, Cupar Fife. Newcastle, 1826.

1824, &c. *Prospectuses and Half-Yearly Reports of the Liverpool and Manchester Railway.*

1830. *An Account of the Liverpool and Manchester Railway.* By Henry Booth, Treasurer to the Company. Liverpool: Wales and Baines.

Of these, the "Finger-post" only is to be found in the Library of the British Museum.

Besides these, we have made use of the following:—

1822. *The Steam-Engine.* By Charles F. Partington. London.

1823. *Description of a Railway upon a New Principle.* By Henry R. Palmer, M. Inst. C.E. London: Taylor, High Holborn, 1823 and 1824.

1825, &c. *Nicholas Wood on Railroads.*

1825. *Thomas Tredgold on Railroads.*

1822, &c. *The Newcastle Magazine.*

1823, &c. *The Mechanics' Magazine.*

1817, &c. *The Repertory of Arts.*

1829. Stuart's *Anecdotes of the Steam-Engine.*

1831. *Historical Account of Rivers, Canals, and Railways.* By Joseph Priestley. London, 1831.

We have likewise referred to the later works of Mr. Whishaw, Mr. Ritchie, the *Monthly Railway Record*, &c.

We shall therefore take advantage of these several works, to give a fuller account than we should otherwise have done of the Growth of the Railway System, of the Mania of 1825, of the History of the Liverpool and Manchester Railway, and of the Locomotive Contest, which are now little known.]

X. BEGINNING OF RAILWAYS.

The beginning of railways has been laid down as owing to several causes, and it may be that the use of slays or sledges in Staffordshire[1] led to it, for the two sides of the slay would readily run on two lines of wooden planks or logs. If, however, railways had their beginning in the north, what so likely as that the thought took its rise from the shipwright's yard. Indeed, the ways on which a ship is built, and from which she is launched, are the oldest and earliest railways: from these she slips down into the sea, and very little strength is wanted to set her going. As, too, the coal-pits lie in the higher grounds, and the coals are brought down to the water to the ship's side, it would strike any workman that the way in which it could be done, and in which the least power would be called for, would be that by which the great weight of a ship was moved by a few men. First, such a way would be made for a short length, and then for greater lengths. It seems the more likely that this is the truth, for the first wagonways were, like shipyard-ways, of timber; otherwise we might have looked to their being made of stone at an earlier time. In shape, too, the shipways are something like wagonways, for they are raised above the road, whereas stone tracks are on a level with it. The stone track has been used from the time of the Romans downwards, and there is no ground for thinking that it led to the wooden wagonway.

A High Dutch writer has said that a railway was made in the mining country of the Hartz, and that the plan was taken to England, in the year 1676, by some miners.[2] Now, it is very unlikely that such miners would go to the Northumbrian coal-pits, where the railway at that time was in use;[3] while the suggestion we have here made is much more in keeping with what we know. Abroad, the railway was first known as the English roadway.

One of the earliest drawings of a railway known is that spoken of in the *Mechanics' Magazine*,[4] and is a representation of a train on a wooden railway at Prior Park, near Bath, a mile long, and which in 1741 was used for carrying stone. Wooden railways were in use until 1811.

When wooden railways came to be better known and more worked, it was to be looked for that they should be strengthened with iron plates on the top.[5] This would be and was the first step.[6] In 1738, rails wholly of iron were tried at Whitehaven, but not being found to work well, were given up, the wagons being too heavy for the cast-iron, and breaking it.

In 1768, cast-iron rails were used at Coalbrookdale, for the books of the company show that on the 13th November, 1767, between five and six tons of rails were cast as an experiment.[7]

Mr. John Curr, author of the "Coal Viewer's Practical Companion" (London, 1797), says in his preface that he had laid down cast-iron rails underground, in the coal-pits of the Duke of Norfolk, near Sheffield, about 1776.[8] What was the form of the early iron rails is not known, but it is thought to have been the plate or broad rails.

In 1799, William Jessop laid down the first railway for a public company, at Loughborough. Here he used the edge-rail, flanges being put on the wagon-wheels.

About ten years afterwards, Mr. William Outram laid down the railway at Little Eaton, in Derbyshire, with plate-rails, having a flange cast on the rail and not on the wheel. Hence such rails were named Outram-rails, or, for shortness, *tram*-rails.[9] This was the favourite plan for some time.

We may here stop to say a few more words on the Railway Dictionary. First, as to the name "Railway" and "Railroad." Both were used for some time, and *railroad* was the favourite; but of late years the other has been taken up in its stead, so that it is now the acknowledged word. What had the most weight in bringing this about was the wish of the writers upon railways to have the word which is smoother, and to get rid of the other, which is alliterative.—Another grammatical note is as to the word "Waggon." The old way of spelling it is with two *g*'s, but the new railway plan is with one, as *wagon*. The French and High Dutch, who have taken up the word, have brought this about.—"Tender" is a new word. This is said to be the shortening of "Attender," the carriage attending on an engine;[10] but it must be remembered that at sea, a small ship waiting on another is named a *tender*.—The

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[1] Dr. Plot's 'Staffordshire.'

[2] Martin's Circle of the Mechanical Arts.

[3] Ritchie on Railways, p. 8.

[4] Vol. IV., p. 141.

[5] Martin's Circle of the Mechanical Arts.

[6] Stevenson, Notes on Essays on Railways, p. 2.

[7] Stevenson, Notes, p. 2

[8] Ritchie on Railways, p. 18.——Stevenson, Notes, p. 2.

[9] Observations on the General Comparative Merits of Navigations and Railroads, p. 11.

[10] Railways compared with Canals and Common Roads. Maclaren, p. 60.

driver of a locomotive engine was at first called an "Engineer," but railway writers, to prevent confusion and keep up the dignity of the professional men, call the civil engineer the *engineer*, and the other the *engine-driver*.—The word "Gage" is not yet settled. It was once written *guage*, and by some *gage*, as the word is spoken; but a very common way is to write it, in the teeth of the lexicographical authorities, *gauge*, which would be spoken "gawge." "Gage" seems, therefore, to be the better way.

Many of the words used in railway engineering were brought from the north by the engine-drivers, who, on the opening of passenger railways in the south, after 1833, were scattered all over England. It is not settled whether "Switch" or "Points" should be the word, but *pointsman* is a name commonly given to the attendant on them.

The New Englanders, it may be said, have a railway dictionary of their own. To *grade a railway* is one of their sayings. A carriage is called a *car*, and to them belongs the naming of the *negro-car*.

The French and Belgians have taken many words from us, as *railway* and *wagon*, and have turned others into French. The Northumbrian engine-drivers spread their vocabulary abroad, as the enginemen of the steamers have given a vocabulary to steamers throughout the world, and "Stop her," "Easy," will be heard from the mouths of those who know no other word of English.

The growth of railways has led to the introduction of many new words and compound words, the greater use of many words, and the use of many old words in other meanings, as, besides those named, chair, sleeper, siding or turn-out, turn-table, train, crossing, buffer, coupling-link, time-table, skew-bridge, &c.

Some railway words have already been lost, as wagonways, plateways, trolley-ways, and prop and pedestal, instead of chair.

XI. GROWTH OF RAILWAYS.

Railways in the beginning were used for the carriage of coals to the seaside; and when the canal system spread in the end of the last century, the railway was found very useful to bring down coals, stone, and lime to the wharves. It was for this latter end, that most of the early acts of parliament for railways were passed.

Perhaps the first railway to work free of a canal, for any length right out, was the Surrey Iron Railway, for which an act of parliament was passed in 1801, and another in 1803; so that the whole length was 21 miles, reaching from the quarries at Merstham, Reigate, and Godstone, to Croydon and the Thames at Wandsworth. Those who put this forward strongly hoped that it would lead to very great ends; but it was so carried out that it was of no good, for wagons could travel more cheaply on the old turnpike road. Had it not been for the ill-luck which befel this tramway, the railway system would have very much spread in the beginning of this century; but it seemed as if rash mismanagement was to be its besetting sin. The Surrey Railway did not pay, and Trevithick's locomotive, brought out soon after, was in no happier hands.

Although many useful things were done in the meanwhile, it was not until the share-madness of 1824-25, that the railway system was again brought forward; but by that time, many things had been brought to bear for its furtherance, and it came to such a head, that no one could help seeing it could not be much longer kept back, and that its time was near. Everything was therefore done to push it on.

The true turning point in the history of railways, the true date at which it was settled they should become the high-roads of England, was in 1825, and not at a later time as is commonly believed. The history of the railway mania of 1825, as it is not within the common ken, has not been written; but it is no less worthy of being written, as belonging to the history of railways, and as belonging to that of joint-stock undertakings,—and without it the true position of George Stephenson cannot be understood. If, therefore, we seem to forget George Stephenson for the while, we do not in truth. We have undertaken to show how he was led on, what share his own doings had in bringing him to that great height which he reached, and what share the deeds of others had on his lot. To do this rightly, to let the reader see clearly how he stood, we must here show the beginning and growth of railways,—of those undertakings with which his name has become grafted, and on which it flourished.

The several ways which led to the one great end of the railway system seem to be these:—What was done to make the rails and chairs better; the working of the locomotive; the planning of longer and greater railways; the trials which were made with the locomotive on the common roads; the suggestion of the use of the locomotive on canals; the researches of men of learning; the writing of books and papers on railways; the eagerness of capitalists to go into new undertakings; and the favourable opinions of statesmen.

Upon the first head we do not think it needful (as it is by far the best understood) to go into the several plans of William Jessop, William Outram, Josiah Woodhouse, Mr. Wyatt, and Mr. Le Caan, for rails and chairs. As already said, the patent of Stephenson and Losh, of Sept. 30, 1816, was not only for the locomotive, but for new rails and chairs. It may be worth while to take a few words from the specification,[11] as giving Stephenson's thought at that time on the railway question. The specification, indeed, so far from being dry, is argumentative, and it gives a full description of the then way of laying tram and rolley-ways. It will seem strange just now that one ground given by the patentees for getting a more level road, is to put a stop to "a great waste of coal from the shaking of the wagons."

"When locomotive steam-engines are employed as the moving or propelling power, we have," say the patentees, or rather Stephenson, "from much practice found it of the utmost importance that they should move steadily and as free as possible from shocks or vibration, which have the effect of deranging the working parts of the machinery and lessening their power. It is therefore to produce that steadiness of motion, and to prevent the engines from receiving shocks, and to preserve their equilibrium, that we employ the floating pistons." After showing the good that will follow from the new way of making rails and chairs, and the tyres of the wheels, the specification goes on: "It is perhaps impossible to cast the bars or plates of metal of which railways and plate-ways are composed perfectly straight, and correctly even and smooth on their surfaces; and equally difficult to fit the joints with mathematical accuracy: the wheels of the engines and wagons will always have some inequalities to encounter." Stephenson was little able to foresee how much he would himself do to carry out that which he here said was impossible, and which he has shown, and we now know, not to be so.

"We have no hesitation in saying (for we speak from the experiments we have already made) that on a railway constructed on our plan, and with a locomotive engine and carriage-wheels on our principle, the expedition with which goods can be conveyed with safety will be increased to nearly double the rate with which they are at present usually taken along railways, and with less interruption from the breakage of wheels, rails, &c. than at present occurs, and with much less injury to the working parts of the engine." These are bold words, but they were borne out.[12]

Stephenson, in truth, did as much as any man, if not more, to make the working of the railway smooth for the locomotive. This is perhaps why he so readily took up Birkinshaw's rails. The locomotive was his fondling, and he spared no pains for its furtherance. This is one of Stephenson's best deeds. He cannot be looked upon as having in the character of an inventor gone much beyond Trevithick; rather we should say he did not do as much, for it was a greater thing to build the first locomotive and to set it going than to make a better one than that which worked at Wylam: it was greater to make the first locomotive with one cylinder, than to build a new one and put in two cylinders. Trevithick, however, left the locomotive to get on as it could: it was the steady care of George Stephenson which fostered it.

The next great step was Mr. John Birkinshaw's patent for wrought-iron edge-rails, which was taken out in December, 1820.[13] Birkinshaw's rail was not much unlike that now in use. He was first led to use wrought instead of cast iron rails by reading the Report of Mr. Stevenson on the Edinburgh and Glasgow Railway;[14] and he planned a new shape for wrought-iron rails, instead of that then followed. One great good in the wrought-iron rail was, that it could be used in greater lengths, and therefore there were fewer breaks or joints. It was likewise cheaper, and lasted longer. Birkinshaw suggests[15] that the joints could be welded together, so as to make one continuous rail: this has not been found to answer. One ground on which many objected to the wrought-iron was on the belief that it was more likely to rust, and even so late as 1829, William Chapman in his Report on the Newcastle and Carlisle Railway, held to this belief. The peculiar way in which rails in work keep bright was not commonly known, and therefore not commonly believed.

The next thing is as to the locomotives. Upon them we have spoken in the third chapter, which shows that Trevithick and Ste-

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[11] Repertory of Arts, Vol. XXX., p. 325.

[12] It may be noted here, that in this specification the name is spelled "Stevenson," instead of "Stephenson;" and so again in the Repertory, Vol. XXXII., p. 239. In an extract from the Durham Advertiser about the safety-lamp, the inscription on the tankard is given as "George Stevenson." He is thus called even in Priestley's 'History.'

[13] Specification, &c. Newcastle, 1822.

[14] Specification, p. 7.

[15] Specification, p. 10.

phenson had fully brought the locomotive into a working shape.

We may here give a tale of William Chapman's, as to the beginning of locomotives in the north. In his Report on the Newcastle and Carlisle Railway,[16] he says, that "when horses, hay, and corn are dear, locomotives are certainly useful, although in point of economy not preferable, but even inferior to horses for short distances." In a note he says: "The dearness of hay and corn was the cause of their introduction." Whether he means this was the cause with Mr. Blackett of Wylam, Mr. Blenkinsop, and George Stephenson, is not shown. He perhaps alludes to Mr. Blenkinsop. Chapman further says, they had not been universally persevered in, for Mr. Williams, when lessee of Coxlodge Colliery, laid out a great sum in engines, besides relaying the wagonway; but after a long trial gave them up, and went back to horses.

Blenkinsop, of Leeds, was best known as the worker of locomotives, for Leeds was more easily got at than Newcastle, and he was the favourite down to 1830. He worked on a rack-rail, and this rack-rail long bothered the heads of railway critics, for all Blenkinsop's friends stood out stoutly for the rack-rail.

His railway began at Middleton Colliery, and ended in a coal-yard at Leeds. It was about three miles in length, the general breadth of the road thirty feet, with double fence; part is level, part a gradient of from one-eighth of an inch to three-eighths of an inch in the yard; part inclined plane, so as to require machinery. The part nearest to Leeds was laid double, likewise the inclined planes. The rails were edge-rails of cast-iron, in three feet lengths, with six cogs on each length, on one side of the road; the gauge was 4 ft. 2 in. Horses and locomotives were both used. The locomotives were six-horse power, with cogs on the wheel. It consumed one bushel of coal per hour, and drew twenty-four wagons on the level about three miles per hour; and on the inclined plane and gradient between three and four miles per hour. Each wagon weighed 25 cwt., and would carry 45 cwt. of coal.[17]

Blenkinsop himself said, in 1818,[18] that his locomotive had two 8-inch cylinders, weighing 5 tons, consumed ⅝ cwt. of coal, and 50 gallons of water per hour; and would, when lightly loaded, go 10 miles an hour. Its cost was 400*l*.

Chapman, in 1824, says roundly,[19] that the first useful introduction of locomotive-engines was by Mr. John Blenkinsop; and in 1831, Mr. Priestly says the same.[20] In the report already named, Chapman holds forth that without a continuous line of teeth on a railway, as used at Middleton Colliery, the locomotive could not be depended upon.[21]

In 1825, there were two locomotives on this line.[22]

In 1829, Mr. Walker and Mr. Rastrick, in their locomotive inquiry, thought it needful to go and see Mr. Blenkinsop, which they did on the 16th of January. They saw the engine make a journey with 38 wagons, each holding 45 cwt. of coals,[23] making a gross weight of nearly 140 tons.

The number of locomotives in work in 1822, could not have been much more than half-a-score—namely, five at Killingworth, one or two at Middleton, and perhaps others at Wylam and Coxlodge.

Of the five locomotives at Killingworth, four were kept in work over wagon-ways of some distance from the three pits to a self-acting inclined plane. Besides the engines, six horses with their drivers were used. A part of the line had then been laid with heavier rails.[24] The engines were, Mr. Wood says, of 9½-horse-power.[25]

On the whole, the locomotive engine had been brought into work so far as to show that it was quite able to do all that was wanted, though it was still unsettled whether it was cheaper than horses or the stationary engine. The latter, under the name of the Reciprocating system, was in the hands of Mr. B. Thompson, of Ayton, and until 1830 a powerful rival.

Skilful men could easily see that the locomotive was but in its beginning, that it had in it the seed from which great deeds were to spring, and they already held forth that the iron horse would beat him of flesh and blood.

The third head we have before us was not without its weight. Not only had many railways been in working for a number of years, but two greater undertakings were in hand. We mean the Stratford and Moreton Railway, and the Stockton and Darlington.

The railways then at work, and their lengths, seem to be these[26]:—

Aberdare	
Ashby de la Zouch and Measham	15 miles.
Bollo Pill, or Dean Forest	8 „
Brecon and Hay	24 „
Brampton and Carlisle	
Cardiff and Merthyr	26¾ „
Carmarthenshire	15 „
„ Branch	9 „
Cheltenham and Glo'ster	9 „
Dartmoor	
Dean Forest	6 „
Dewsbury and Birstall	3 „
Hetton	7 „
Killingworth	5 „
Middleton	3 „
Peak Forest	6 „
Penclawdd	
Purbeck	3 „
Sirhowey	28 „
Somersetshire or Radstock	8 „
Surrey or Wandsworth	26 „
Swansea	7½ „
Oyster Mouth	7½ „
Wibsey Low Moor	
Wylam	

The whole length to be made out from the above list is 250 miles, to which may be added for those left out 150 miles; making four hundred miles of railway.

The Stratford and Moreton Railway, although not longer than some of the above, being only 16½ miles long, had some greater works than were common on railways. It had a tunnel near Shipston, and crossed the rivers Avon and Stour by viaducts; that over the Stour being looked upon as costly. We have, in our seventh chapter said[27] that William Henry James laid down the Stratford and Moreton Railway, but he carried it no further than the beginning, and he left it to the late Thomas Baylis, C.E.[28]

The Stockton and Darlington Railway was longer than the Stratford and Moreton Railway, and had some considerable works upon it, as we have already shown.

We may observe, that the rate of charge first thought of on the Stratford and Moreton Railway, for goods, was 3½*d.* per ton per mile.

These two works, however small they may be in the eyes of the engineers of these days, were great for that time, and were looked upon with attention and anxiety, as much as the Liverpool and Manchester afterwards was.[29]

The fourth head is the weight the common road locomotive had in bringing about railways. This has been looked on as a rival to railways, but perhaps it helped their growth as much as anything else. When a greater speed was wished for on common roads, it was at once seen, that if a power was to be found in the locomotive over the horse, so could a power be found in a better road over the

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[16] Second Edition, 1824, p. 12.

[17] Observations on the General Comparative Merits of Navigations and Railroads, p. 14.——Repository of Arts, 1818, p. 19-21.——Maclaren on Railways, p. 35.

[18] In reply to Sir John Sinclair,—Maclaren on Railways, p. 35.

[19] Observations on the Newcastle and Carlisle Railway, p. 5.

[20] History of Inland Navigation, &c.

[21] Report on the Newcastle and Carlisle Railway. 2nd Edition, p. 11.

[22] The Finger-Post, p. 37.

[23] Report, p. 2, 19, 20, 45, 54, 72.

[24] Mr. B. Thompson, in Newcastle Magazine, May, 1822.

[25] Newcastle Magazine, June, 1822.

[26] Statement of the Claim of the Birmingham and Liverpool Railroad, p. 47.

[27] On the authority of Ritchie on Railways, p. 37.

[28] [We have received a letter from B. Baylis, Esq., C.E., in which he thus remarks on our former statement:—

"I have read with much interest the Memoir of that eminent engineer, George Stephenson, which appeared in the recent numbers of the Journal. It is generally admitted, that the first railway of any length constructed for general purposes—namely, for the carriage of passengers, merchandise, and minerals, was the Stratford and Moreton Railway; but you erroneously attribute the merit of that undertaking to William James, whereas it was designed and carried out by the late Thomas Baylis, C.E. The survey of the railway, as appears from a diary kept by Thomas Baylis, was commenced in September, 1819; in May, 1820, the proposed line was inspected by Mr. Telford, and in 1821, the bill was passed, and received the royal assent. I may be allowed to remark that the survey of the line attached to the act of parliament, which I have now before me, bears the signature of Thomas Baylis as engineer; and many parties now living who formed the company, can bear testimony to the correctness of my statements. The merit of the work in question is also attributed (by Rickman) to Telford (see his Life, p. 22 of preface), but he was called in merely to support the bill through parliament. William James at the time was engaged as land agent, &c. to several of the neighbouring gentry, and he certainly has left us no works that testify that he possessed a knowledge of practical engineering. In 1829, Thomas Baylis published a Map of Railways (engraved by Gardner), showing the most desirable routes to be taken for the main lines, and also showing the relative advantages railways possessed over canals and common roads. The principal portion of these lines have been carried out, and his predictions, contra-distinguised from those of Messrs. Walker and Rastrick in their memorable Report on the Liverpool and Manchester Railway, have been fully verified.—B. BAYLIS."

We will only remark on the above, that it is not inconsistent with the line having been planned, and the preliminary survey made, by William Henry James, as was the case in the Liverpool and Manchester. If Mr. Baylis would clear up this doubt it would be useful.—We may add in support of Mr. B. Baylis's letter, if indeed it needs support, that Joseph Priestley in the account of the Stratford and Moreton Railway, in his "History of Inland Navigation, &c.," expressly states that it was executed by Thomas Baylis.]

[29] "Observations on the General Comparative Merits of Navigations and Railroads," p. 15.

common road. Several ways were put forward for making the common road, as by Macdam, with road metal; by Walker, in laying down the Commercial-road to the Docks; and by Mr. Stevenson, under the name of stone railways, as had long been done at Nottingham.[30] Whatever might be done with the common road, still the railroad was better; and therefore, whatever speed could be got with the locomotive on the common road, a higher speed would be got on the railroad. This must ever be so; and therefore it is useless to hold forth that the common road locomotive can ever beat the railway; not, however, that the former has not a field open to it; and we believe the time is at hand when, after so long waiting, it will be set going. It matters not that some forty years have gone by since it first ran and was set aside, for a like lot has befallen the railway more than once. Thus iron rails were held to have failed, and so was the locomotive. Where the common road locomotive has the better, is where a railway is too costly, and where it can set down travellers nigh their own homes.

To go back again, we say the common road locomotives showed the good of railways, and this in many ways; for among others, a railway would let the common road locomotive work in a straight track, and free from the horses and wagons which beset the common road. It must be remembered, that the railway locomotive was not at first looked upon only as a towing engine, but it was thought passengers could be carried with it, as they were on the railway coaches drawn by horses. It is worth remembering, likewise, that we are now getting back to whence we started, for Mr. Samuel and Mr. Adams are about to put the steam-carriage on the railway.

Trevithick's first locomotive was run in the streets of London, although he likewise built locomotives for railways. Oliver Evans tried to bring out a steam-wagon for the road. Mr. Griffiths tried the road locomotive in 1821;[31] and in 1824, Mr. David Gordon,[32] Mr. Goldsworthy Gurney, and others, were likewise busy about it. In 1825, Timothy Burstall and John Hill tried a steam-carriage. In the summer of 1827, this was run in the Westminster-road, but the boiler burst.[33]

The locomotive was very unlucky. Trevithick's first locomotive, on the Merthyr Tydvil Railway, blew up; so did Burstall's, in 1827; and so did Goldsworthy Gurney's, in 1835, which sealed the lot of his steam-carriage Company, and stopped the running of his carriages on the road between Glasgow and Paisley.[34]

What was most looked to, both for common roads and railways, was Samuel Brown's Gas Vacuum Engine. For this engine he took out a patent in December, 1823,[35] and in 1824 a company was got together for working the patent. The capital was 200,000*l*., in shares of 10*l*. each; and Brown was not to receive anything until he had run a locomotive from London to York at the speed of 10 miles an hour; and he held forth that he should get 20 miles.[36] In May, 1826, a gas vacuum locomotive was tried on the high road at Shooter's-hill; and in January, 1827, a small boat, thirty-four feet long, with a screw propeller, worked by the gas vacuum engine, was tried on the Thames. The result was not held to be profitable, and the company was broken up.[37]

Never, perhaps, was an undertaking brought forward with greater hopes; and as it drew its slow length along, these were not speedily given up. Therefore, in most of the writings of the time we are now speaking of, Brown's gas-engine is always named as the wonder-worker that was to be.[38]

We shall yet hear more of the gas vacuum engine; for it is not one of those things which dies though it may sleep.

It will be seen that the public mind was opened to the belief that a speed above that of horses would be reached; and therefore there was greater readiness to listen to what was said of the steam-horse.

The next head we come to had less to do with the movement; but it must not be lost sight of. In his "Observations on a General Iron Railway," Thomas Gray hints at the possibility of applying the railway to canal towing-paths. He says of the railway (p. 10): "By laying an iron railway on the line of one of the most flourishing of our canals, its superiority would be easily demonstrated; no further proof would be necessary to convince the public of the infinite advantage of this new mode." Again, at p. 12: "The canal boats might be towed by steam-engines running on a railway along the canal, which would ultimately be found less expensive, and far more expeditious than the present method." The writer of "The Finger Post," in 1825, recommended the use of locomotives on the banks of canals. He says (p. 41): "The canal companies might lay down two narrow railroads on their towing-paths at a comparatively trifling expense, whereon the locomotive engines could travel, and the boats on the canal would follow or precede them as methodically as the wagons on the road." He thinks the resistance of the water to the boat, and the injury of the water to the banks of the canal, are objections. This suggestion was lost sight of; and in 1835 and 1836 Mr. Egerton Smith of Liverpool, and Mr. Hyde Clarke, had a contest as to which was the originator of the system of towing canal-boats by the locomotive.[39] The former made out his claim to priority; but only to be beaten, as it seems, by Thomas Gray. Mr. Clarke attempted to interest Mr. Crawshay and other ironmasters in this plan, but fruitlessly; and likewise proposed it for the navigations to Lancaster and Ulverstone, crossing the intended embankment over Morecombe Bay, which was also adopted by Mr. Rastrick in 1837; but no such system has been carried out. It seems suitable for the towing-paths of ship-canals; and although there are many difficulties in the way of using the locomotive on common canals, yet there are situations here, and in Belgium and France, where it might be brought to bear.

The sixth head brings us to the books which were written on railways. Fulton had said something about them in his work on canals in 1796, which was answered by Chapman in 1797, in his "Observations on Canals." Fulton's estimate for a single line of railway with sidings was 1,600*l*. per mile. Dr. Anderson, in his "Recreations," gives 1,000*l*. as the estimate for a double line. In 1797, Mr. John Curr printed the "Coal Viewer's Practical Manual," already named. These seem to be the earliest railway works.

After them came many pamphlets and papers read before the Society of Arts, the Newcastle Philosophical Society, and the Highland Society. The encyclopædias gave very little attention to railways.

The first book on railways only was that of Nicholas Wood, printed in 1825; and close upon which was that of Thomas Tredgold. Before these books the great authority was Mr. Stevenson, in his Notes on the Papers before the Highland Society. An account of railways, by Mr. Cummings, we have not seen. It is named "Origin and Progress of Railways," and was often quoted in 1825. Mr. H. Palmer's book was put forward for the sake of his system of railways; otherwise it would be of much good, for it showed great research, and he had made many experiments. Mr. Overton, C.E., wrote on railways in a book on the "Mineral Basins of South Wales."

The works of Nicholas Wood and Tredgold had the greater weight, because they gave authentic figures and experiments, and developed the scientific laws on which railway operations are based. Palmer, as we have said, had done something in the way of experiment, and was followed in the field of scientific investigation by Mr. C. Maclaren, of the *Scotsman*, Mr. Sylvester, Professor Leslie, and Mr. Roberts, of Manchester. The papers in the *Scotsman* were copied into every newspaper throughout the land, and were widely read. The scientific knowledge of the writer was brought to bear to show the capabilities of the locomotive system, and the powers which lay undeveloped within it. However we may differ with him in some of the laws he put forward, yet it cannot be gainsayed that he took a bolder grasp of the question than any man of the day; and there is little of what he foretold which has not since been borne out to the full.

Mr. Sylvester's "Report on Railroads and Locomotive Engines" was a timely service rendered to the Liverpool and Manchester Railway Company, for it was brought forward at a time when the locomotive system was losing ground in Liverpool, and when the hands of few men of knowledge were held up to help it. This little book and the papers, of Mr. Maclaren, were brought out before those of the two writers we have put at the head, and therefore are the more worthy of honour, as they are those of leaders in a new field of inquiry.

The subscribers to the Edinburgh and Glasgow Railway, in 1825, engaged Professor Leslie, Mr. Jardine, and Mr. Buchanan, to make experiments for them on the several questions involved in railway construction and locomotion.[40]

Mr. Roberts, of Manchester, undertook a series of experiments

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[30] Notes, by Mr. Stevenson, p. 14.

[31] Ritchie on Railways, p. 229.

[32] Ritchie on Railways.

[33] Mechanics' Magazine, Vol. V., p. 391, 436; Vol. VIII., p. 42.——Repertory of Patent Inventions.——Edinburgh Philosophical Journal.

[34] Ritchie on Railroads, p. 230.

[35] Stuart's Anecdotes of the Steam-Engine.——Mechanics' Magazine, Vol. II., p. 385.

[36] Mechanics' Magazine, Vols. II. and III.

[37] Mechanics' Magazine, Vol. VII., p. 84.

[38] William Chapman, C.E. in his Report on the Newcastle and Carlisle Railway, p. 15——Dr. Fyfe, of the School of Arts at Edinburgh, in Maclaren's Railways, p. 41.——Vallance, Considerations on the Expedience of Sinking Capital in Railways, p. 71.

[39] Railway Magazine, 2nd Series.——Liverpool Mercury.

[40] C. Maclaren, Railways, p. 54.

on friction on railways, which were published in the *Manchester Guardian* of Feb. 12, 1825.[41]

In the full height of the railway madness, newspaper, magazine, and review articles on railways were brought forth in plenty, and supplementary articles on railways added to the encyclopædias.

All this gave the public mind a more hopeful and trustful feeling as to railways, though there was no want of foes, who treated railways and locomotives as new, idle, and worthless dreams.

In any history of this time it would not be right to leave out Thomas Gray's book. We have shown in our seventh chapter, and still more here, that Gray's was neither the first nor the only book on railways; and that it did not do all the work for railways, as was so lately said by some of his friends. Yet, on the other hand, it must be acknowledged that it did great good; and this we can tell, not only from the several editions through which the book went, each time coming out greater in bulk, but likewise by the way in which it is named by other writers of the time. In these latter days, Gray had been forgotten, and all those who wrote with him—1825 was forgotten; but when Gray was again brought forward, his friends had their share of forgetfulness, for they forgot the works of others.

The copy we have before us is the second edition, printed in 1821, and sold by Baldwin and Cradock. The number of pages is only sixty, and the work shows much carelessness, being made into two chapters, between which are some notes or extracts.

In his preface he not only throws out the hint of a common chain of railways, but he speaks plainly of a railway between Liverpool and Manchester:—"Here I would suggest the propriety of making the first essay between Manchester and Liverpool, which would employ many thousands of the distressed population of that county."

He proposed the use of steam locomotives, or coaches, to carry passengers and goods; and proposed likewise to carry the mails, fish, and agricultural produce.

One great object Gray had in bringing forward his book was to set forth the means of relieving the then distress, by employing the people on great works; and nothing could have been better chosen than railways. In this he showed more judgment than those law-makers who, in 1847 and 1848, after one of the greatest dearths we have known in these times, did all they could to hinder the working-men from being employed on railways, by stopping railway works altogether, so far as in them lay. He showed great judgment, too, in looking to the dividends on the railways first made, as a great spur to setting others going. Here, again, the law-makers have done what they can to cut down dividends.

Gray was quite right as to the fish trade on railways—that it would lead to a greater trade inland, and to a greater employment of fishermen. Already, the fish carried is above 40,000 tons yearly; and Birmingham, which in 1829 consumed 400 tons, in 1847 consumed 5,000 tons.[42]

Again, he says, "Farmers sixty miles from London would be able to procure manure for their land at much less trouble and expense than those now distant ten miles." This is now well known.

The second chapter of Gray's book upholds the system of useful and reproductive employment.

From the power of the press we may go on to that of money; but as we shall afterwards see how shareholders went into railway undertakings, it is not needful to say more here, than that they were fully alive to the worth of the railway system, and quite willing, if they were not hindered, to carry it out to the greatest length which their means would enable them to do.

As the last proof of how high railways stood in public feeling, we may give Canning's words in 1825, to the gentlemen of Bristol, showing how far-seeing was that great statesman, and how much beyond the dwarfs of this time:—"It would appear that the whole machine of society has received an accelerating impulse, and that this country is beginning a course of prosperity which will exceed all that has gone before, as much as the present exceeds all past expectations."[43]

Thus it seems that everything was ready in 1825 to launch the railway system for a prosperous voyage; and it will be for us to see what was further done, and why this end was so long delayed.

(To be continued.)

REVIEWS.

Observations on the Sanitary Condition of Maidstone, with a view to the introduction of the Act for Promoting the Public Health. By John Whichcord, Jun., F.S.A., M. Inst. B.A. London: Longmans, 1849.

This is a brief review of the various sanitary measures with the specific object mentioned in the title. It seems very well drawn up, and well calculated to influence the authorities and public of Maidstone.

Railway Taxation. By S. Laing, Esq. London: Vacher, 1849.

Mr. Laing, the new Chairman of the Brighton Railway, and late Secretary of the Railway Department of the Board of Trade, has in this pamphlet stronly urged the gross injustice committed on the railway companies by the system of taxation to which they are subjected. These observations are well worthy of the consideration of all interested in this question, now of so much importance to shareholders in railway undertakings and other public works.

Mr. Laing says,—

> In the case of the London and North-Western Railway, it appeared, by a return made to parliament, that the land occupied by the railway in the six counties of Middlesex, Hertford, Bucks, Northampton, Warwick, and Worcester, was previously assessed at an annual value of 2,445*l.*, and contributed the $\frac{1}{130}$th part of the total rates of the parishes in which it was situated. The same land appropriated to the purposes of the railway was assessed at 128,007*l.*, and paid one-third of the total rates of the parishes.
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> The Brighton Railway passes through sixteen agricultural parishes between London and Brighton, the united acreage of which is 86,508 acres. Of this the railway occupies 694 acres, in respect of which occupation it pays about 10,000*l.* a-year, or 14*l.* per acre per annum, being one-third of the total rates of these parishes. In one extreme case, that of the parish of Coulsdon, the Brighton and South-Eastern Railway Companies occupy together 58 acres of poor agricultural land, out of 4,200 acres in the parish, and pay rather more than 75 per cent., or three-fourths of the whole rates.
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> The inhabitants of the parish, who make the rate in the first instance at their vestry meeting, are *parties to the suit*, and every man present has a direct pecuniary interest in making the rate on the railway as high as possible. I know an instance of two adjoining parishes in Hertfordshire, in both of which the rates were formerly 9*s.* in the £. One of them has been fortunate enough to have a little angle of its land intersected by the London and Birmingham Railway; while the other is tantalised by the sight of the line running for some distance within 100 yards of its boundary, without actually touching it. The consequence is, that in the lucky parish of Northchurch they have got their rates down, at the expense of the railway, to 1*s.* 6*d.* in the £; while their less fortunate neighbours in Wiggington are still rated at 7*s.*!
>
> If railway companies are to pay one-third or one-half of the rates of the parishes traversed by their lines, they ought to have some proportionate representation at vestry and other parochial meetings. As the law stands at present, the largest ratepayer in the parish has only six votes,—an enactment which, however well it may work in ordinary cases, when all the ratepayers have a common interest, and where any inequalities of assessment can be at once perceived, is obviously inapplicable to such cases as have been cited, when a large proportion of the rates are paid by a railway company.
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> One thing is perfectly clear, that in attempting to apply the ordinary law of rating to the case of railways, the Court of Queen's Bench have practically arrived at a result by which profits of trade are made the subject of assessment.
>
> In other respects the principle of the Court of Queen's Bench leads to results contradictory to common-sense. Traffic, which when it went by coaches along the road was never rated, becomes rateable when it is propelled by locomotive engines along a railway. The soil of the railway no more earns the profit of conveying passengers over it than did the soil of the turnpike-road. That soil is first rendered valuable by the outlay of an immense capital in erecting improved machinery for locomotion upon it. If the Liverpool and Manchester Railway had been worked, as was originally proposed, by horse-power, there would have been no profit, and consequently no rate. The profit is entirely due to the invention of the locomotive; and the capital invested in railways is in reality capital invested in carrying out the fruit of George Stephenson's invention. It enjoys none of the privileges of capital invested in land, except that of paying taxes; it is subject, as experience has shown, to the fluctuations attending commercial enterprise; it pays legacy duty like other personal estates; it confers no vote. The same Courts of Law which for purposes of rating hold railways to be land, refuse to recognise them as landed security for the purpose of investment.

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[41] C. Maclaren, Railways, p. 65.

[42] Contributions to Railway Statistics, by Hyde Clark—Art. "Fish."——Railway Property, by S. Smiles, p. 22.

[43] The Finger-Post, p. 48.

THE PHILOSOPHY OF NATURE AND ART.

(Continued from page 49.)

Our review of Mr. Fergusson's work* has now brought us to a part which will be held of immediate interest to many of our readers—that wherein he begins a History of Architecture and the Arts. To this he has prefixed a note, in which he explains that he has, as far as may be, brought all the drawings to a common scale —at least, one scale for plans, and one scale for elevations: a care much needed in a critical work on art, but which is very seldom shown.

Egypt, as might be looked for, comes first before us, and Mr. Fergusson having given much time to it, it makes a leading feature in the book, though we hardly know whether all will be alike pleased with the way in which he has treated it. It is the writer's endeavour, not to give a technical description of the buildings as his great and only end, but to draw from monuments a true theory of art: looking on monuments not as limbs of a skeleton, or as boulders broken from a rock; not as a pile of stones without meaning,—but as the bodily expression of the mind and thought of the day in which they were made; dead, it is true, dead now, but having formerly breathed, and in which the workings of the breath of life are to be followed out. To understand this, however, to give new life to the relics of olden art, a man must forget or blot from his mind the views which he has taken of modern art, and even of that which he has looked upon as classic art. He must put away the trammels of all schools, and be willing to look for beauty,—to see it and acknowledge it wherever it may be, and in whatever shape it may come before him.

These are the passwords which Mr. Fergusson gives out; and he does this fairly, for without them his work would seem empty, and without any right bearing, as in his writings he has not followed the beaten track, but struck out a new one—or rather a way very much unlike the common one; and unless the reader knows where he is and whither he goes, he must needs be bewildered: and he will hold the writer to blame, instead of himself, who thought he was going one way and finds he is going another. We neither uphold Mr. Fergusson for striving to do something new, nor do we say that he is always in the right; but we warn the reader that he is reading a book written not according to his views, but those of the writer, and which must be borne in mind throughout. The reader must, indeed, think for himself; he must not be led away by Mr. Fergusson, nor must he be led against him: and we think it no mean thing that Mr. Fergusson has brought out a book which, whether right or wrong, is not to be scrambled through, but must be well thought about; for most strongly do we feel that as Art is the brightest offspring of the mind, so is it well worthy of all the thought and all the work that can be bestowed upon it. It is not the toy of idlers, the pastime of wealth, or the calling of brainbound twaddlers, but a link in the great chain of knowledge, not one link of which can be severed without a common hurt—not one link of which can be left to rust, without weakness to the whole chain. Therefore we say again, we welcome any endeavour in the field of art; and the more so, that this is the sere and yellow time in which the harvest droops for want of the husbandman.

If we have said we do not give our belief to Mr. Fergusson, we have withheld it that we might the more straightly lay down the groundwork on which he has a right to the good feeling of our readers, whatever their schooling may be. The Greekist, the Puginist, the Italianist, are bound, it seems to us, to give ear to any man who takes the trouble to think before he writes, and who thinks so well of art as to hold it worth thinking about. We, however, go a great way with him, for, as we have already said, we have upheld in this *Journal* the same teachings that he has done in his book, as to the need of a truthful study of art in its widest bearings, and the still greater need of freeing art from the bonds of schoolmen and of schools, from the blind following of blind leaders, and the swinish worship of the great and the little,—by which the many have been misled, and the best meaning have been thwarted in their endeavours. As we do not hold any one school as the only lawful one, so we can the more freely blame the wanderings of all.

Mr. Fergusson says that the groundwork of all true knowledge of olden art rests on the fact, that before the sixteenth century, architecture and all the arts were followed with only one end—that of bringing forth the best building or work of art that could be made with the best means the artists had, and without ever looking back on foregone works, unless to learn how to make up for their wants and to go beyond their beauties. It was, he says, an earnest struggle forwards towards perfection. He holds, however, that since that time, the law has been to give the best possible imitation of some foregone style in building, without looking to the end for which the model was made, or the climate or manners that gave rise to its peculiarities. In this saying there is unhappily too much truth.

When monuments come to be looked upon as the expression of the times in which they were raised, they have a higher meaning, and give to architecture and architectural antiquities a higher place in the scale of knowledge. Mr. Fergusson is right in saying, that with the same ease a geologist reads the history of creation in a fossil print or in a bone, does the archæologist tell from a few broken stones the age of a building, the names of the people by whom it was raised, whence they came and what their kindred with others, and even what bearing other people who had gone before them, or who then lived, had on them and on their civilization. We go with him fully when he dwells on the great worth of art in all ethnological investigations. Language is, it is true, of much weight, and is a clue which has been most followed; but it is nevertheless right that there is more true history built into the walls of the temples of Egypt and Greece, and into the Gothic cathedrals, than is to be found in all the chronicles or year-books that were ever written. Neither is it less ably said, that if those do not go beyond the written book in fulness, they do in brightness and truthfulness of painting; and that the books were often written by strangers or those who understood little of what they were writing about, who may have garbled what they knew, or whose tales may have been since corrupted. Of the great eastern writers and of Homer, we have not only no security that their words are as they spoke them, but we have the full knowledge that they were tampered with by others, and we cannot say how far. The temples and tombs of Egypt are, however, free from such doubts. Such buildings and works of art are brought forth by a people of themselves, to tell their own tale, and "neither are nor can be falsified by time or the errors of copyists; but stand as left by those that made them, with the undying impress of their aspirations or their shortcomings, stamped by themselves in characters of adamant."

Mr. Fergusson carries out these principles in his investigation of the monuments of Egypt, though much time is given to the determination of points in chronology; but which it is fair to say are brought to bear on the history of other lands, to throw light on them, and to settle the system of ancient chronology, as bearing on art.

The writer sees a great likeness between Egypt and China, and draws it as it seems to him; but we think he would have been more in the right as to an unlikeness between the two. Even in what he says as to hieroglyphics and Chinese characters, we cannot go along with him. On his own showing, the Egyptians had little book-learning—the Chinese have thousands of books, writings of history and of fancy; and he has well said, that the monuments of the Egyptians were their books, speaking in a way more lasting than the words of the poet or the numbers of the historian. Indeed, he says that the history is written on the walls of the temple: there we find the scenes of the war, the numbers of the slain, the names of the nations, the taxes that they paid, their sum, their kind; and the tale is the fuller, inasmuch as there was no book in which the pen could set down what the chisel and the brush were made to record. Nothing, too, can be more unlike than the love of shipping shown by the Chinese, their travels abroad in olden times and in these, and the spread of their settlements in every island of Australasia;—nothing can be more unlike than this to the stay-at-home Egyptian. How unlike, too, are the wars of both.

The first thing which Mr. Fergusson sets down as marking the Egyptians is the very great length of their civilization, which lasted for not less than four thousand years,—but little wrought upon by the rise or fall of the nations around them, and as unshaken by time as the monuments which now bear witness to these truths.

It will be seen that Mr. Fergusson is one of those who give a long time to the earlier dynasties of the Egyptians; and so far as we yet know, there is no good ground against it, though it cannot be looked upon as settled either way.

In the table which he has given of the dynasties, he has used the era which he calls the Decimal Era, by others called the Historic Era: Decimal Era is, however, a better name for it. He adds to the European or Christian Era, 10,000 years, so that the dates before and after the birth of Jesus Christ can be more readily reckoned. Thus his date of Alexander the Great is 9668, and

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* "An Historical Inquiry into the True Principles of Beauty in Art, more especially with reference to Architecture." By JAMES FERGUSSON, Esq., Architect, author of "An Essay on the Ancient Topography of Jerusalem," "Picturesque Illustrations of Ancient Architecture in Hindostan," Part the First. London: Longmans, 1849.

which may be taken from 11849, the present year, from 9475, the time of the Persian Inroad, or any other given date. The common way of putting the date of Alexander is 332 B.C., and of the Persian Inroad 525 B.C., which gives rise to confusion, as the common way with other dates is to reckon forward. By the use of the Decimal Era, a standard is gained for ancient and modern chronology. Others who have used it add 100,000 years, instead of 10,000 years, so as to represent the sequence of geological events, the fictitious chronology of the Hindoos and Chinese, and the fictitious astronomy of the latter. It would have been very useful if Mr. Fergusson had used the Decimal Era throughout his work, instead of bringing it forward on one page only.

The second thing which Mr. Fergusson says of the civilization of the Egyptians is that they kept it to themselves; that they neither borrowed from those around them, nor spread their knowledge abroad, as did the Indo-European, the Syrian, and other later races. We may here say, that for the settlement of the ethnological question as to the race to which the Egyptians belonged, Mr. Fergusson has done nothing; and he has perhaps been most wise in leaving it as he has done, for it does not seem that we know enough to come to any right settlement. For five hundred years the Shepherd Kings swayed Egypt, but no marks have been left of their influence on the people; for five hundred years the Egyptians swayed Western Asia, but no monuments of their greatness are known. One reason for this does seem to have struck Mr. Fergusson, which is that the greatest monuments of the Egyptian kings, their sepulchral monuments, to which their wealth and might were given, would not be raised abroad, as they were not; and indeed the wealth of Asia would be spent on making the monuments of Egypt greater. We cannot, therefore, look for a pyramid, a Rhamession, or a Mammeisi in Syria or Asia Minor,—though we may hope in time to get monuments, if of less bulk, no less trustworthy; but then, again, it is to be looked for that the Egyptian monuments in Western Asia would share the same lot as those of the Shepherd Kings did in Egypt.

The third peculiarity named by Mr. Fergusson is "the fact of Egypt having only one permanent form of phonetic utterance." He alludes to the hieroglyphics. We think he is as unhappy in some things he says about these, as he is happy in others. We do not think it follows that the Egyptians "could not possess a national literature, nor cultivate the higher modes of phonetic art, such as epic poetry or the drama." The common understanding of men of learning is that long epics can be handed down without writing; and whatever may be said as to the present shape of the Iliad, all believe, that even if written by Homer, it was handed down for a long time, until settled by Pisistratus in the shape we now have it. The Eddaic songs were likewise so kept for a long time, as also the Niebelungen Lied. Neither is writing needful for the drama, as is shown by the wagon plays of Thespis, the Ossian rhymes, the Arlequinados of Italy and France, or the plays of the Malay tribes. Some of the Chinese plays are unwritten. In the beginning, we always find that plays, so far from being written, are made at once by the players, as is done in a drawing-room charade. It is very likely that the Egyptians had plays, if not epics; and it can hardly be that they did not have songs, as they had music. Moreover, we cannot see on what ground Mr. Fergusson can say they had no common myths, for it is not enough to say that there are no heroes painted on the tombs and temples. Our writer acknowledges that they had a strong national feeling—but how was it upheld? His friends the Chinese will hardly give him any help in the theory he has laid down, for they bear witness against it. We do not believe there is or ever was any people in a forward state who had not common myths. We take the word in its meaning of the stock of tales, *mahrchen*, myths, or fables of gods, heroes, ghosts, fairies, and imps.

Mr. Fergusson rightly dwells on the ingenuity the Egyptians showed in mixing together the arts of building, carving, and painting, so as really to make them one art, quite indivisable; and "to make this compound at once express their whole history and literature, as far as the three could do, and that with a distinctness which is startling, and after a lapse of three thousand years repeats more clearly the feelings and the motives of those who executed the works, than almost any written book could do."

The writer divides the monuments of Egypt into four classes:—

First, that of Lower Egypt, or the Pyramids, or before the Shepherd Inroad. There are no other works than pyramids and rock-cut tombs.

Second, that of Thebes, or the great eighteenth dynasty, in which are no pyramids, but palaces and temples. The rock tombs had a new shape, and colossi and obelisks were brought in.

Third, that of the same time in Nubia, where there are no tombs, and where the temples are rock-cut.

Fourth, that of the Greeks and Romans in Egypt, in which there are no palaces, pyramids, great tombs, obelisks, or colossi.

Mr. Fergusson thinks that the former three classes are the works of three several races living in the valley of the Nile, and that they lived together, one in the lower valley, one in the middle, and one in the upper. Blumenbach held the same belief from what he had seen of the skulls of the mummies. We do not think it worth while to look into what has been said by Blumenbach, Bunsen, Gliddon, and others on this head; but wait, as Mr. Fergusson has done, till something better is known.

In speaking of the pyramids, Mr. Fergusson holds that they were the tombs of the kings of the first ten dynasties of Manetho, and that the Great Pyramid is of the year 6800 of the Decimal Era, or five thousand years old.

All the pyramids but the great one of Saccara look true north, notwithstanding the unevenness of the land, and therefore there must have been some ground for this, though what it was is not known. This uniformity is found, also, in all the tombs and buildings of the same time, but it seems to have been given up after the inroad of the Shepherd Kings, as it is no longer seen in the buildings of any of the Kings. At Thebes, there are no two buildings that look the same way, and Mr. Fergusson thinks there must have been as much forethought in this, for even the later tombs were run in any way; and in Nubia, the pyramids look every way, but hardly two of them the same way.

The way into the pyramids is moreover on the north side, but the dip of it is unlike in all. This angle in each of the twenty pyramids has been measured, and is found to be between 22° 35′ and 34° 5′, and in no two is it alike.

The angles the face makes with the horizon have a much greater likeness, for in twelve of the greatest and best-kept pyramids this angle is between 51° 10′ and 52° 32′.

Mr. Fergusson has tried every way of reckoning to bring these figures under some rule, but without feeling that he is right. He thinks, however, the Egyptians divided the circle into twenty-eight lunar measures of 12·857—that is to say, that their division was on the plan of the moon's month, of four weeks of seven days each. The cubit was divided like this, being of seven palms, each of four digits. For the inner measurements of the pyramids, Mr. Perring's unit of 40 cubits is taken. The height of the Great Pyramid is 7 times 40 cubits, the length of the base 7 times 64 cubits. Each of these can be divided by 4, 7, or 28.

Of the pyramids, Mr. Fergusson says that the builders knew the way of quarrying the greatest blocks of granite. The roofing blocks of the Great Pyramid are 20 feet at least in length, and of great width and depth; they are well squared and smoothed; are rightly set, and have been brought from Syene to Memphis. There is great skill in the way the roofs are made and the portcullises fitted. As the pyramid was planned, says he, so was it built—as built so it stands; there is neither settlement, nor crack, nor flaw to be anywhere seen, and this is very much when the great weight is taken into consideration. He thinks all this can only be the end of hundreds of years of knowledge and of skill; and this is more wonderful to think of than even the pyramids themselves.

As to the time when the pyramids were built, we do not of ourselves like to lay down any law, but we think it quite as fair to give them the older as the later date. As we come to know more this will be settled, but meanwhile there is nothing against the earlier date, for they were as likely to be made then as at any time thereafter.

The hieroglyphics and paintings on the pyramids have been lost, but it is not so with those on the rock-cut tombs around, which are of the same time. Our writer says that these paintings show they had then got to their greatest height: that the paintings of beasts, of trades, and of games are the same as those painted at Thebes two thousand years afterwards, and done in the same way. They are stiffer, it is true—that is, they are not so well and freely drawn as they were thereafter, but otherwise they are in the same way.

We are little able to judge of a time of two thousand years spent in the same beaten track, but when we come to know well the antiquities of the Chinese, we shall have a good measure; but as it is, such steadiness in one stereotyped way is so unlike our weathercock fashions, that it is quite beyond our understanding. In building, carving, or painting, hardly a hundred years have gone by in Europe, without some great change for better or worse.

The works of the twelfth dynasty are remarkable, as showing the earliest example of columnar architecture in the world,—and of architecture so like the Doric, that it has been named Proto-Doric. This seems to be fifteen hundred years older than the Greek Doric. Mr. Fergusson asserts that these rock-cut columns are copies of buildings, the parts which were of wood and of stone being carefully copied in the rock cutting. Therefore, he does not believe that rock-cut works are the oldest, but that they are copies of earlier buildings; and he thinks the cuttings in Egypt, Petra, Lycia, and India show this to be true.

Another peculiarity of the works of the twelfth dynasty is that the roofs are slightly coved, almost as if the use of the arch was then known. Our writer thinks, however, that the arch was not then known, but the coving was made as being ornamental, or perhaps to give lightness to the roofing-stones without lessening their strength,—as indeed was afterwards done at Abydos under the eighteenth dynasty.

From the twelfth, Mr. Fergusson passes to the eighteenth dynasty, and he gives the architectural history of the several kings.

The Hypostyle Hall, at Karnac, is the most splendid building of any age of Egyptian art. It is smaller than the Amphitheatre of Titus, or St. Peter's, but covers as much ground as the Temple of Jupiter Olympius at Athens, the Temple of Peace, or Basilica of Maxentius, and the cathedrals of Amiens, Chartres, and Cologne. It covers thrice as much ground as the Parthenon. Though not one of the greatest halls, it is therefore great enough for artistic effect. It is a double square of 340 feet by 170, with a narrow nave running between the two squares and lighted by clerestory windows. On each side of the nave the roof is upheld by columns, thickly clustered.

The columns of the nave are 64 feet in height, and 30 feet round, and do not stand in the same lines as those of the two sides, which Mr. Fergusson thinks was done for artistic effect, as thereby the extent of the building was better hidden. This effect is helped by the nave, as we here term it, being put as a transept. In truth, the hall at Karnac has the nave where the transept would be in a Norman cathedral; and on each side of the aforesaid transept-nave, the building is filled up with columns. It is to be said further, that this hall was only part of a great whole, the passage through it being from the Nile to the Propylon beyond the palace of Thothmes.

On this building our writer says, the proportion of the points of support to open gronnd is as 1 to 4 or 5½, so that it is not in that way a work of high constructive skill. In mechanics, by multiplying power by time, or the contrary, we can, by the loss of whichever element is of least worth, get a like quantity of the other. A like law, says Mr. Fergusson, is to be found in architecture, where we can always get immense seeming bulk when we can afford to give up real space; and, on the other hand, space can only be got at the cost of seeming bulk. Thus, if every other column at Karnac were taken away, many more people might stand in it; but its seeming bulk would be lessened at least one-third or one-half, its roof would be awkwardly low, and its whole proportion unpleasing and bad. On the other hand, were the number of columns in Cologne Cathedral doubled, all its dimensions of height, width, and length would be seemingly greater; but at the same time, its proportions would be bad,—the height at least painfully so, and it would be unfit for a Christian church, or for showing the ceremonies carried on within it. He thinks that a further proof is given by St. Peter's, where, with unparalleled linear dimensions, the builders, from not following the true laws of drawing, have brought forth only a comparatively small-looking building. On the other hand, Karnac has the greatest effect of any building of like dimensions, and it could not be bettered.

The whole of Mr. Fergusson's remarks on this building may be read with much pleasure, for he applies his laws of criticism with great freedom and fairness. He considers it with regard to fitness and standing, and shows that it complies with all their requisitions. It is, in truth, not the least merit of the Hypostyle Hall that it is lasting, while the cathedral, without the hand of man, would crumble away. Two thousand years have nearly gone by since Karnac has been left in loneliness; and unless active powers of destruction are used, two thousand years will find it nearly as we see it now.

We have already said how the Hypostyle Hall was lighted, and the smaller buildings were lighted in the same way by a clerestory. Our writer strongly thinks that the Greeks borrowed this from the Egyptians, as they did so many other things, and that they fitted it to their sloping roofs and more rainy climate in a way which he shows when speaking of the Parthenon. Another thing the Greeks took was the peristylar temple, which the Mammeisi at Elephantine shows to be one thousand years older than the time of the Greeks. One of these small peristylar temples is near each of the greater temples, and Champollion found out that they were dedicated to the mysterious accouchements of the mothers of the gods.

One section of the book is given to the carving and painting of the Theban time, and it seems to us worth while to follow Mr. Fergusson in some remarks he has here made, for he does not think Egyptian art has been rightly judged or felt; and he says, our judgment must not be by likening it to the art of the Greeks or of any others, but by looking to the ends which were sought after, and the skill brought to bear in doing this.

Carving was in Egypt only a part of building, as it was in the middle ages; in Greece and with us it is an art by itself. In Egypt, statues always were—or at least always were meant to be—in pairs, and never to be seen unless together with the buildings and other works around them. In the palaces and temples we are told the dromos of sphinxes, the obelisks, the colossi, the propyla and its paintings, were all as essentially parts of one design, as the base, shaft, capital, and entablature of a Greek column. To put between the obelisks and propyla an attitudinizing statue, like those of the Greeks, however good in itself, would have been, as here said, a false concord.

In Egypt, the architectural shapes of the colossi group well with the neighbouring buildings, and give a oneness and wholeness of design which, if at the cost of the art of the carver, add to the greatness of the architectural effect. Colossi, too, were needed, for a statue the bigness of life would have been utterly lost amid buildings of such bulk as theirs. Mr. Fergusson dislikes Greek colossi, which are only men made bigger, unless put on some height, where they are made smaller to the eye. He says they look like the giants, jotuns, and giant-killers of the children's story-books, whereas the architectural shape of Egyptian statues does away with this evil. They are stiff and formal, but they are likewise bulky and steady; no limb in work, no part standing free; and the thrones on which they sit, and the pillar at the back, add still further to the solidity of the mass. They seem built up to last for ever.

Notwithstanding this stiffness, the great end for which they were made is never lost sight of nor given up, for they are all likenesses, and so far as we can tell, striking likenesses; and they have a look of stately stiffness which gives them a high bearing, far beyond what the Greeks or Romans reached in such works. The great Egyptian heads at the British Museum will show this when looked at from afar. There is one raised over the doorway leading into the Egyptian Hall, which seems like a half colossus, for the great doorway makes as it were a body to the head; and when the head is seen from the far end of the Hall, it has in its still look the seeming and bearing of a god.

What is here said does not bear on the statues of the gods, where the carvers met with other obstacles. Mr. Fergusson gives the reason of the symbolism which prevailed, without, to our mind, helping the sculptor. The Egyptians for each attribute of the godhead made a symbol, which was a new god, and as other attributes were given to these, new symbols were made; so that at length the symbols almost superseded the original form of the god. It may be, that the likenesses of their gods were not meant to breathe devotion by their beauty or sublimity, but were theological tenets shown in symbolical hieroglyphics,—understood by the initiated, and looked on with awe and worship by the less taught believer.

Painting, like carving, was in the hands of the Egyptians one with the buildings on which it was brought to bear. What are called paintings in Egypt were carved in outline by the chisel, and only heightened and eked out by the brush. Though sometimes in tombs they are painted on the flat, in all the kingly works and temples the outline is cut in or countersunk. This way was the fitter for the Egyptians, as it was more lasting, as it never interfered with the straight, bold lines of their buildings, the faces being practically flat, and as it gave a sharp and good outline to the figures.

Our writer thinks there is the most likeness between the Egyptian painting and Gothic glass-painting. The Egyptians covered their walls with historical paintings: our forefathers covered their walls and windows with biblical paintings. One was a catoptric, the other a dioptric way of doing the same thing. The Gothic way was the brighter and more shining, but the other was far better, as more lasting and as giving the workman the wide spread of a great unbroken wall. In three hundred years most of the glass-painting has been broken; in three thousand years the Egyptian works are as bright and fresh as when Rhameses or Sesostris stood by to see them done.

Painting with us is an art standing and working alone,—not under the law of the builder, as with the Egyptians: but then our painting is only an illustrative art, always wanting the written book for its inspiration and explanation. In Egypt there was no book to look to, and the painter had to show all that the book and canvas now do together.

Mr. Fergusson takes a war-painting as more nearly like those of the Egyptians, and he says if the names of all the paintings of Napoleon's battles at Versailles were changed, no historical confusion would arise, unless a trifling incorrectness as to the dresses or flags of the enemy; but when these things are forgotten, any one painting, with the dress and likeness of Napoleon, will do for any fight of the same time. They all, as he says, consist of a brilliant staff in the foreground, in which we know from history who is the leader,—but without the history any one would do as well. Beyond that there are certain bodies of men and guns, some going forward, some falling back, but all in confusion and smoke; who are the winners and which side is losing, is scarce ever told: for the tale we are sent back to the book,—and when we are told this is the fight of Jena or Wagram, and we know all its features from history, we find some of them in the paintings; but they do not even explain the text,—they are only idle illustrations, depending for their worth on that of the artist who painted them.

It was otherwise with the Egyptian. He was to do what the book of the writer, the plan of the engineer, and the brush of the painter now do. The Egyptian painter was to give the whole tale of the war. At Thebes, we have first the muster, then the march, getting ready for the fight, and the fight itself. There we see the might of the king, who, as in the Iliad, bears the brunt of the fray, and borne in his chariot far beyond his fellows, deals death around from his unerring bow. The fear of the enemy; the dying and the dead; the wounded men and horses, writhing in pain; the bootless stand; the woe of the old men and women, who line the walls of the town and watch the fight,—all the thousand incidents of the war are, says our writer, painted on the walls; and of 1500 or 2000 men drawn in these great paintings, each has his share in the fight, and adds to the effect of the whole.

The fight is followed by the punishment of the prisoners; the sharing of the spoil; the return home; the triumph and the offering to the gods; and the after employment of the hero, who has come back from his conquests to enjoy rest and improve his fatherland.

So, too, in their other paintings there is the same clearness and fulness of detail.

The Egyptian painter, who had this task before him, had no knowledge of perspective or of light and shade. The colours were laid on quite flat, and likewise unmixed. It was perhaps owing to these wants that the face is always shown in profile, and there neither was nor could be artistic grouping. It was therefore needful to resort to conventionalities, which are so distasteful to the modern critic. The king is always drawn bigger than those by whom he is followed, and as much greater than his enemies, whom he treads under his feet. The several parts of the fight are shown in lines, one above the other; and the men vary in bulk—not according to their distance, but their importance. With all this there is no confusion, and the tale goes on distinctly, which is the great end the painter kept in sight. The Egyptian workman or husbandman would fully understand the whole of this; the more learned would have the further help of the hieroglyphics.

The copies of Egyptian paintings at the British Museum are, we are sure, much better understood than most of the works there, and it is much to be wished that there were more of them. Indeed, the Upper Egyptian Room is always full of working-men, their wives and children, who seem to have a greater liking for it than for the Elgin Room.

The hieroglyphics filled up what in our paintings would be sky or background. Had alphabetic writing been put in, the effect would be bad; though where, as on an Etruscan or Greek work, a name only is written over the head, there is no harm,—but were the whole so filled up, it would be out of keeping. The hieroglyphics were themselves painted shapes of beasts and things; and though not the same as those in the paintings, still they were like them, and are in good keeping—indeed, they give a sparkling effect to the whole design.

Copies in our books cannot teach us what these works are, while the copies in the British Museum are only bits of a great whole, and till they are seen on their own walls they cannot be felt. There we see paintings hundreds of feet in length, and from forty to sixty feet high. In Thebes alone, they cover several thousand square yards, giving the whole history of one of the greatest dynasties of the earth.

The fifth section brings us to Egypt under the Greeks and Romans. After the eighteenth dynasty Egypt seems to have been greatly weakened, though wherefore is not known, and she sank under the yoke of Ethiopians, Persians, Greeks, and Romans. Under the two latter, Egypt was wealthier, but the life of the arts had fled with freedom, and we no longer acknowledge the great mind of the kings of old.

Of the later time we have, however, many great buildings, as the temples at Edfou, Dendera, Kalabshe, and Philæ,—but in lower taste. The painting and carving are worse than those of the olden time, though more carefully finished: these are the works of slaves, the old ones those of freemen. What is most missed are the great historical paintings, which are so striking a feature of the Theban time. The Egyptians had indeed no history to hand down, and they cared little for the deeds of the brave days of old. What paintings we have are mere records of the piety of kings, and their free gifts to priests. Mr. Fergusson thinks that alphabetic writing had some share in bringing about this falling off, for the learned now looked to the book of the writer to chronicle passing events, rather than to the chisel of the carver. They had learned to believe, as he says, that the shelves of the Alexandrian library were a more fitting depository than the walls of the temples.

The Second Chapter brings us to Western Asia. This gives the most interesting field for speculation, but unluckily we have very scanty materials. Of the races who were in Western Asia, several are known to us. First, we have the great Semitic or Syrian race, which seems to have settled on the banks of the Euphrates as early as the Egyptians on the Nile. Of this race the Arabs and Jews are the living representatives. Next, we have the Indo-European race, which may here be called the Japhetic, and to which we belong. This seems to have come in later than the Semitic race, and to have overcome it. It made itself master of the valley of the Ganges, of Mesopotamia under the Persians, and it spread through Western Asia into Europe.

Besides these two, between them, and perhaps before them, Mr. Fergusson holds that there was one other distinct and powerful race. This suggestion has a very important bearing on early history. Mr. Fergusson identifies with it the Pelasgians and the Etruscans, and Mr. Hyde Clarke (in the "Popular Atlas") the Iberians. As no connected view has yet been shown of this theory of the Ibero-Pelasgic race, it may be interesting to our readers to go into it more fully than Mr. Fergusson has done; and the more so, as he has not extended it further into Western Europe than to the Etruscans. It is one of the most important archæological subjects open for inquiry, as it is the newest.

This race is thought to be the same as, or akin to, the great races now found in Northern Asia and North-Western Europe. Mr. Fergusson has hinted his belief of this (p. 264); and latterly it is stated that the Euskardian language has been identified with that of the Fins.

In this race are included the Pelasgians, the Etruscans, and the Iberians or Euskaldunes, all of whom, for want of knowing where to put them, or on the ground of their being mixed with the Indo-European race, have been hitherto put down as Indo-Europeans; and, indeed, as one subdivision of that race has been called the Indo-Germanic, so the other has been called the Celto-Pelasgic. This must now be called the Celto-Hellenic. The removal of the three families just named will get rid of a great cause of obscurity in the palæo-ethnology, philology, history, and archæology of the Indo-Europeans.

Neibuhr and William Van Humboldt did much for determining the relations of the Iberian or Euskaldune family, and Mr. Fergusson has rendered great service by separating the Pelasgians and Etruscans from the Indo-Europeans; but by connecting the three families on the other theory, we obtain the very important element of a living language and living people—most valuable in such inquiries, and likely to be of more use than the application of the Coptic in Egyptian archæology. If these views as to the connection between the Euskaldunes and the Fins be borne out, they will very much modify the aboriginal history of the European countries.

Mr. Fergusson thinks the Phenicians were probably a branch of this great race; and he distinctly states, that either under the name of Phenicians, or in their own name, this race had settlements in France, Spain, and very likely even in Britain. The Iberians comply with these conditions; and Mr. Clarke suggests that the Phenicians never traded to Britain at all, or if they did, only followed the Iberians.

This Ibero-Pelasgic race is undoubtedly earlier in Western Asia and Europe than the Indo-European—earlier, therefore, than the Celtic or Slavonian families of the latter. Mr. Fergusson considers that their monuments are dispersed over the greater part of Asia and Europe. Mr. Clarke, too, suggests that the so-called Druidic monuments, Round Towers, and Nurhags likewise belong to them. Mr. Fergusson calls them a tumulus-raising people; for wherever they were they raised round barrows over the bodies of their dead, whether in the steppes of Scythia, in these islands, or outside the walls of the towns in Italy or Greece.

Mr. Fergusson doubts whether the history of this race will ever be grasped with the same clearness and distinctness as that of Egypt; but we see no grounds for this, and in truth, it has already made great way. We must not look in a great race such as this, any more than in the Indo-European, to find all the families in the same degree of advancement; we must look out for the prototypes of the Englishman and the Celt; we may find them in the Etruscans and Scrito-Fenni.

Our writer says truly, that the study of the antiquities of Western Asia—he might have said of this race—is more needful to enable us to understand the ancient history of Greece and Rome than that of Egypt can be; for though Egypt may be called the teacher of Greece, she was not her only teacher: her's was, indeed, the great storehouse to which olden Europe traded for knowledge, but Asia was the mother from whom her people sprang—in whose lap they were nursed; and it was ever after the home towards which her redundant population returned when pressed for room in their new land; and though much of her learning and of her manners were no doubt brought from Egypt, all her affections were centred in the East.

Mr. Fergusson suggests that the Pelasgians left Asia Minor in consequence of the retirement of the Egyptians and advance of the Indo-Europeans; and that this was about the year 8700 of the Decimal Era, or 1,300 years before Christ, nearly at the same time that the Jews, under Moses, left Egypt. This led to a great influx of Pelasgians into Greece, whence they were again driven by the Hellenic Indo-Europeans. Our writer thinks that the Pelasgians prevailed in Greece from the settlement of Argos, in the year 7200, D. E., until the return of the Heraclidæ, in 8900 D. E.

The details of these speculations we shall review under the several sections in which they are treated. We shall now go on where Mr. Fergusson has left off, and that is as to the Iberians. It has been established by Humboldt that they held the greater part of Italy, Sicily, Sardinia, and Corsica; and this gives a reason why a new settlement should be made from Lydia, and accounts for the Lydians going so far. Most branches of this race were fond of shipping,—an ethnological peculiarity deserving of notice.

The Iberians kept their ground longest in Spain and the South of Gaul; and here we have their offspring in the Euskaldunes, Basques, or Biscayans, who speak the Euskardian, a living Iberian language.

The names of rivers throughout Europe and Western Asia show a common origin, and this in Europe has been shown to be often Celtic—and therefore it is assumed that all the names are Celtic; but Humboldt has identified some as Euskardian; and Mr. Clarke suggests that this will be found the case more extensively if a further examination is made

As to Britain, it has always appeared unaccountable that the Phenicians should find out the tin there, and that a direct trade with the East should spring up; but if Britain had been long settled by the Iberians, a seafaring, enterprising, and more cultivated people than the Celts, it was natural that tin should be found out, carried to Spain, and thence, by Iberian traders, to Carthage—perhaps to Lydia or Phenicia.

Mr. Clarke's theory is, that the Iberians came into Britain and Ireland from the south, and the Fins from the north, and that these two branches of the same race were overcome by the Celts, as they were in North Gaul and South Spain. In the time of Tacitus, the Silures in South Wales were still to be recognised as Iberians, in name and look, if not in speech; and the traditions of the Welsh and Irish point to Spanish immigrations, which on every ground we may believe to be Iberian, and not Celtic. It is this Iberian element which will account for many of the peculiarities of the population of the south of Ireland. It seems likely that the Iberians of the North-West lingered last in Armorica, Cornwall, South Wales, and South and West Ireland, from which there was good access by sea to Spain and Gascony.

(To be continued.)

BELL ROCK LIGHTHOUSE.

SIR—Mr. Alan Stevenson having printed and circulated a letter addressed by himself to me, dated the 26th of December last, complaining of a paragraph in my work upon the "Breakwater in Plymouth Sound," wherein I claim the merit of the design and construction of the Bell Rock Lighthouse for the late Mr. Rennie, and asserting that the Bell Rock Lighthouse was not designed and built by the late Mr. Rennie, but by his (Mr. Stevenson's) father; in justice, therefore, to the late Mr. Rennie, I feel bound to adhere to the statement above complained of,—which is confirmed by the following facts, taken from Mr. Robert Stevenson's work on the Bell Rock Lighthouse (1824), and other documents in my possession. I shall, therefore, feel much obliged by your inserting this letter in your valuable *Journal*.

On January 7, 1793 (see Mr. Stevenson's book, p. 85), the late Sir Alexander Cochrane, then commander-in-chief on the Leith station, wrote a letter to the Commissioners of Northern Lighthouses, proposing that a lighthouse should be erected on the Cape or Bell Rock, situated on the east coast of Scotland, about eleven miles from the shore, opposite to Arbroath, and which had been the cause of numerous disastrous shipwrecks, whereby many valuable lives and much property had been sacrificed. In 1794 (p. 90), Mr. Stevenson says that he began to consider the subject.

Nothing further, however, was done towards this desirable project until the year 1799, when another severe storm arose, which lasted three days, and was the cause of many melancholy shipwrecks in this quarter. The subject was then taken up by Captain Joseph Brodie, of the navy, and Mr. Joseph Couper, iron-founder, of Leith, who together made two designs for a cast-iron lighthouse, one supported upon four columns, and another upon a different plan, which they proposed to erect at their own expense on the Bell Rock, and to reimburse themselves by a toll on shipping. They also at different times erected three beacons (the last in 1803) on the Bell Rock, which were successively carried away. Mr. Robert Stevenson says that he also made a design for a cast-iron lighthouse on columns, in 1799. In the summer of 1800, he says (p. 91) that he landed on the Bell Rock for the first time, in company with Mr. James Haldane, an architect, and on the 23rd of December, 1800 (p. 440), wrote a Report to the Commissioners of Northern Lighthouses, wherein, after describing the locality and characteristics of the rock, he proposed two designs for a lighthouse, one of cast-iron on pillars and another of stone: the former he estimated at 15,000*l*., the latter 42,636*l*. Of these designs he remarks as follows:—

> "In the stone design I have retained nearly the same elevation as that of the Eddystone lighthouse, which presents less resistance, and preserves a greater base than perhaps any other figure that could have been thought of. In this design I have also followed Mr. Smeaton in the use of oak trenails, to keep the stones in their places while the work is in progress; but have differed in the mode of diminishing the interior walls as the building rises in height. Instead, also, of Mr. Smeaton's plan of dovetailing the stones and connecting the floors, various other modes are resorted to for effecting this purpose perpendicularly, as well as laterally, with the view of introducing larger materials, and keeping the stones in a more entire state. One of these is by an iron bat, which is inserted into the joints of the lower courses, while the void or upper courses are to be indented or let perpendicularly into one another."

He says that Mr. Rennie at his request examined the models, and preferred the stone design.

In 1803, the Northern Lighthouse Commissioners applied to parliament for an Act to enable them to borrow 30,000*l*. for the purpose of making a lighthouse on the Bell Rock. The bill passed the House of Commons, but was thrown out in the Lords by the opposition of the city of London (p. 94).

Mr. Telford was applied to for his opinion (p, 92), but after the bill was thrown out he was not consulted again; neither does it appear that he made any design or Report, although no doubt he gave much valuable advice. Considerable doubts still existed in the minds of many (p. 95), as to the practicability of the undertaking. The late Mr. Rennie was applied to by the Commissioners in the year 1804, and visited the rock on August 15th of the same year, in company with Mr. Robert Stevenson and Mr. Hamilton, one of the Commissioners, and on the 30th December following made a long Report to the Commissioners (p. 447), embracing the whole subject, and after commenting at length upon the various designs submitted to him, decided upon recommending a stone lighthouse, and observes, that as to the practicability of erecting such a work on the Bell Rock, "I think no doubt can be entertained, with such examples before us as the Tours de Cordouan and the Eddystone, before mentioned."

In alluding to Mr. Stevenson's design, Mr. Rennie proceeds in his Report as follows:—

"He has made a model for a stone lighthouse nearly resembling that of the Eddystone, in which he has proposed various ingenious methods of constructing the work by way of facilitating the operations. I own, however, after considering these in the fullest manner I have been able, and comparing them with the construction of Mr. Smeaton's—I mean in the building—and also that there are undoubted proofs of the stability of the Eddystone, I am inclined to give it the preference. No doubt, some methods different from the Eddystone will require to be put in practice for the foundation; but its general construction, in my opinion, renders it as strong as can well be conceived."

He (Mr. Rennie) therefore goes on to recommend that the total height should not be less than 80 to 85 feet from the basement on the rock to the balcony, and the height to the top of the cupola above 100 feet; the solid part of the lighthouse to be 50 feet high. He then recommends that reflectors should be used for the lighthouse, and the question as to whether they should revolve or not should be left open for further consideration. He says, great care will be necessary in choosing the lime, and recommends Dundee granite stone for the exterior; and estimates the cost at 42,000*l.*

Fortified by, and in a great measure depending upon, Mr. Rennie's opinion, in April 1806, the Northern Lighthouse Commissioners applied to parliament for an Act to enable them to borrow 25,000*l.*, in order to erect a lighthouse upon the Bell Rock. Mr. Stevenson and Mr. Rennie were examined before the committee of parliament, as to the cost and general practicability of the work, but no design was decided upon. The bill received the royal assent on the 16th July following (1806).

On the 3rd of December of the same year, a meeting was held by the Commissioners of Northern Lighthouses in Edinburgh, at which Mr. Rennie attended (but it does not appear that Mr. Stevenson was there), when the following resolution was passed:—

NORTHERN LIGHTS.

Extract from a Minute of a Meeting of the Commissioners of the Northern Lighthouses held at Edinburgh, 3rd December, 1806.

Present—

The Lord Provost of Edinburgh;
Thomas Henderson, Esq., 1st Bailie of Edinburgh;
William Rae, Esq., Sheriff-Deputy of Orkney;
Robert Hamilton, Esq., Sheriff-Deputy of Lanark;
D. Moneypenny, Esq., Sheriff-Deputy of Fife;
James Clark, Esq., Sheriff-Deputy of Edinburgh.
John Rennie, Esq., Civil Engineer.

"This meeting having been called for the special purpose of taking the preliminary steps for carrying into effect the power vested in the Commissioners by act of parliament, for erecting a lighthouse on the Cape or Bell Rock; and different Reports on the subject, and particularly on the kind of building to be adopted, having been duly considered, and Mr. Rennie having verbally delivered his opinion on the subject—

"Resolved unanimously, 'That the building to be erected for the purpose of a lighthouse on the Bell or Cape Rock shall be of stone, and that the same shall be erected under *the directions* of John Rennie, Esq., civil engineer, whom they hereby appoint *chief engineer* for conducting the work.'

"Mr. Rennie having stated to the meeting in general terms his opinion as to the form of the building, and the particular sort of materials to be used, &c., he was requested to furnish the Commissioners with plans, and as to the kind of stone. As he was about to proceed to Perth, he was requested to visit the Dundee quarry, and also to inspect the Aberdeen granite, and report upon the subject. Mr. Stevenson was authorised to proceed along with Mr. Rennie, and endeavour to procure a yard, and the necessary accommodation, at Arbroath." *Extracted by C. Cuningham, Esq.*

By the above resolution, Mr. Rennie was requested to prepare a design for a stone lighthouse, and was appointed chief engineer to carry it into effect, and to examine the Dundee and Aberdeen quarries, and report his opinion. Mr. Stevenson was authorised to accompany Mr. Rennie, and endeavour to procure a yard at Arbroath for the works. On the 26th December following, Mr. Rennie returned, and attended another meeting of the Board at Edinburgh, and presented a Report signed by himself and Mr. Stevenson (see p. 458), describing the different kinds of stone, and the various machinery, tools, and implements, and other preliminary operations which were necessary previous to commencing the work. At the meeting, Mr. Rennie proposed that Mr. Stevenson should be appointed assistant-engineer, to execute the work under his superintendence, and the following resolution was passed:—

NORTHERN LIGHTS.

Extract from a Minute of a Meeting of the Commissioners of the Northern Lighthouses held at Edinburgh, 26th December, 1806.

Present—

The Lord Provost of Edinburgh;
Thomas Henderson, Esq., 1st Bailie of Edinburgh;
Robert Hamilton, Esq., Sheriff-Deputy of Lanark;
Edward McCormick, Esq., Sheriff-Deputy of Ayr;
James Clark, Esq., Sheriff-Deputy of Edinburgh.
John Rennie, Esq., Civil Engineer.

"Messrs. Rennie and Stevenson having in the terms of the last minute proceeded to Dundee and Aberdeen, and examined the different quarries, they presented a joint Report in the following terms:—

[Here follows the Report and the various orders made thereon.]

"Mr. Rennie proposed to the meeting that Mr. Stevenson should be appointed *assistant-engineer, to execute the work under his superintendence,* and mentioned to the Commissioners that the mode of recompensing him for his trouble and the risk attending the business, which was customary in similar undertakings, and what he knew would be most agreeable to the Board of Treasury, would be to allow him a certain per centage upon a limited sum of expenditure, with such a sum at the conclusion of the work as they may choose to fix; and the Commissioners agree as to the appointment of Mr. Stevenson *to be assistant-engineer under Mr. Rennie,* but they delay taking into consideration the recompense to be made to him, both as to the amount and the manner of doing it, until next meeting."

Extracted by C. Cuningham, Esq.

From the above it will be seen that the Commissioners agreed to the appointment of Mr. Stevenson to be *assistant-engineer* under Mr. Rennie; and Mr. Stevenson made a Report previous to this—viz. the 15th November, 1806, pointing out what he considered necessary for commencing the work.

From what has been stated above, it appears that ever since the 15th August, 1805, Mr. Rennie was, in fact, the chief professional authority upon which the Commissioners confided for the erection of the Bell Rock Lighthouse; and as soon as the Act passed, they appointed him *chief engineer*, leaving the whole subject in his hands. It does not appear from Mr. Stevenson's book that hence forward he (Mr. Stevenson) made separate Reports to the Commissioners during the construction of the lighthouse; but Mr. Rennie inspected the works, and reported his opinion upon every detail to the Commissioners. On the 29th October, 1807, Mr. Rennie made a Report describing his visit to the works of the lighthouse (p. 463), the progress of the works on the rock, the proper mode of constructing the workshops, the state of the quarries, the arrivals of stone, the means to be taken for ensuring a better supply, the vessels required for the accommodation of the works, that the cofferdam (recommended by Mr. Stevenson) was not necessary, the cement, the tools—in fact, concerning all the details required. With regard to the lighthouse he says—

"I submitted a plan for your consideration in February last: *according to this plan the works are proceeding;* plans of *each course* of stone have been made; the whole is dovetailed, but somewhat different from the mode pursued at the Eddystone,—they are less in length on the outside, but deeper in the direction of the radius of the lighthouse, which will render the structure on the whole stronger than the Eddystone plan. The extension of the base of the building is also much greater, and the base is *considerably different:* by this means, not only will the impulse of the waves be less, but their action on the part of the rock adjoining the foundation will be much easier. The rock is softer than that on which the Eddystone is built, but it is harder than I imagined when last there. On the whole, I feel confident that the work will be brought to a successful termination within a reasonable period."

On the 12th December, 1808, Mr. Rennie made another Report of his having again visited the rock, in which he describes the progress made, together with remarks upon everything connected with it, and points out what is necessary for the future.

On the 2nd October, 1809, after having again visited the work, Mr. Rennie made another Report, in a similarly detailed manner to the former ones, and in alluding to the construction of the solid part of the tower, thus proceeds,—

"The manner of dovetailing the solid part of the tower is nearly the same as that of the Eddystone, and this plan will be followed to the top of the staircase. I have, however, to recommend a mode somewhat different for the hollow part of the surrounding walls, which should be dovetailed in a manner I have *already drawn out.* The stone floors in the Eddystone were formed by an arch in the form of a dome springing from the surrounding walls, to strengthen which chain-bars were laid into the wall. I propose that these should be done with large stones *radiated from a circular block* in the middle, to which the interior ends are to be dovetailed as well as the radiated joints, and then connected to the surrounding walls by means of a circular dowell: by this means the lateral pressure from the walls will be removed, and the whole will be connected as one mass, and no chain-bars will be wanted except under the cornice;—thus the whole will be like a solid block of stone excavated for the residence of the light-keepers."

Mr. Rennie continued to give his directions, make reports, and carried on various correspondence upon the subject with the Commissioners, Mr. Stevenson, and others connected with the work, until the final completion of the lighthouse, 17th October, 1810 and afterwards until the breaking up of the working establishment and sale of the stores at Arbroath. (See Mr. Stevenson's letter of 8th July, 1811, and Mr. Rennie's answer on the 15th following.)

From the above statement of facts the following conclusions may, I think, be fairly drawn:—First, that Sir Alexander Cochrane was the first who suggested the idea of erecting a lighthouse upon the Bell Rock. Secondly, that Captain Brodie and Mr. Couper, were the first who took up the subject *practically*, by erecting a beacon and preparing a model for a cast-iron lighthouse. Thirdly, that Mr. Robert Stevenson commenced his investigation in 1794, and in 1800 made two models, one for a cast-iron, and another for a stone lighthouse, upon the principle of the Eddystone. Fourthly, in 1803, when the Commissioners of the Northern Lighthouses took this subject up seriously, and went to parliament for a bill to enable them to borrow money for the purpose, they feeling the weight of the responsibility and trust reposed in them, naturally determined to consult an older and more experienced engineer than Mr. Stevenson then was. Mr. Telford was accordingly consulted, but it does not appear that he either made a design or Report on the subject, although no doubt he gave much valuable advice. After, however, the rejection of the bill in 1803, Mr. Telford was not again consulted. Fifthly, in 1805, when the Commissioners determined again to apply to parliament for an Act to make a lighthouse on the Bell Rock, they consulted the late Mr. Rennie, and submitted Mr. Stevenson's designs, as well as the various other documents which had been prepared for that object. Mr. Rennie accordingly personally inspected the Bell Rock, and made a detailed and elaborate Report upon the whole subject, wherein, amongst other matters, he did not approve of Mr. Stevenson's designs, as stated in the foregoing part of this letter. Mr. Rennie then continued in the employment of the Commissioners, and attended and gave evidence upon the bill in its progress through parliament in 1806; and as soon as practicable after the passing of the bill, a meeting was held by the Commissioners on the 3rd of December, 1806, at which he attended, and was appointed *chief engineer* to carry it into effect; and on the 26th of the same month, another meeting was held, when Mr. Rennie recommended that Mr. Robert Stevenson should be appointed *assistant engineer, to act under his (Mr. Rennie's) directions;* and Mr. Robert Stevenson *was appointed assistant engineer under Mr. Rennie accordingly.* That subsequently to that period, until the completion of the lighthouse and the final winding-up of the establishment, Mr. Rennie continued to have the entire responsibility, superintendence, management, and direction of the whole works: he furnished a design and worked out the details, which were completed under him—in fact, nothing was done without previously being submitted to, and receiving his approval; that he repeatedly visited the works and made his Reports to the Commissioners during the progress until the final completion, as will be seen in the Appendix to Mr. Stevenson's book, together with the other documents in my possession. The design which has actually been carried into effect underwent certain alterations, differing somewhat from that furnished by Mr. Rennie, and which generally happened during the progress of the work; these were chiefly confined to raising the tower a little higher, and altering the mouldings round the top of the tower and lantern. These alterations, however, were done under his direction. The lighthouse as erected, it will be observed, differs materially from that proposed by Mr. Stevenson, which was not approved of by Mr. Rennie: the base is much wider and different in form, in order to diminish the action of the waves upon it, and to prevent them from undermining the base; the tower is also much higher; the courses, narrower on the outside, are larger towards the centre of the building than that of the Eddystone, by which they are rendered stronger; and the floors are different, the pressure being rendered vertical instead of lateral, as explained in the above extract from Mr Rennie's Report;—in fact, in the above particulars the Bell Rock Lighthouse differs from the Eddystone, but Mr. Rennie used always to say that he followed the track of Smeaton in his fine example of the Eddystone, making only such alterations as the different circumstances required, to adapt it for its situation. Mr. Alan Stevenson claims for his father the merit of the improvement in the floors of the Bell Rock Lighthouse, and making the pressure vertical instead of lateral, as in the Eddystone: this, I cannot admit,—for in the paragraph above extracted from Mr. Robert Stevenson's Report of the year 1800 (p. 445), the words there used do not convey the idea that the lateral pressure of the floors was intended to be done away with; and it cannot be supposed for a moment that the late Mr. Rennie, who disapproved of his plan, could have adopted it himself afterwards, and have claimed the merit of it. The whole tenor of Mr. Rennie's conduct throughout his long career, was totally at variance with such a proceeding, and it was always his greatest pleasure to recognise and bring forward merit in every case, and to give the inventor the full benefit of his inventions. I trust, therefore, that I have clearly established my proposition—that Mr. Rennie designed and built the Bell Rock Lighthouse. In saying this much, I should be extremely sorry to detract in the smallest degree from the highly-meritorious exertions of Mr. Stevenson, for the important part he took in forwarding the undertaking, from the year 1794 to 1805, and for the subsequent part which he performed as assistant-engineer in carrying the work into effect under the late Mr. Rennie; and I am quite ready to admit that very great credit is due to Mr. Stevenson for the energy, skill, and indefatigable perseverance he displayed in the above capacity, and which contributed materially to the success of this great work. The labours of those valuable sub-officers, Mr. Peter and David Logan and Francis Watts, were of the greatest service; and Mr. David Logan subsequently distinguished himself as resident engineer at Dundee, Donhagadee, Port Patrick, Whitehaven, Port Rush, &c., and finally closed his valuable career as engineer to the Trustees of the River Clyde; and I cannot close this letter without adding, that the greatest credit is due to the Commissioners of the Northern Lighthouses, and their secretary, Mr. Cuningham, for the public spirit, energy, and ability with which they brought forward, and carried out to a successful conclusion, this important maritime work, which has conferred such invaluable benefits upon the shipping interest and commercial world.

I am,

Your humble servant,

London, February 8th, 1849. JOHN RENNIE.

P.S. Mr. Alan Stevenson complains, in a postscript to his printed letter, of my want of courtesy in not replying to him.—The fact is, I was absent on the continent, and did not receive his letter until I returned some time after. I then immediately wrote to him, apologising that absence had unavoidably prevented me from replying to his letter before.

REGISTER OF NEW PATENTS.

COMPASSES, BAROMETERS, &c.

DAVID NAPIER and JAMES MURDOCH NAPIER, of York-road, Lambeth, engineers, for "*improvements in mariners' compasses; also in barometers, and in certain other measuring instruments.*"—Granted July 20, 1848; Enrolled January 20, 1849. [Reported in the *Mechanics' Magazine.*]

The improvements sought to be secured under this patent, relate—1st, to mariners' compasses; 2nd, to barometers; 3rd, to tachometers, or instruments for ascertaining the speed of vessels through water, or the velocity of currents of water; and 4th, to weigh-bridges or platform weighing-machines.

1. *The compass-box* is gimballed, as usual, and contains the compass card, which is bound by a brass hoop, to which grip-pieces are soldered. Above, and resting upon the needles, is a thin disc of "talc-brass," to which is fastened a disc of cotton or velvet, or other soft substance. A printed or ruled piece of paper, containing twenty-four concentric circles, and a number of radiating lines corresponding with the points or parts of points in a compass-card, is temporarily held in the grips above the talc-brass and soft substance. Underneath the compass-card there are three branches fixed to a loose collar on the spindle of the point, so that they may be slid up and down to serve as abutments or supports to the card. A lever is connected at one extremity with a vibrating frame, and carries at the other a vertical pricker, which is made to travel over the surface of the paper from the inner concentric circle to the outer one, and in a line parallel with the keel of the vessel, once in twenty-four hours. The lever is made to rise and fall, and consequently the pricker to puncture the paper at certain regular intervals of time, and the branches to rise up and support the card each time the puncture is effected. By this arrangement, the direction of the ship's course will be indicated by the punctures on the radiating lines, and the time by those upon the concentric circles. The lever, together with its pricker, and the branches, are actuated by ordinary clock-work machinery, which is carried in the bottom of the compass-box, by means of a peculiar combination of toothed gear and levers. The printed paper is, of course, changed every twenty-four hours.

2. *The improved barometer* is constructed with a vertical spindle which carries a card, having on its surface a number of concentric circles which represent portions of time, and radiating lines which represent fractions of inches. Above the card is a lever carrying a vertical pricker, which is made to rise and fall at certain regular intervals of time, and to travel from the inner concentric circle to the outer one once in twenty-four hours. On the vertical spindle, and underneath the card, is fastened a grooved wheel, round which is passed a cord. A counter-balance weight is attached to one end of the cord, while the other one is made fast to a float resting upon a column of mercury in a tube. The card has a fixed point representing 29·5 inches, which, at commencement, is placed underneath the pricker. As the column of mercury falls or rises the printed card will travel to the right or to the left accordingly, and its variations of height be indicated by the distance of the punctured lines from the starting point, on either side.

3. *The improved tachometer*, or apparatus for measuring the speed of vessels through the water, and the velocity of a current of water, consists of a horizontal spindle moving freely on pivots attached to the side of the vessel beneath the water-line, and inclosed in a case open at both ends. The spindle is fitted with vanes, the pitch of which is regulated so that ten revolutions of the vane-spindle shall equal one fathom. The vane-spindle carries a tangent-screw, which gears into a toothed wheel keyed on the end of a shaft which passes into the interior of the vessel, whereby the number of nautical miles is marked in units, &c. up to 10,000, on ordinary indicating dials through the medium of trains, such as are used in gas-meters, with the addition of four spring barrels, whose especial office it is to work the indicating dials and trains, and diminish the friction of the different parts so as to relieve the vane-spindle from this duty, whereby the speed of the vessel, or velocity of the current, will be more correctly indicated and registered. The spring barrels have no effect of themselves upon the dials and gearing, but appear to facilitate the action of the vane-spindle thereon. We say "appear," for we observe with regret that the relative connection of these barrels with the rest of the apparatus are anything but clearly and distinctly described, although they constitute the novelty of this portion of the invention, and form the subject of a separate claim.

4. The *platform* of the improved *weigh-bridge* is supported upon a horizontal cross-bar attached to the lower end of a vertical-bar, which is made fast at top to the end of a horizontal lever, whereby the platform is supported on a centre. The weight to balance the platform, with the goods thereon, is hung upon this horizontal lever, which carries a short upright, attached to a shorter horizontal lever, which is placed above and parallel to the first. The other end of the short lever is pivoted loosely to a standard of the frame, and has above it a coiled spring. From the top end of the short upright is a chain, which passes over a pulley, suspended between friction-rollers, and terminating in a weight that balances the connecting pieces. This pulley is keyed on a rod, to the end of which is a pointer, whereby the weight of goods on the platform is indicated on a dial; while, at the same time, a paper is made to travel underneath a pencil, so that the weight is also at the same time registered.

Claims.—1. The combination of suitable apparatus with a maintaining power, so as to produce a self-acting means of registering the direction of the head of the vessel, as indicated by the magnetic needle.

2. The method of registering upon a circular disc by a travelling point or pencil, as applied to barometers, and described.

3. The combination of a supplementary or auxiliary power, with apparatus for indicating and registering the speed of a vessel through the water, and the velocity of currents of water.

4. The measuring and registering of weight by a weigh-bridge or platform machine, having attached thereto apparatus such as described.

THE ELECTRIC LIGHT.

Chevalier Alexandre Edouard Le Molt, of Conduit-street, Regent-street, Middlesex, for "*improvements in apparatus for lighting by electricity; parts of which may be made use of in other applications of electricity.*"—Granted July 20, 1848; Enrolled January 20, 1849. [Reported in *Newton's London Journal.*]

The first part of this invention relates to certain improvements in the manufacture of piles or batteries, for evolving electric currents, to be applied to the production of light and other uses.

One of such improvements consists in the application of the carbon which is found in the retorts used in the manufacture of coal-gas as one of the elements of an electric pile. The carbon, as it comes from the retorts, simply requires to be cut to the required shape: the patentee prefers to use it in rectangular plates or blocks; but it may be cut into other forms. *a*, (fig. 1), is a plate or block of carbon, connected with a cylinder of amalgamated zinc *b*, by means of a strip of metal *c*, which is soldered or rivetted at one end to the cylinder *b*, and at the other end is soldered to the upper extremity of the carbon: the upper end of the carbon is coated with copper or other metal, for this purpose, by the electrotype process; and this constitutes another of the improvements. A further improvement consists in coating the cylinder of amalgamated zinc on one side (the outer side in the present arrangement) with a varnish or other suitable matter, which will prevent the liquid used from acting on the zinc on the protected side: such side having no relative influence whatever with the carbon element would otherwise be uselessly exposed to the destructive action of the acid. The patentee prefers to use copal varnish as the protecting material; and he gives a body to the same, by grinding finely-powdered retort carbon therewith. The connecting strip of metal, and the electrotyped end of the carbon element, are also to be coated with the varnish. A battery, constructed according to this invention, is shown in fig. 2, where *d*, *d*, are two stoneware jars, each containing a porous jar *e*, which receives the carbon element *a*, of the pile, and is surrounded by the cylinder of amalgamated zinc *b*; into the jars *e*, nitric acid is introduced; and in the jars *d*, a solution of sulphuric acid, composed of one part of acid to seven parts of water, is used. When the apparatus is intended to be carried about, the patentee prefers to make the jars *d*, with a flange or rim at the top, as shown in figs. 3, and 4, to prevent the liquid from splashing.

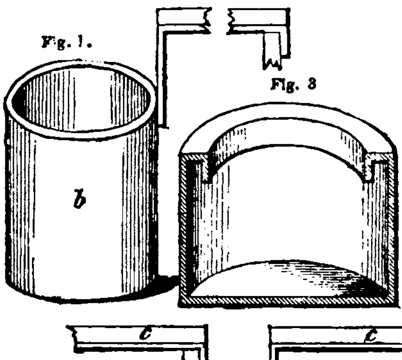


Fig. 1.

Fig. 3

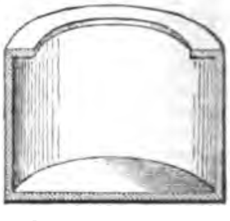


Fig. 4.

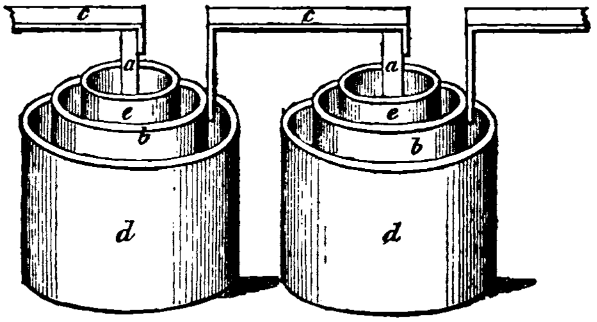


Fig. 2.

Another improvement, described under this head of the invention, consists in making carbon elements for electric piles by causing the carbon to be moulded and then subjected to great pressure, by means of hydraulic or other suitable presses, in order to obtain the carbon as dense and compact as possible. The patentee prefers to use one part of powdered coal, coke, or charcoal, three parts of carbon from gas-retorts, and one part of tar; these materials are to be well mixed, moulded, and subjected to pressure; then dried, by exposure to the action of the atmosphere, in the shade, for a few days; and, when dry, the mixture is to be subjected to heat in a nearly-closed retort for thirty-six hours,—the heat being applied gradually till it arrives at a bright red heat, and then to be allowed to cool down gradually: the carbon is then ready for use.

The second part of this invention relates to the apparatus for producing light by electricity; and it consists in using discs of carbon as electrodes, in such manner that, by revolving near each other in the same plane or in planes at an angle to each other, they shall constantly present fresh surfaces, and, when they have made a revolution, they shall be caused to approach each other, so as to maintain a constant and proper relation to each other for the production of a continuous light.

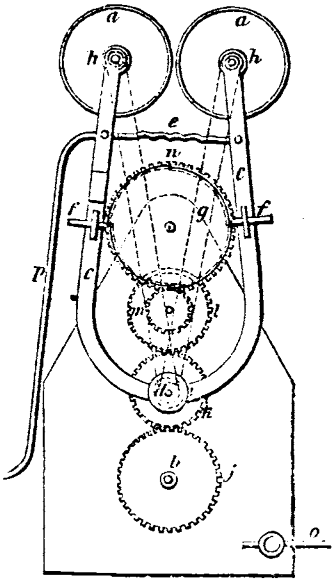


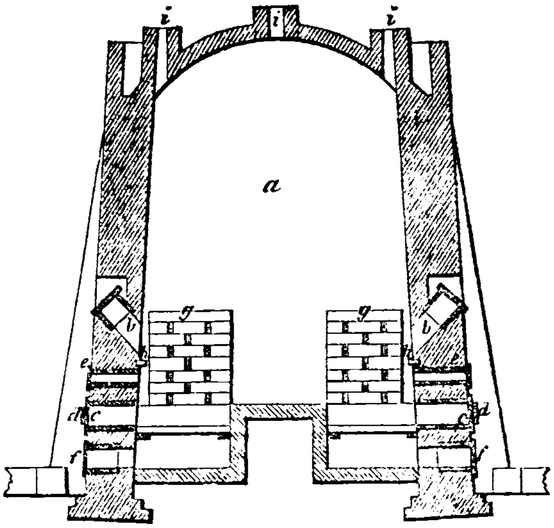
Fig. 5.

Fig. 5 is an elevation of the apparatus employed in carrying out this part of the invention. *a*, *a*, are two electrodes of gas-retort carbon, which are first cut into the form of discs, and then purified by immersion in a solution of nitric and muriatic acid for twelve hours, and afterwards in a solution of fluoric acid for twelve hours. A slow uniform motion may be communicated to the discs by any suitable mechanism; but the patentee prefers to employ that shown in fig. 5, wherein the motion is derived from suitable clock-work, the axis *b*, of which only is shown. The two discs turn on pivots or axes at the upper ends of the arms *c*, *c*; these arms are mounted, at their lower ends, upon an axis *d*, so as to move freely thereon; and the upper ends of the arms are continually drawn towards each other by a spring *e*, but are prevented from approaching too closely by the pieces *f*, *f*, which bear against the periphery of the eccentric or step-wheel *g*. The two discs are caused to rotate by means of two endless chains or bands, passing around the pulleys *h*, *h*, on the axes of the discs, and around a pulley *i*, fixed to a toothed-wheel *k*, which gears into another toothed-wheel *j*, on the axis *b*. Rotary motion is also given to the eccentric or step-wheel *g*, by means of the train of wheels *j*, *k*, *l*, *m*, *n*; so that, when the discs have made a complete revolution, the wheel *g*, may present a deeper step or depression to each of the pieces *f*, *f*, and thus permit the arms *c*, *c*, to approach nearer to each other, in order to compensate for the wear of the two electrodes. *o*, *p*, are the wires connected with the battery. The part marked with a * is made of some non-conducting material; and the other parts are made of metal. It is not essential that the two electrodes should rotate in the same plane, as they may rotate in planes at right angles to each other. The patentee states that he does not confine himself to the use of two discs, as a single disc may be employed with another form of electrode.

The patentee claims—Firstly, the application of that description or quality of carbon obtained by the destructive distillation of coal and other matters, such as are used in the manufacture of gas, as one of the elements of an electric pile; also the employment of carbon moulded and subjected to pressure and manufactured as above described; also the electrotyping the ends of carbon used as elements in electric-piles; also the connecting of carbon elements of an electric pile with other elements used, by soldering, or by other permanent fixture. Secondly, the so applying two discs of carbon as electrodes that they shall (when they have completed a revolution) be caused by the mechanism to approach to each other, and thus obtain a continuous light by electricity.

BRICK AND TILE KILN.

William Swaine, of Pembridge, Hereford, brick-maker, for "*improvements in kilns for burning bricks, tiles, and other earthen substances.*"—Granted July 18, 1848; Enrolled January 18, 1849.



The improvement relates to the construction of a kiln, as shown in the annexed engraving, which is a transverse section. *a*, is the kiln; *b*, the feeding-places, kept closed excepting when fuel is introduced; *c*, furnace-doors, formed with an opening for the introduction of a rake, to rake the fire without opening the doors, the opening is closed at other times by a small door *d*; *e*, air-pipes; *f*, ash-pit doors; *g*, fire-boxes, built of fire-bricks, with holes between the bricks, similar to those heretofore used in some kilns; *h*, brick ledges, for throwing off the coals as they pass through the feeding-pipes; and *i*, chimneys, of which there are nine. The doors must be made to fit closely, in order that the passage of air into the fire-places and kiln may be partially or entirely stopped, so that the fires may be regulated with great nicety, and, when necessary, may prevent combustion, by stopping the supply of air.

SHIPS AND PADDLE-WHEELS.

James Taylor, of Furnival's-inn, gentleman, for "*improvements in propelling ships and other vessels.*"—Granted December 2, 1848; Enrolled January 27, 1849. [Reported in the *Patent Journal.*]

The specification describes, in addition to a mode of propelling vessels, a form of construction of vessels generally; the first part of the specification describing the mode of forming the mould or model of the vessel; the second, the construction of a paddle or propelling wheel; and the third, the constructing the parts of the vessel for the reception of this paddle-wheel. The patentee gives rather a vague rule for the moulds or models of ships and vessels. He proposes to form the 'midship section of the vessel of an ellipse, the longest diameter being the horizontal one, and the shortest the vertical. As the cross sections approach the stem and stern posts, the horizontal diameters become gradually less, while the vertical diameter remains the same until a certain point between the 'midship section and the stem or stern, where the horizontal diameter becomes equal to the vertical; or, in other words, the cross section of the vessel is a circle; from this point to the stem or stern posts, the order of the ellipses forming the cross sections are reversed—that is, the vertical diameter remains precisely the same as before, but is now the longest, and the horizontal diameter the shorter, and gradually becoming less as it approaches the stem and stern posts, to whose shape it at last resolves itself; thus, the patentee states that either obtuse or acute forms of vessels may be constructed, the degrees of acuteness depending upon the proportion the longest diameter of the ellipse at the 'midship section bears to the extreme length of the vessel; the vessel thus constructed, is provided with a keel, the sides of which are concave, so as to agree in contour with the convex form of the hull of the vessel, and is to give the necessary strength as well as to prevent lee-way. The patentee proposes, in the case of sea-going ships and vessels exposed to tempestuous weather, to continue the elliptic form of the vessel above the water-line, and entirely over the deck; but for vessels intended only for the navigation of rivers and smooth waters, then the upper parts of the vessel may be of any shape, but strictly following the rules laid down by him with respect to the hull below the water-line.

The second part consists of a paddle-wheel; this wheel is formed of a large sheet-iron cylinder, upon the sides of which are secured two extending flanges of larger diameter than the cylinder. Between these flanges and the periphery of the cylinder are secured the flats, which are of a curved shape; the depth of the curve being equal to the draught of water of the boat.

The last part of the specification merely describes the means which the patentee proposes to adopt for applying the paddle-wheels to vessels. He proposes in river-going boats to place a single wheel in the middle, an aperture or case being there made for the reception of the same; and from it a trough or way to the stern of the vessel is formed. In sea-going vessels, he proposes to apply two wheels, one placed on each side of the keel, also in a case or aperture. He also proposes to cover this case or aperture with a cap or covering, which is to be secured air and water tight; but it is to be provided with a valve, so situated that when the wash of the sea shall rise in the wheel-case, and expel part of the air therefrom, upon its receding the air shall enter through the valves from the outside. The patentee gives several rules or proportions for making the wheel-case and trough.

He claims generally: First, the mode of forming ships and vessels of the elliptical cross-sections, as described.

Secondly, the construction of the paddle-wheel, as described.

Thirdly, the manner of arranging and applying the paddle-wheel to ships and vessels, as before described.

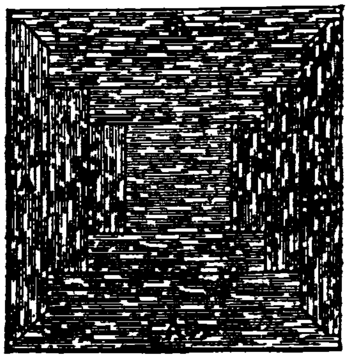
MANUFACTURE OF IRON.

Samuel Lees, of the firm of **Hannah Lees and Sons**, of Park-road, Lancaster, iron manufacturers, for "*certain improvements in the manufacture of malleable iron.*"—Granted August 8, 1848; Enrolled February 8, 1849. [Reported in the *Patent Journal.*]

The improvements described in this specification relate to the manufacture of malleable iron—first, as to the mode of arranging and forming the piles and faggots, and second, the construction of the machinery to be employed in rolling and manufacturing such piles or faggots into bars, rods, &c.

The first of the improvements consists in placing the plates or bars of iron of which the pile is to be formed, in such manner that the grain of the iron of the several pieces shall be in different relative positions to each other. In the ordinary mode of forming the piles, the flat bars of iron which compose them are merely placed in regular order one upon the other until the required thickness is obtained; the width of the bars being equal to the width of the pile. This mode of piling, when rolled out into bars, rails, &c., presents an exterior surface, upon which the junctions of the bars appear, and thus render them very liable to laminate; as also the strength of the article manufactured is irregular in consequence of the lamilar direction of the grain. This is particularly the case in railway bars, where, by the action of the heavy weights rolling over them, the upper surface is laminated; as also the middle vertical web of the rail is comparatively weak from the cross direction of the grain of the iron. The patentee piles his faggots in the following manner—a cross section of one being shown in the annexed cut. The sides of the pile are formed of plates, or flat bars, A, A, dovetailed at the edges, in the manner shown; or if found more convenient, they may have their edges merely overlapping each other. These plates, when placed together, form the exterior of the shell of the pile, and it will be seen that they present exteriorly their sides; thus the grain of the iron is in a better position. The middle portion is to be filled up by other plates or flat bars, either in the manner shown, or by dovetailing the edges, but in both cases so arranging them that their sides, and consequently the grain of the metal, are in different positions.

The patentee also forms piles in which the exterior shell or case is formed in the manner described, but the interior is filled with plates or flat bars piled or placed in the ordinary manner. He likewise describes and illustrates in the drawings accompanying the specification, a mode of forming the pile from which hollow shafts are to be made. This is formed in nearly the same manner as the preceding, differing only in the employment of two peculiar shaped bars, for the centre of the pile, which when placed together form the hollow or cavity required. For the manufacture of grooved or fluted rollers, such as is used in several of the processes in the cotton manufacture, the patentee describes a mode of proceeding. The shell or case of the pile is to be made of the four plates or bars, as before described, and the interior to be filled up with the best strap iron, and then manufactured up in the usual manner. The patentee states the kinds of iron he proposes to manufacture from piles thus formed and arranged,—as angle-iron, tee-iron, bar-iron, railway-bars, fluted or grooved rollers, shafts piston and pump rods, &c.



The second of the improvements described is that relating to the machinery to be employed for the manufacturing and rolling the piles, formed as above described. This part of the specification is subdivided in two parts. First, the construction of the rollers to be used in rolling the plates or flat bars into the shape desired to form the piles; as also the application to the rollers of a bar or mould, for the purpose of preserving the form of the groove or recess previously formed while passing between the rollers upon its edge. This bar or mould is fixed to the framing of the rollers, and thus allows the grooved bar to slide over it whilst being drawn between the rollers; the bars being successively passed between them until of the proper size.

Thirdly, another of the improvements named in the specification is the employment of two distinct sets of rollers, for rolling the bars, &c., placed side by side, and which are to be driven in opposite directions; so that the bars, after passing through between one set of them, is returned through between the rollers of the other set to its original place before the first set of rollers are ready to be again passed between them,—thus obviating the necessity of returning the bar over the upper roller to its former place in front of them, as is usually the case, thus saving time and facilitating the operation.

The fourth improvement is the mode of supporting the bars of iron as they are passed between the rollers by a carriage over head, and to which a traversing movement is given, for the purpose of bringing the bar of iron before the grooves in the rollers in their proper order; there is also communicated to the carriage a traversing motion for the purpose of bringing it back.

The fifth part describes a mode of straightening bars of iron after having been rolled. This the patentee proposes to do simply by means of their contraction during cooling. The bar to be straightened is taken, while still hot, and placed upon a flat iron plate or bed, to which, by clamps or other convenient means, the ends of the bar are firmly secured; the contraction upon cooling being sufficient to straighten the bar.

The patentee claims: First, the mode of forming the outside of a pile, or faggot of iron, by placing plates or flat bars of iron together at right angles to each other, the edges or corners of them being dovetailed or overlapped, the interior being filled either with scrap iron or with iron plates, whether arranged one upon another or at right angles to each other.

Second, the use and employment of the bar, or mould, attached to rolling mills, for preserving the form and shape of the groove or indentation upon the bar under operation, whilst it is being passed between the rollers upon its edges.

Third, the method described of driving the rollers in opposite directions.

Fourth, the mode described of actuating, and also reversing the movements of the carriage for holding the bars.

Lastly, the mode described of straightening bars of iron, by confining and holding them at their extremities while in a heated state, and by their contraction in cooling assuming a straight line.

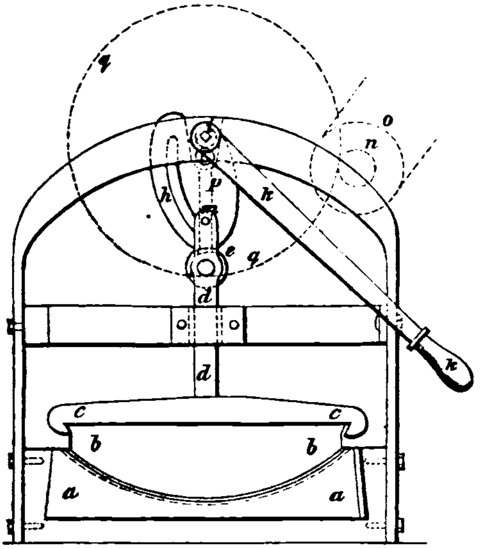
MACHINE FOR BENDING IRON PLATES.

Thomas Burdett Turton, of Sheffield, steel manufacturer, for "*improvements in machinery for bending and fitting plates or bars of steel, iron, and other materials, to be used for locomotive engine and carriage springs, and other purposes.*"—Granted June 1; Enrolled December 1, 1848.

The first part of this patent relates to a machine for bending plates or bars of metal by means of three rollers placed vertically, to be driven by steam or other power, and is for the purpose of superseding in a great measure the manual labour now employed for bending or fitting carriage springs.

The second part of the invention relates to another machine for the same purpose; of which fig. 1 is a front elevation, fig. 2 a transverse section, and fig. 3 a plan view, partly in section, of such a machine.

Fig. 1.



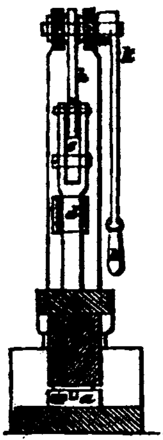


Fig. 2.

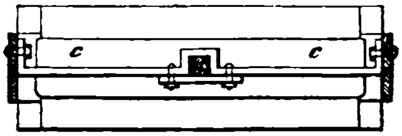


Fig. 3.

In this machine the process of bending and fitting is performed by suitably shaped blocks, the lower one *a*, remains stationary when the machine is being used, and the upper one *b*, is lifted up to allow the bar which has been bent to be removed, and an unbent bar to be put in its place; the upper block is attached to a plate *c*, to which is secured the guide-rod *d*. Near the upper extremity of the rod *d*, is the antifriction-roller *e*, against which the cam *h* works when the top block is being pressed down upon the plate or bar to be bent. The cam *h* is fixed on a shaft *i*, and is provided with a segmental slot, through which and through a fork made at the top of the guide-rod *d*, a pin or bolt *m* is passed; to the strap *i* is also fixed a long lever *k*, by means of which the machine is worked. When the attendant elevates this lever, the upper block is raised by means of the bolt or pin *m*, above described, and when the bent plate has been removed, and another plate substituted between the blocks, the attendant, by pressing down the lever *k*, causes the cam *h* to bear upon the antifriction-roller *e*; and by this means the top block is depressed, so as to give the proper curve to the plate or bar between the blocks. If it should be found more convenient to work this machine by steam or other power, instead of by the lever *k*, and its adjuncts, a wheel *q*, represented by a dotted line in fig. 1, should be keyed on the shaft *i*. This wheel would be driven by the pinion *n*, fixed on the same shaft as a pair of fast and loose pulleys*o*, the cam *h* would have to be replaced by a crank, to which the upper end of the connecting-rod *p* would be attached, and the lower end of the connecting-rod would be attached to the guide-rod *d*. It will be evident that by changing the blocks *a*, and *b*, any variety of curve may be given to the plates or bars under operation. It is necessary to remark that the block *a* is provided with a groove to admit the nibs of the spring-plates, as seen in figs. 1, and 2.

The construction of the framing for supporting and guiding the various parts of this machine does not require to be particularly referred to, being well understood by any competent workman.

HYDRANT OR FIRE-COCK.

An improved Hydrant or Slide-Valve, for Water-Pipes, Fire-Hose, &c. Registered for Messrs. **George Forrester** and Co., of Vauxhall Foundry, Liverpool, Dec. 29th, 1848.

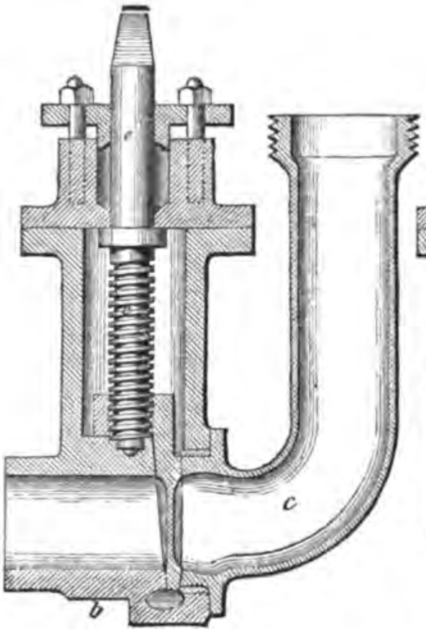


Fig. 1.

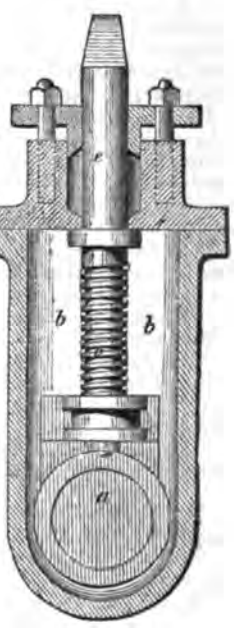


Fig. 2.

Fig. 1 is a longitudinal section, and fig. 2 a transverse section of the hydrant. The improvement is in making the branch *c* project so far through the body of the valve *b*, as to form its own face for the valve *a* to shut against. The projecting end of the branch *c*, is truly faced in the lathe. In the engraving, the branch is shown with a bend, but it may be made of any suitable form. The valve is opened by a handle on the screw, *e*.

CAST AND WROUGHT IRON BRIDGES.

Sir—Having read in the January number of your *Journal* the remarks taken from a paper read at the Royal Scottish Society of Arts, by its President, George Buchanan, Esq., F.R.S.E., on the "*Strength of Materials as applicable to Cast and Wrought Iron Bridges*," I beg leave to send you the following communication, which being confirmatory of some of the views brought forward therein, will, I trust, be deemed worthy of insertion.

The formation of beams of a compound nature, so as to insure a proper combination of the distinct qualities of cast and wrought iron, by subjecting the one to compressive strains only, and the other to those only of tension, is a subject worthy of much practical investigation; and in which economy of construction, safety, and durability, are particularly involved.

The principle which governs the construction of the beams alluded to by Mr. Buchanan is indeed a modification of the old and simple principle of the roof, where two rafters meet and abut at the top, and are tied together at the feet by a longitudinal beam; but it also exhibits a modification of the common king and queen post truss—a combination that cannot fail, if rightly carried out, to ensure great rigidity; for taking a pair of the main-braces, with their adjacent counter-brace, and the vertical tie, we have a complete king-post truss; and if all the braces be removed for a couple of spaces, we then have a queen-post, with the top cord acting as a straining-beam for this distance, and resisting, unaided, the compression to which it is subjected by a passing load. As proof of this fact, I have frequently had adjacent main and counter-braces removed for the purpose of repairs during the regular transitu of trains.

The term Lattice is therefore incorrectly applied to these bridges; and in America, where the two are quite distinct structures, the lattice has fallen into disrepute among railway engineers, having generally failed, and exhibited a want of rigidity—a natural result where the parts are not abutted but placed side by side, and fastened with pins passing through the very heart of the material itself, on which, as so many pivot points, there is a constant working of the whole structure, which splits the material, and produces fracture and sinking, unless, as in the extensive lattice bridges now in use in America, the whole fabric be timely supported by heavy queen-post trusses inside, and bolted to the lattice beams, or by timber arches, which really do the whole duty. But the strain on a lattice bridge is felt as in all other common rectangular beams; and it fails, therefore, in the centre of the span invariably, there being no strut or brace, with properly abutting surfaces, to relieve the weak part, and carry back the strain to the legitimate points of support—viz., the abutments.

Now, in truss beams of the former construction the strain communicated by a load is at once taken up and distributed by the forces which act only in the *direction of the grain* of the material employed,—the weight felt by the vertical ties in a tensile strain acting on the braces in compression, these communicating it in tension to the bottom chord, and in compression to the top chord; thus getting rid of all direct transverse strain, and affording one of the greatest elements of strength, which is materially assisted by the fact that the heavy weight of all surplus material is dispensed with.

Having for some years given this subject a good deal of time and consideration, and had the benefit of experience in the erection of many of these structures, I have observed—1st, that a tensile strain is not confined to the bottom chord, but that the top chords immediately over the points of support on the abutments are subjected to a considerable degree of tension. 2ndly, that in case of any tendency to failure of the bottom chords, vertical ties, or braces, such invariably takes place at about $\frac{1}{5}$ of the span from the abutments; and that it is therefore advisable to increase the sectional areas of all these parts for some distance from each abutment. Indeed, in spans of any great length, the sectional areas should be as large as possible at the points of support, and gradually decrease towards the centre of the bridge; and 3dly, that a due proportioned height of truss on the abutments is requisite to ensure the stability of the structure.

There are two chief points only to be determined by the engineer before erecting a bridge of this kind, which, if correctly obtained, will enable him to carry it to any extent known—viz., the sectional areas of the parts, and the height of truss due to the required span which must control the proportions adopted.

After explaining the principle of certain timber bridges in North America, Mr. Buchanan suggests the adaptation of this principle to *iron*, for the purpose of forming extremely simple and strong beams, by making the bottom chords of malleable iron and the braces and counter-braces of cast-iron in the form of hollow square tubes.

The perishable character of timber, and the difficulty which has been always experienced by its inability to withstand the great tensile strain to which the bottom chords are necessarily subjected, engaged the attention of the subscriber some years ago, as affording an opportunity for the adaptation of the principle to iron exclusively; and it is gratifying to him to find that the views which have controlled his efforts in the work, so closely correspond with the opinions of such high authorities as Professor Forbes and Mr. Buchanan.

In the year 1844, after sundry experiments for the purpose of ascertaining the proportions of the various parts, and for adapting those parts to iron, the subscriber built the first iron bridge on this principle for railway travel in the United States of America, and in 1845 introduced it into this country; since which he has constructed about a dozen iron bridges, varying in span from 30 to 90 feet, in the latter of which, it is not a little curious, Mr. Buchanan's suggestion of hollow, square, cast-iron braces has been actually anticipated, by which strength and lightness of material is certainly affected.

The advantages derived by this adaptation are—

1st, Economy combined with rigidity.

2ndly, Simplicity and facility of construction and erection.

3rdly, The great ease with which any camber can be given, and a certainty of its being permanently retained.

On the first of these points, it will suffice to give a brief statement of the cost of two of the bridges just alluded to. They have been in use for upwards of two years, and were built under the disadvantages of having inexperienced workmen, and without the aid of any machinery whatever.

Length of beam 98 feet.

	£	s.	d.
Cast-iron, 56 tons, at 12*l*.	672	0	0
Wrought-iron, 37 tons 1 cwt. 3 qr. 3 lb. at 14*l*.	519	4	10
Workmanship and erecting	270	10	6
Total	£1461	15	4

equal to almost 15*l*. per running foot of bridge, which is higher than any of the others, being unnecessarily heavy, particularly in the item of cast-iron, although it has the hollow traces suggested. It is on a skew of 24½°.

The next statement exhibits the cost of a beam 71 feet long, across an opening of 50 ft. 10 in. in the clear.

	£	s.	d.
Cast-iron, 16 tons, at 12*l*. per ton	192	0	0
Wrought-iron, 13 tons, at 14*l*. per ton ...	182	0	0
Workmanship and erecting	103	10	0
Total	£477	10	0

equal to about 6*l*. 15*s*. per lineal foot of bridge, which will give a better idea of economy.

About a year ago, one of these bridges was severely tested by the breaking down of a ballast-train on it; and though several of the axles were broken, and five of tho wagons were heaped in perfect wreck upon the structure, tearing up the floor, breaking out four of the adjacent braces of one of the outer beams, and fracturing others, it was found after the wreck was removed, that the bridge had not yielded in the least, either vertically or laterally,—and was subsequently repaired, at a cost of 36*l*.

Simplicity of construction, which naturally produces economy, as the second point, presents itself for consideration.

The braces on being furnished from the foundry, are put under the plane or vertical chisel, to bring them to an exact uniform length by taking off a mere shaving and leaving the abutting ends square: the remainder of the cast-iron requires only a careful cleaning. Thus, with very little workmanship, near two-thirds of the material is ready for use.

In ordinary spans, the chords may be composed of plates of Welsh iron, welded into one continuous piece (where careful smiths can be procured); or they may be left in convenient lengths, and fastened at the joints by suitable scarfs and bands or rivets. The chords are then clamped together, placed on edge, and the recesses for the blocks cut out in the rough, and afterwards dressed up with the file; the blocks are then fitted, and they are ready for erection. In addition to the wrought-iron plates which compose the top chord, there is usually a cast-iron cap which covers it, formed with flanges on the under surface, which fill up the spaces between the wrought-iron plates. The whole being clamped together, forms a beam more or less solid in proportion to the compression it is calculated to resist; while the wrought-iron in the top chord resists any tensile strain to which it may be subjected over the points of support, as before referred to. These cast-iron caps are made in convenient lengths, and require no workmanship but fitting on during the erection of the bridge.

The vertical tie-rods are of cable iron if the span is large, and are made without a weld, having the heads and nuts uniform.

All the respective parts of these structures are uniform, and any previous fitting together is unnecessary; indeed, they may be made in different establishments, brought to the abutments, and put together at once for the first time.

From the position of the abutting surfaces, the beam, on screwing up the vertical ties, adjusts itself in line and camber, and no force will prevent its assuming the required form with truth. The sectional areas are left whole and available, there being not a pin or bolt through any of the parts.

The portions of the structure liable to injury from accidents can be repaired without deranging the whole, or rendering it unfit for constant use.

The third point is the facility of cambering, which is peculiar to this structure. In ordinary horizontal beams, about four inches in the 100 feet has been adopted; but *less* can with a great degree of *nicety* be given, and if carried to even a semicircle involves *no additional expense whatever* in framing or general construction,—the uniformity of the parts being preserved as in the ordinary straight beam. It would appear that so small a camber as four inches, in a structure composed of a number of parts, would soon exhibit irregularities in its curve; but under the heaviest traffic this camber is truly retained, and indeed must remain while the ties are able to keep the abutting surfaces of the parts in close contact.

The is one point in the remarks contained in your *Journal* on this subject, which my experience in these structures would seem to indicate as somewhat erroneous; for while aware of the loss of material in rectangular beams generally at the extremities, so far as they depart from the arch,—particularly in cast-iron beams, where the transverse strain acts on the centre, and a depth of material and large sectional area is indispensable. There being *no transverse action* on these beams, and the centre not being therefore so liable to give way as those parts nearer the abutments, owing to the increased leverage acting on those parts, I conceive (although admitting the correctness of arching the top chord if practicable) that the height of truss at and near the abutments is requisite to the stability of the beam, and in the case of a very long span, that rigidity would be gained by making the bottom chord in the form of an arch, even if obliged to keep the top chord horizontal; thus decreasing the height of truss at the centre of the span, say one-half, and consequently its own weight, and gradually increasing in weight and proportions towards the extremities,—which is the natural form of a lever supported at one end and left to sustain itself.

It is evident to my mind, from models and some experiments (although open to conviction), that a structure of the kind described, suitably proportioned, might be built for a considerable distance from each face of a supporting pier, without the aid of temporary scaffolding; and I would be willing to undertake to build a bridge involving this principle, on tidal waters or rivers, to swing upon a centre pier as a pivot, and allow a water-way on each side of 70 or 80 feet, the extremities of which should only be supported when brought in line with the two abutments, to accommodate the passage of trains.

There is another bridge which may be termed a modification of the foregoing general principle, several of which have been also erected in this country, and are worthy of notice. My remarks have, however, already gone much beyond my intention,—and asking for them a place in the next number of your valuable *Journal*,

I am, Sir,
Yours obediently,
Perry-square, Limerick. RICHARD B. OSBORNE, C.E.
Feb. 21st, 1849.

GOVERNMENT SHIP BUILDING.

When, in his brilliantly-written "*Organization du Travail*," M. Louis Blanc propounded his scheme for making government the comptroller-general of national industry, he little thought that the Destiny of Empires would shortly thrust into his hands the means of realising his political theories. Suddenly, however, national work-shops and all their external machinery was created at his command, and one thing alone was wanted for perfect success—a supply of national *workers*: for the inhabitants of his palaces of make-believe industry no more deserved the name than do state pensioners generally.

There is a propensity common to our nature, which, though not formally stated in ethical works, is universal among mankind —that we all work best *by the piece*. When a man's industry is rewarded in direct proportion to its results, and not according to a fixed rate, pre-arranged as a probable equivalent for his labours, his exertions receive a stimulus which the most exalted sense of duty and honour cannot afford. Had M. Louis Blanc's pensioners been what he supposed them to be, all brothers, even then his splendid scheme of universal fraternity could have been only partially realised. The will to work for the general maintenance might have existed, but the requisite power and energy would still have been lacking. Poor human nature requires constant encouragement and stimulus to animate its exertion; and this is true of all men—prince, philosopher, and peasant,—that *no man ever worked long and worked hard for the sake of an abstract idea.*

This is the fatal and irremediable error of all government manufactories; and in England, the public dockyards are the most gigantic exhibitions of its results. From the first Lords of the Admiralty to the meanest ship-carpenter, not one of the whole corps of national ship-builders has a direct interest in producing the best possible ship at the cheapest possible rate. The consequences are worse—no, not worse, but just as bad as might be expected. Of all maritime nations, England possesses the worst ships, produced at the dearest rate. The excuse for this result is, that the excessive difficulty of ascertaining the proper form and dimensions of a ship, and of predicting its sailing qualities, are so great, that occasional errors in the calculation are unavoidable. We wish to show that this position is untenable,—that the errors do not arise from the complexity of the problem, but from the manner in which it is worked out. Our purpose is to demonstrate that the error is not confined to ship-building, but unavoidably attaches to all government manufacturing. We believe, for example, that if pins were a government monopoly, their market price would be a shilling a dozen: nor have we the least doubt that if under such circumstances a parliamentary enquiry were instituted, the result would be a respectable blue-book demonstrating by irrefragible reasoning and the highest official testimony that it would be as impossible to alter the laws of nature as to produce pins at a cheaper rate.

The sailing qualities of a ship are of two distinct kinds—those relating to her motion, and those relating to her stability. The former constitute a difficult mechanical problem, the latter a very simple and easy one. The former refer to the unknown resistance of fluids, the force of wind, the hydro-dynamical question of the pressure of waves, and the results of the combined effect of these on a curvilinear body. But the latter is simply a hydrostatic problem, which may be solved with perfect certainty and readiness. Were science no more advanced than it was in the days of Archimedes, we might still predict with absolute precision whether a vessel of given dimensions were capable of sustaining the weight of her guns without suffering too great an immersion. And in like manner the transverse and longitudinal section of the ship, and the weight of its several parts, would supply sufficient data for ascertaining whether she possessed sufficient stability to prevent her from rolling and pitching excessively.

Now it is in the easier problem that our government ship-builders so eminently fail. The history of a new vessel is commonly this. First her guns are found too heavy for her weak powers; or if she be a steamer, she reels and groans beneath the burden of her too ponderous engines: this evil partially remedied, either by diminishing her load or enlarging her dimensions, she is at last, perhaps, fortunate enough to reach her destined element, the open sea. But the trials which began at her birth, and unceasingly attended her cradle, pursue her in the career of adult existence,—her calamities are now severer than ever. She behaveth not with the steadiness and dignity befitting her character, and the ponderous respectability of the lords and gentlemen who called her into being. On the contrary, she rollicks and reels like any harridan: she, the scion of aristocracy, disgraces her noble origin! and some vulgar craft, built by plain Mr. Jones, passes her in all the dignity and ease of superior virtue.

To correct the faults of her light behaviour, she is again returned to dock, becomes the subject of much official correspondence, then is cut in two, and lightened or razeed, curtailed here and pieced out there, until her oldest friends can no longer recognise her. She will sail now, perhaps—not so well as one of the old French ships taken in the last war,—but still she keeps above water. There remains nothing but the bill to pay.

When mishaps like these occur, not once nor twice, but systematically, when the slightest knowledge of mechanics convinces us that they might be avoided with as much certainty and far more ease than errors in the Bank accounts,—when the expense of these renewed failures is estimated not by thousands but by millions, when the whole country is impoverished and almost overwhelmed by its excessive taxation,—when the national defences are imperilled by the insufficiency of the navy,—when we find our private merchantmen and foreign men-of-war regularly equipped for sea without these disasters, the investigation of their causes begins to possess some interest.

How are the Lords of the Admiralty, the Surveyors of the Navy, the Port Admirals, *et hoc genus omne*, selected? "Doubtless," says the intelligent foreigner, "for their familiarity with naval affairs, their long experience of the practical requirements of a ship, their profound research in the science of ship-building." Simple man! the First Lord of the Admiralty was never out of sight of land in his life; but then he is of the highest respectability in his county, and his family have always been most consistent politicians. The Port Admiral's uncle regularly divides with the Ministers; the Surveyor of the Navy is nearly related to a bishop; and the commander of the experimental squadron was always making such troublesome motions and inquiries in the House, that government sent him to sea in pure self-defence.

There appear but two ways of remedying this state of things, and both—so are we trammelled and involved in an artificial system—but partially practicable. If the government ceased to manufacture on their own account altogether,—if they would purchase their ships like other commodities at the market value, the whole coil would be remedied at once. There are many opulent firms in this country who would readily enter into competition to supply government with war vessels capable of battle with the war of elements and the fury of human conflict. A system of contract and competition, properly regulated, would spare the country all the evils of enormous expenditure and worthless ships. Indeed, it has been already carried out in an important part of naval service—the supply of engines by private contract for the government steamers.

It is easy to suggest such a plan: the discovery of its advantages does not require much study. But there is this fatal objection—that it would destroy an enormous amount of government patronage. Were it objected that the works required one of such magnitude that they could not be safely entrusted to any private contractor, and that there are no private dockyards where the works could be adequately carried on, the difficulty might be removed by dividing the work into distinct contracts; one for building the hull, another for the engines, another for the tackle, &c.,; and by assigning the dockyards, basins, and shops for the contractor's use.

But imagine the weeping and wailing at Portsmouth and Plymouth consequent on such an arrangement! The vested interests disregarded, the sons of noblemen thrown on their own resources, the votes lost to the government!

Yet when John Bull sees that the system of private contract works well, and greatly spares his pocket, he will insist that if it become not universal, it shall at least be extended. Once every ten years he becomes poor, and gets eager for retrenchment; and while the fit is upon him, is tolerably severe in his demands for economy. If the government would resist that demand, they must adopt the alternative plan, and have a better—that is a less grossly ignorant—class of dockyard officers. At the risk of appearing scientific enthusiasts, we will venture to recommend that these gentlemen should acquire a smattering of the science of hydrostatics. It may be that they care nothing for theory—but *nature does*. If they disregard the laws of floating bodies because they are generally expressed by the aid of mathematical symbols, the winds and waves will not sympathise with their ignorance. Therefore, O surveyors of the navy, when you lay down a ship's lines, bestow one thought upon her *metacentre*.

Metacentre—what is that? A long Greek word, unknown and unheard of in our dockyards. Its meaning was, however, all in all to the men of profound science who designed the old French vessels, now imitated by us with stupid Chinese fidelity.

INDIAN RAILWAYS AND STEAM NAVIGATION.

(*With an Engraving, Plate* V.)

1. *Report on the East Indian Railway.* By R. MACDONALD STEPHENSON.
2. *Railways in Bombay, and the Cotton Question.* By JOHN CHAPMAN.
3. *Account of some Recent Improvements in the System of Navigating the Ganges.* By ALBERT ROBINSON, C.E. London: Weale.

When any objection is made to the mode in which we have seized hold of Hindostan, the common answer is, that we have done a great deal of good for the country, and the people were never so well off. If this were true, it would not be a bad answer, as times go; but unhappily there is very little truth in it; and were we turned out of the country to-morrow no one would care, and there would be nothing to show that we had ever been there. Our readers may take a technical view of the question, but here it is a very fair one. They naturally ask what public works have the Indian government carried out, how many steamboats are there, and how many miles of railway? and the answer is one which may be very satisfactory to East India directors, but very unsatisfactory to the English public.

Of late years, many new settlements have been founded, and many of our readers have gone out to them as surveyors-general, and surveyors, and proceeded in the discharge of their duties. One of the first of these duties is to provide proper accommodation for communicating between the several parts of the settlement; and if this is a great duty in a newly-settled country, and one punctually discharged, of course we expect it should be attended to in an old and cultivated country like India. We may say that it is not—so little has been done for the roads and for steam navigation.

In our last number, in a notice of Mr. Albert Robinson's book, we said something as to the rise of steam navigation on the Ganges; but we really cannot, in the present state of the question, dismiss it so summarily. Year by year the grievance becomes greater, and we see no effort on the part of the government to give the social and commercial interests of India the necessary facilities of communication. The policy as to railways is more disgraceful and narrow-minded than that of the home legislature; and that is saying a great deal.

The besetting sin of the Indian government is the exercise of a red-tape system of administration, which leaves nothing to local or individual action, while the general administration does not exhibit the paternal care it professes. The railway question has been badgered from office to office, till any one but the managers of the companies which still keep the field would have been disheartened, and given up the attempt to carry out their undertakings. We hope they will have the reward of their perseverance.

In 1845 and 1846, companies asked the permission only to lay out their money in railways in India; the undertakings were well received by the public, and the shares at a premium. Had the necessary powers been given by the Indian government, neither guarantee nor contribution would have been required, and a considerable extent of railway would now have been opened, notwithstanding the disastrous panic which affected the East India merchants. The Indian government had one of the finest opportunities that could be wished or invented to advance the prosperity of India. Capital, which India wants, was offered, and the attention of the public having been drawn to the failure of the American cotton crops, there never was a better occasion for giving a great impulse to the cultivation of cotton in India. Had the government been wise and liberal, offered every facility in their power, and given a temporary guarantee, the success of the railway system in India would have been decided, and the trade of India would have been greatly promoted.

The Indian government were too great in their notions to be ruled by such considerations: they thought they were giving a favour instead of receiving it, and acted accordingly. Instead of granting charters of incorporation to those who asked for them, they appointed an inspector-general to examine India, and report upon the plans. Meanwhile, the face of the money-market altered; several of the companies, wearied out and hopeless, wound up their affairs, and the others were languishing. After much delay, the government came forward to offer terms to the companies, and did offer terms which would have been satisfactory enough in 1845, but were quite out of place in 1848. Nothing has therefore been done, and the Indian government stands accused before the legislature and the citizens of England, of having stood in the way and impeded the welfare of India. This is the issue now, and though the Indian government are haggling with the companies, they are really making a bid on the question of the future government of India. When the charter of the East India Company comes to be renewed, it will be asserted that they have done nothing for the good of India; and in particular, they will be charged with the two heads we have just named—of wilful injury to the progress of India, and, so far as the growth of cotton is concerned, of wilful neglect of the interests of England. Had they acted as they ought to have done, it would have been a good plea to point to the busy rivers of India, the miles of railway, the increase of production, the establishment of a staple trade in cotton. These would be results which everybody could understand and nobody could gainsay, and would far outweigh any Ellenborough peccadillo. Such, however, has not been the case.

If we reflect upon one great object of having improved communications in India—namely, the increased production of cotton, we are of necessity led to the consideration of the United States, now the great cotton-producing country, and equally under the government of an English people. That country is supplied with rivers like Hindostan—it has its Mississippi and its smaller rivers; the latter, its Ganges and its Indus. The rivers of America have long courses, and are embarrassed with sand-bars and other obstructions; but the steamboat is to be found everywhere. Though the country is thinly peopled, the railway system is very extensive, and has now been for years in operation. In the beginning, the capital was got from England. The electric telegraph wires are now laid throughout the length and breadth of the land.

Thus the United States have all that Hindostan wants, though there is no apparent reason for this great difference in the condition of the two countries. It may be added, that the taxation of the United States for public works is not greater than Hindostan. The reason for the different state of affairs must be sought for in the policy and legislation of the two countries, for India has rivers, has cotton, has an English government, a settled state of society, good credit, and access to English capital. It is to the mode in which these resources are managed that we must look.

What has been done with regard to railways in Hindostan we have seen; but it has been far otherwise in the United States. There every encouragement has been given to joint-stock companies, and every facility for the raising of capital. The greatest freedom is shown in granting powers to new companies, and the expense and delay are trifling. The Indian railway companies have not yet been able to obtain charters of incorporation, and they have been thwarted in getting acts of parliament; and we are not aware that the Ganges Steam Navigation Company, or the other steam navigation companies, have been better protected.

How miserable has been the policy and proceedings of the Indian government. They have caused difficulties to the railway companies by requiring a preliminary deposit; whereas in the States, an act of incorporation and full powers would be granted without any money being paid up. The Indian government have been obliged successively to reduce the amount of this deposit, or expose themselves to the accusation of strangling the companies: but as it is, they have much crippled them,

The United States believe that people would not ask for railway powers, without meaning and striving to carry them out; and while they take the application for evidence enough of the intention, they recognise the difficulty of raising the money for new undertakings; and if they cannot encourage this operation, never place any restrictions in its way. Although there are many imaginary obstacles to the free grant of powers for executing public works, there are no real objections, and no difficulties have arisen where the system of making such free grants has prevailed. The saving of time by authorising an undertaking on its projection is very great, and the projectors come into the market with a full assurance that when the money is raised, no delay will take place in its profitable application. The powers of such an act of incorporation, of course, only become operative in proportion to the capabilities of the subscribers to carry them out.

The New Englanders do not send out railway inspectors-general to settle how works shall be made years before they are executed, whether the white ants will eat up the sleepers, or the railways will pay a good profit. These are left to the shareholders and their officers, for it is the money of the shareholders that is laid out, and not that of the government. The appointment of Mr. Simms we regarded at the time as calculated seriously to prejudice and delay the execution of the works; and so it has proved. Instead of having a number of miles of railway after four years of agitation, we have only a number of blue-books, which, however well written, are not calculated to satisfy any one, for practice and experience alone can determine what are the best materials to be employed, and how the works can best be executed. Had Mr. Simms spent his time in India as engineer to a railway, his abilities would have been more honourably bestowed, his reputation would have been extended, and some lasting good would have followed. As it is, positive injury is the absolute result.

The Indian railway question is no longer a *res integra;* the government have damaged, and instead of being able to start afresh, they have to repair the injuries committed. We consider it necessary that liberal guarantees should forthwith be given to the two companies — the East Indian Railway Company, and the Great Indian Peninsular Railway Company—with full powers to raise money, with free grants of land, and if needful with loans of money on debenture. The lost ground must be made up, and the only way is by encouraging a start, for capitalists are disgusted and disheartened by the difficulties which have been thrown in their way.

This should be accompanied by a general railway act for India, which should authorise the several governors, without reference to the home government, to grant charters of incorporation for railway companies. Such charters should ensure the non-liability of the shareholders beyond the amount of their payments, *exemption from being sued for calls*, *unlimited powers of borrowing money at any rate of interest*, and the liberty of paying interest on calls, dividends, and bonuses, and the issue of new shares. There should be full power of taking land—the compensation, in cases of dispute, to be settled by the local courts. The shareholders should have the right of making bye-laws for their own government. There should be no limit to the amount of dividend, nor to *the amount of fare to be charged*, nor any restrictions as to the running of trains.

A similar law should be passed for steamboat and electric telegraph companies, and to include such joint-stock undertakings as the several governors might think fit.

The above recommendations are widely different from the usual course of railway legislation, and will appear extravagant to those who have not watched carefully the workings of the joint-stock system; but they are supported by the theory of political economy, and by the most extensive practice.

Unless there is a limited liability, a man of large capital will not for the sake of a small profit make an investment, as his whole property is at stake; and the millionaire will not jeopardise his thousand of thousands for one thousand.

Freedom from being sued for calls is the most essential power to enable the shares to pass current, and capital to be raised. The power of forfeiting shares for non-payment of calls is quite a sufficient penalty on the defaulter, and inducement enough to make him strain every nerve to raise the money for the calls; if not, he can always sell them to some one else, who will venture another call. As the other provision enables the man of large capital safely to become a subscriber, so this enables the man of small capital safely to become a subscriber. The objection which is commonly made, that directors could not carry out contracts with creditors of the company, does not apply, for the creditors would have the property of the company to fall back upon, and they would contract with a full knowledge of the conditions on which they gave credit. If a man is willing to give credit to a corporation, let him do so: he can better protect himself than any government can.

The same reason applies to lenders of money on debenture; let them take any rate of interest they can get; and let them, as in case of lending money on any other security, ascertain for themselves the nature of the property on which they lend. They are willing to do so, if the law-makers will not insist on protecting them. It is indeed strange, when capitalists are so ready to lend money to Spain, Peru, and Columbia, without any protection by act of parliament, that law-makers should persevere in protecting them, as they call it, in lending money to railway companies. Rothschild and Baring must surely be better able to protect themselves than the collective wisdom can be to do it for them; and as to the poor, at present no protection is wanted for them, as the companies do not like to take money in sums less than 1,000*l.*

The shareholders are best able to determine how many directors they shall have when they shall meet, and how the business shall be conducted, and let them make the arrangements; whereas now, a company that wants six directors, is obliged to have twelve; and one that wants eighteen is limited to the smaller number of twelve.

We do not propose a limit to the amount of dividend, because the higher the dividends that are declared the more capital will be brought to bear on railway construction.

We consider it equally needless to place any limit on fares; for with the full opportunity for starting opposition lines, and the full knowledge of this on the part of the companies, there will be every disposition to suit the public convenience. Nothing can be more mischievous than inculcating the belief in a monopoly of public works and public accommodation, as it acts for the injury and disappointment of all parties. We believe that an old company, fairly conducted, has such superiority in raising capital and giving accommodation, that no opposition company could be started against it. We mean, that an old company could always maintain a higher rate of dividend than that which any new opposition company would dare to offer as an inducement to subscribers.

In conclusion, we earnestly advocate that the government should remove every obstacle on its own part to steam navigation; that it should not allow its own boats to compete; and that it should give every encouragement to steam navigation on the Ganges, Indus, Burhampooter, and other rivers.

If enterprise be left unfettered, we believe the result will be, first to extend steam navigation on the rivers; and then to establish railways as an auxiliary, or in those places where there is no railway accommodation. Nothing is better calculated than steam navigation to develope the traffic in India, because it is impossible at once to lay down a complete railway system; and there will be a natural tendency to work the two together, so that the river shall feed the railway, and the railway bring traffic from those districts in which there is no water communication.

As a further measure for the benefit of inland communication we advocate the adoption of the plans of Mr. Albert Robinson, the engineer of the Ganges Steam Navigation Company, for improving the course of the Indian rivers, as mentioned in our last. This can be done at a small expense. Whatever increases the traffic on the Indian rivers diminishes freight, and makes out a case for the railways.

Attached to this article is an engraving (Plate V.), showing the class of vessels Mr. Albert Robinson has introduced on the Ganges, and which are well calculated to promote traffic, and ensure the comfort of the passengers. It will be seen that ample space is left below, and the engines kept down, which allows of the upper deck being built upon and appropriated to passengers, without making the vessel topheavy. It is this combination of a large space for luggage with spacious saloons that will make steam-vessels pay. The boats built by Mr. Robinson draw very little water, and can pass the shallows with facility.

REMARKS ON PATENT INVENTIONS.

[A very able article on the Progress of Mechanical Invention is given in the last number of the *Edinburgh Review*. It is a valuable exposition of the mania that has begotten many persons for taking out patents for the most puerile inventions, founded upon gross ignorance of the common principles of mechanics. We are induced to transfer to our columns a lengthened abridgement of the paper, in the hope that it will in some measure arrest the folly of inventors, and prevent many artful scheming parties palming upon the public pretended inventions, for the purpose of getting up a company and duping the subscribers out of thousands, for a patent that is not worth a straw.]

The Reviewer very properly observes that—

> "The simple perusal of their own specifications, aided by a very moderate degree of scientific knowledge, will suffice to prove that, nine times out of ten, all the labour and expense that have been lavished upon the production of these cunningly devised engines could result in nothing but total failure. Nor do the inventors appear to profit by example. In spite of the abundant warnings held out to them in the fate of their predecessors, they persist in adopting the same inefficient means, the same defective construction; or in hopeless attempts to extort from some natural agent the performance of tasks for which it is manifestly unfitted. Nay, the identical mechanism, that has broken down a dozen times in other hands, is once more made the subject of new patents, by men who are not only ignorant of the simple scientific principles which would have taught them their folly, but who do not know the fact that the selfsame ideas have long since been worked out, and abandoned as impracticable. Without skill to shape their own course, they cannot perceive the scattered debris that might warn them of impending shipwreck. Is it credible that ingenious men, who have seen or heard of the suspension tunnel, and the electric telegraph, should still waste years in search for the perpetual motion? Yet such is the fact; and one such machine, at least, may even now be seen in London, by those who have more faith than knowledge, pursuing its eternal revolutions.
>
> In the majority of instances, we apprehend that these inventors are but little acquainted with the practical details of the branches of art or manufacture whereon they exercise their ingenuity. They attempt to do better than other men, things which they do not know how to do at all. And if, perchance, some remark be hazarded as to their want of experience, they consider it sufficient to reply, that Arkwright was a barber, and Cartwright a clergyman; that Sir William Herschel taught music before he became the celebrated astronomer; and Sir Michael Faraday passed the earlier years of life in practising the handicraft art of bookbinding.
>
> Considering that the state of the law renders the privilege of a patent both expensive and difficult of attainment, and that the whole cost, in addition to that required for completing the invention, must be incurred before any benefit can possibly be derived;—it becomes an inquiry of some interest to trace the motives that lead men, many of whom are sufficiently needy and busy already, to embark upon enterprises so hopeless. One chief cause may, perhaps, be detected in that propensity to gambling which is unfortunately so prevalent in every stage of civilization. In literature, as in manufactures—among members of the learned, the military, and even the clerical professions, as among mechanical inventors and merchant adventurers,—the rewards of industry are divided into great prizes, and blanks. Success admits the aspirant within the dazzling circles of wealth and fame; failure condemns him to oblivion, and too often to penury. Whatever may be the effect upon individuals—and to him who has aimed high, even failure is not without its consolations—there can be little doubt, that in a national point of view the results are advantageous. The general standard of excellence is raised. When more men "dare greatly," more will achieve greatly. A larger amount of talent is allured to engage in active careers, and to endure in patience their inevitable fatigues and disappointments; while from time to time, discoveries and works of magnificent novelty and utility are contributed as additions to the stores of national wealth.
>
> Abstract science, until within a comparatively recent period, was the almost exclusive occupation of all men claiming to rank among the "sect of the philosophers." With the brilliant personal exception of Watt, they appear to have considered it beneath their dignity to carry out their learned theories into any practical or profitable employment. Great mechanical ingenuity they no doubt displayed; but it was devoted to the construction of instruments adapted to scientific research, some of which, it is true, have since been found of utility to the general public. A few investigations were diligently prosecuted which promised to be of national benefit, such as those relating to the longitude, chronometers, and the lunar theory; but they were entertained rather as favourite scientific puzzles, inherited from from past generations, than as problems whose solution would prove a vast commercial good. Davy's safety lamp was almost an exception, at the time it appeared: and people wondered to hear that Herschel had made anything in the vulgar way of money by his telescopes, or Wollaston by his platinum.
>
> The "curiosities of the Patent Rolls" would furnish materials for a copious chapter in some work devoted to an exhibition of the eccentricities of intellect. Even the titles affixed as labels to a multitude of inventions suggest very curious reflections. In the list of patents registered during a part of 1846-47, we find, along with a family of contrivances for personal and household uses, one for an "anti-emergent rat-trap;" others for "improvements in bedsteads,"—in pianofortes, saddles, and pen-holders; for "a new fastening for shutters;" or securing corks in bottles; and for "certain improvements in the manufacture of spoons." Articles of dress supply their quota. We have improvements in "sewing and stitching;" "a new mode of applying springs to braces;" improvements in "hats and bonnets;" an "improved apparatus to be attached to boots and shoes in order to protect the wearer from splashes of mud in walking;" and a long list of inventions connected with the application of gutta percha.
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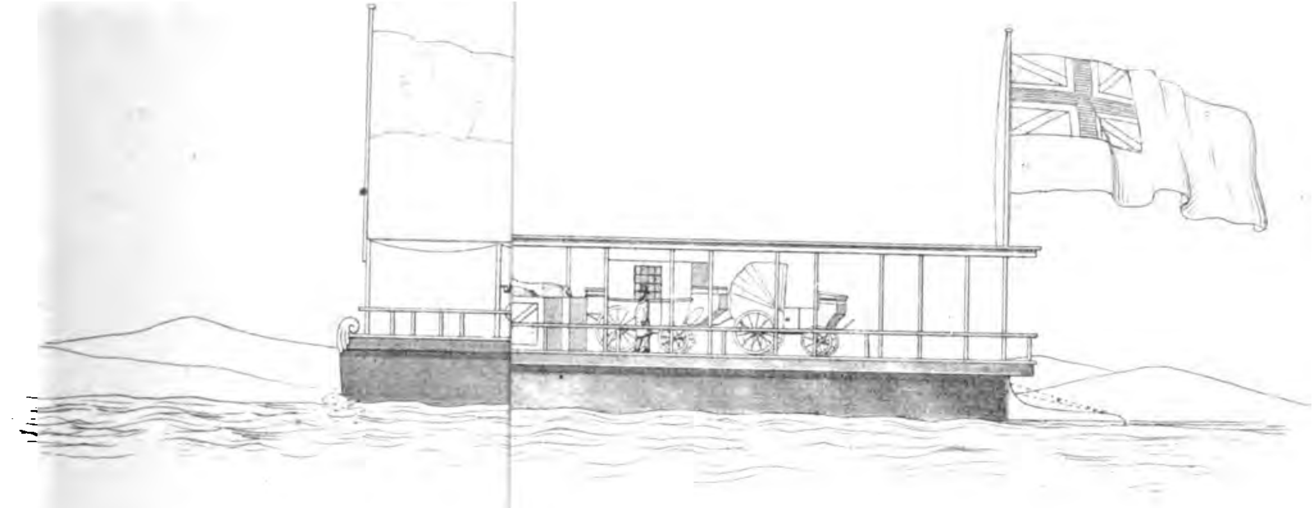
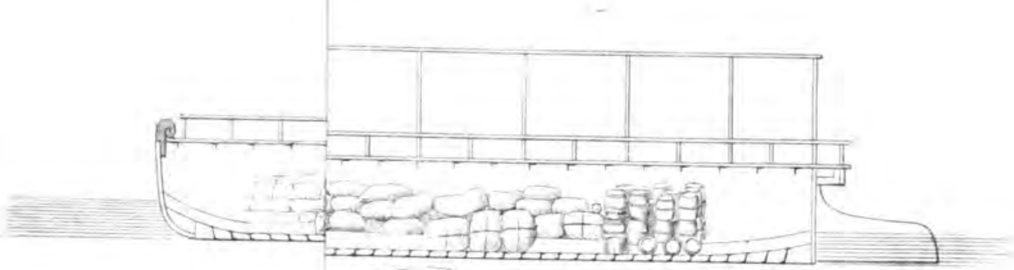
> It is a theory rather in favour with inventors, that many of the most brilliant discoveries have been made by accident; and indeed the examples are sufficiently well-known, of apparently fortuitous occurrences giving birth to very wonderful realities. But if we could inquire more accurately, we should probably learn that the lucky accident had but set in motion a certain train of thought in an already prepared mind; while by far the majority of cases exhibit to us the new discovery elaborated by reiterated trials and improvements from its rude original. A word dropped in casual conversation suggested an idea to the mind of a clergyman (Cartwright) of practical and benevolent tendencies; which, under the influence of contradiction, became hot and strong enough to absorb all his energies for the production of a power-loom. On the other hand, we hear of a practical manufacturer (Radcliffe) becoming convinced that it was possible and desirable to effect a certain operation by machinery instead of manual labour; and shutting himself up with workmen and tools for many months, until he emerged from his seclusion with a warp-dressing machine, to testify to the success of their prolonged exertions.
>
> Even the simplest-looking contrivances require knowledge, especially mathematical knowledge, of no ordinary degree at every step. The mere calculation, for example, of the best form to be given to the teeth of wheels, which are intended to transmit motion reciprocally, requires a process of analysis beyond the competence of ninety-nine in the hundred even of educated men. In more primitive stages of the mechanical arts great nicety was not required. The cogs were then rudely notched in the peripheries of the wooden wheels by the saw or chisel. But now that more perfect workmanship is necessary, the mechanist must form the surfaces of the teeth into such a curve, that they shall roll instead of rubbing on one another, as they successively come in contact, and the friction and wear of material be thus reduced to a minimum. It is true that many of these calculations are already prepared and published in tabulated forms, and therefore the inventor is not called upon to calculate them for himself. But few can hope to become successful improvers, who are not at least competent to understand their nature, and able to determine the particular points of every new contrivance where such considerations become important.
>
> Were it not that no exercise of tyranny would be more fiercely resented than any attempt to interfere with the true-born Englishman's privilege to throw away his time and money at his own pleasure, we could suggest the appointment of certain boards of examiners, whose approval should be first secured before any invention, purporting to be novel, could be admitted to the expensive honours of a patent.
>
> A more popular suggestion has been made, that every patentee should be required to deposit in some pulblic museum an accurate model or specimen of his invention; which would thus prove highly useful as an object of interest and instruction to others, as well as by rendering more easy of determination any litigated question of priority. We should anticipate this further advantage from,—the attempt to construct his model would often leave the inventor self-convicted of the inutility of his scheme and save him much disappointment. Even the preparation of an accurate drawing often has a salutary effect. Mr. Babbage relates that in the construction of his calculating machine, not one single portion of the works, although these were of extraordinary complication, required any alteration after it was once made, owing to the admirable care which had been bestowed upon the drawings.
>
> The *limitary principles* (by which term we purpose to specify everything, whether quality or accident, which tends to limit our progress towards perfection) may be divided into two great categories,—including, first, those derived from the natural properties of matter; and secondly, those arising from the construction or arrangement of the mechanism necessarily employed. The higher importance of the former class is at once manifest. Difficulties which arise from construction may be overcome or eluded; but the task is very difficult where we find that Nature herself raises the bar-

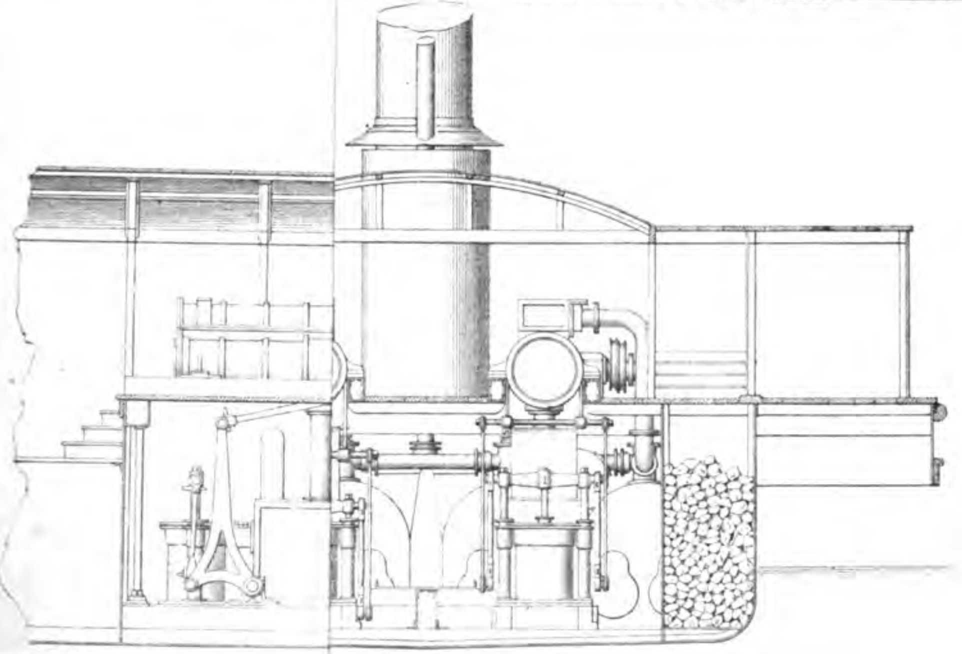
PLATE V.



195 feet Tonnage 400

8 feet Horse Power 120





A Robinson del^t

Section at Cylinders

J. W. Lowry Sc.

rier in our path. Man has succeeded in rendering almost every quality of every various form of material substance available for some purpose of utility. On certain occasions only, and for certain purposes, some one or other of those qualities will be found to stand in the way of his success.

Chemistry has gone far towards establishing the hypothesis that all natural bodies are susceptible of assuming three forms—the solid, fluid, and gaseous,—according to the degree of heat by which they are affected. At all events, it is certain that heat exercises, in various proportions, such an influence on the constituent atoms as to destroy or diminish their mutual attraction; and even when the mass does not subside into fluidity, it loses its strength and cohesive properties, and becomes disintegrated. The uses to which this property of matter have been applied are infinite. Let us see how it may become a *limitary principle.*

It is supposed that the possible heat of a burning atom (in which of course we shall find the theoretical limit) is very far above the highest known temperature attained in our furnaces; and it would consequently follow that we might more nearly approach that limit by varying the arrangement of the fuel and the supply of air for combustion. This has been accordingly done, until we have found our progress stopped by the impossibility of discovering any substance whereof to build our furnaces, which will bear the heat. Porcelain, fire-brick, and plumbago, in various combinations are adopted: but they either crumble or sink down into a pasty mass, as the fire is urged. The qualities of matter itself here act as a complete *estoppel:* and if we would experimentalize further upon the phenomena of caloric, we can operate only upon a minute scale by means of the gas blowpipe, or the heated arch evolved from charcoal points interposed in a galvanic circuit. But for this limit, many useful purposes might be accomplished, by the mutual actions or changed forms of material bodies when subjected to the intense action of heat. For instance, in the case of platinum,—we might then separate it from its ores by the ordinary methods of smelting and fusion; in place of being compelled to adopt the laborious and costly process of solution in acids. The steam-engine offers an example nearly parallel. The power of a steam-engine depends primarily upon the area of surface exposed to the action of the fire, and the intensity of the fire itself. In marine and locomotive engines, where space must be economised, the practical limit is fixed only by the degree of heat; and this, of course, must be kept below the utmost limit which the material of the boiler furnace will endure. As yet, there has not been discovered any material better fitted for this purpose than iron; and we have made our fires as fierce as the melting point of iron will permit: even now, the fire-bars are destroyed sometimes upon the first journey.

Farther than this we obviously cannot go, so long as we use water for the power-producing agent. Attempts have however been made, to conquer the difficulty by taking advantage of some other properties of matter in its relation to heat; based upon the fact that the "evaporating point"—that is, the degree of heat at which fluids expand into vapour—is found to differ considerably in different liquids, just as does the melting point of solid bodies. It would therefore appear probable that, by filling the boiler with alcohol, which boils at 173°, or with ether boiling at 96° Fahrenheit, the tension of the vapour and consequent power of the engine, could be increased without increasing the heat of the furnace. As both of the above-named fluids are expensive, it was first requisite so to contrive the machine that no loss should be experienced, but the whole vapour be recondensed and returned to the boiler. For this purpose a variety of ingenious contrivances have been suggested, the earliest of which, and one perhaps as effectual as any other, was patented by Dr. Cartwright, in 1797; while new forms of mechanism, with the same object in view, are even still appearing on the patent rolls from time to time. Whatever the ingenuity of man could do, has probably therefore been done: but the practical utility of all these contrivances was destroyed by the influence of other properties of matter altogether overlooked, although of necessity involved in the question.

These regard the relative bulk of the vapour produced from corresponding quantities of different fluids, and the proportion of heat absorbed or rendered latent in each during the process of vaporisation. The calculation is sufficiently simple; and the result effectually annihilates all hope of advantage, either potential or economical, from the etherial or alcoholic engines. Thus, to convert a given weight of water into steam, 997° of heat are required as what is called "caloric of vaporization." The same quantity of alcohol will become vapour with 442°, and sulphuric ether with only 302°. But to set against this apparent gain, we find that the specific gravity of steam (air being = 1) is ·6235; vapour of alcohol 1·603; ether 2·586; and the result may be thus tabulated.

	Caloric of Vaporization.	Spec. Grav. of Vapour.	Useful effects of Caloric.
Water	997°	·6235	10,000
Alcohol	442°	1·603	8,776
Sulph. Ether	302°	2·586	7,960

The disadvantage of the latter fluids will be farther enhanced by the circumstance that, being lighter than water, a larger boiler will be required to hold the same weight of vaporific fluid:—*i.e.*, a pound of water, when evaporated, will form about 21 cubic feet of steam; while a pound of ether will require a larger boiler to hold it, and will only form 5 cubic feet.

Weight is one of the properties of matter which in practice we encounter chiefly as an obstacle or inconvenience, tending to increase friction, to resist motion, and generally to crush and destroy. Meanwhile, the limits of its range are comparatively narrow—that is to say on one side. We can, indeed, rarefy a gas until its weight disappears in infinite tenuity; but we very soon find ourselves at the extreme verge of any possible increase of specific gravity. The most ponderous substance known is not quite twenty-two times heavier than water. And yet there are many purposes for which bodies of greater weight might be made useful. If, for example, closer or deeper search amid the stores of the mineral kingdom should lead to the discovery of some substance bearing the same proportionate gravity to platinum, that platinum does to cork, how many possibilities of improvement would be placed within our power! A thin sheet of such a substance, interposed among the keel timbers of a ship, would give stability and other sailing qualities at present unattainable. Blocks of it would afford sure foundations for piers, bridges, and all marine works. It might then be found no longer impossible to establish a lighthouse on the Goodwins. As a regulator, or reservoir of power—for counterpoises, pendulums, and fly-wheels; for all purposes where percussive force is required; and in steam-hammers, pile-drivers, and shot of long range, the utility of such a substance would be enormous. In each and all of these objects, we are limited by the limits of specific gravity in our materials.

The "Strength of Materials" is an element that enters into almost every calculation of the mechanist; and it is found to constitute not only an absolute limit to all possibility of advance in certain directions, but also a relative limit universally, when we attempt to reduce beyond certain proportions, the size, weight, and cost of our mechanical erections. Its variations also are extensive both in degree and in condition. Some bodies offer strong resistance only to certain modes of attack. Impervious on one surface, they will yield and splinter into laminæ under a slight blow upon another. Some will bear pressure to an enormous extent, but are easily torn asunder; others resist the divellent forces, but crumble under a light weight. A very extensive variety of substances possess a fibrous texture, and are endowed with vast strength to resist a strain in the direction of their length, but are much weaker against a lateral or transverse force. This difference is found to vary to an infinite extent; from that of certain metals where the advantage is only four or five per cent. in favour of the direct resistance, to the vegetable and animal fibres, such as flax or silk, which possesses enormous tenacity, combined with most complete flexibility.

The variations in the natural properties of bodies have given infinite scope for the exercise of human ingenuity. In the erection of engineering works, and in a still higher degree in the contrivance and construction of moving machinery, the combination of theory and practice is perpetually exhibited in surprising perfection. By nice calculation of the opposing forces, together with great practical skill in the mechanical details of construction, we can now attain a result in which abundant strength is united with the utmost possible economy of space and material. There is no waste; no addition of useless and cumbrous weight: all irregular strains are skilfully counterbalanced, and the greatest pressure distributed over the points of greatest resistance. Experience has entitled us to place implicit confidence in the scientific precision of our engineers. Every day we trust our lives and fortunes, without misgiving, into situations where a slight error in the calculations, or a slight defect in the workmanship, would inevitably lead to some terrible catastrophe. How little do the crowds who throng the deck of a Thames or Clyde steamboat, or who allow themselves to be hurried along at fifty miles an hour in a railway carriage, reflect upon the delicate conditions which must have been fulfilled—the complicated mechanical problems which must have been solved, in order that they might accomplish their journey in security. A multitude will gather upon a suspension bridge without fear or danger, although the rods by which the massive roadway and its living freight are sustained appear as mere threads in comparison with the mass they have to support: while, if any one reflects at all upon the matter, it is to assure himself that every possible amount of pressure has been theoretically provided for; and that, practically, every separate bar and joint has been severely tested, so that no single flaw in the material, or defect in the workmanship can have passed without detection. Fribourg, before the civil war of the Sonderbund had given it a political notoriety, was celebrated chiefly for its wire bridge, hung at an altitude of nearly 100 feet between two summits. "It looks," says a recent traveller, "like a spider's web flung across a chasm, its delicate tracery showing clear and distinct against the sky." Diligences and heavy wagons loomed dangerously as they passed along the gossamer fabric.

The force that enables a suspension bridge to sustain itself is, what we have called the *cohesive* force, and is due, we must suppose, to some variety of the attractive principle among the corpuscular atoms, which causes them to resist a separating or divellent strain. In ordinary bridges and among the usual erections of architects, on the other hand, the pressure to be considered is that which crushes the parts together. To resist this, the piers of the bridge must have strength sufficient to support the loaded arch; and the pillars of the cathedral to sustain the fretted vault that rests upon them. In this case we find that the strength which arises from the cohesion of the atoms between themselves is increased by that due to another quality of matter—namely, its incompressibility. When any solid body yields to a crushing weight, the consequent effect must be, either that its particles are actually pressed into a smaller space; or that, being made to exert a wedge-like action upon one another, the exterior layers are forced out laterally. The addition of a band or hoop will then bring the incompressibility of the atoms more fully into play: and bodies that are endowed with slight powers of cohesion may thus be rendered enormously strong. Indeed we find that fluids, in which the cohesive force is practically at zero, cannot be crushed by any pressure we can exert, provided the hoop or tube that surrounds them can be secured. Now the interior atoms of every substance under pressure are more or less thus hooped-in and strengthened by the exterior. To the strength from cohesion is added that from incompressibility; and this effect is produced in a rapidly increasing ratio as the sectional area of the body is enlarged. A cube of lead suspended from its upper surface and held together only by cohesion, will break down if larger than 180 feet to a side. If standing upon one side as a base, it might be made of infinite size without danger of fracture from its own weight.

We may conclude, therefore, that the total force of resistance is amply sufficient to answer any call we are likely to make upon it. It is certain, at all events, that we have not, as yet, built up to the strength of our actual materials. Our marble and granite columns will sustain ten times the weight of any edifice the present generation can wish to erect Or if not, they will use iron. The theoretical limit to the span of our bridges is that only at which the voissoirs of stone or iron would crumble under the intensity of pressure. The cost and inutility of even approaching to such a limit, will always assign them much narrower dimensions: though large enough, nevertheless, to admit of the accomplishment of that magnificent project—of which the first design is due to the genius of Telford—for spanning the Thames at Westminster by a single arch. Such a work would be worthy alike of the age and the site; and we see no reason why it should not be undertaken, and completed at least as soon as (supposing promises to be kept in future only as heretofore,) the last stone is laid upon the Victoria Tower. The tubular bridges now in course of erection by Mr. Stephenson, upon the Chester and Holyhead line of railway, will probably remain for many years unsurpassed, as specimens of science and engineering skill.

The hypothesis that the force of cohesion is proportional to the area of section, leads us to the ordinary rule of practice—that as the magnitude is increased, the strength increases as the square, and the strain as the cube of the dimensions. The proportions consequently which offer abundant strength in a model, must be materially altered when the design is executed at full size. When any of the parts are intended for motion a new element is introduced, from the inertia of the moving masses; and thus both the size and the velocity of our machinery are confined within definite limits. To extend these limits, it is often necessary to solve the most complicated problems of dynamics, and to follow the train of motion through an intricate series of action and reaction. We must simplify and reduce the number of moving parts, and so adjust the *momentum* of the inertia, that the resulting strain shall be neutralised, or reduced to a minimum: and where it is necessary that the direction of motion should be reversed, we must accomplish this object with no such sudden or violent shock as would dislocate the machinery. The difficulty of this attempt in many instances is proved by the heavy motions and hideous noises that accompany the working of almost all newly-invented mechanism, and of the simplest machines found among nations less skilled than we are in the arts of construction.

It is equally unscientific, and almost equally dangerous, to give too much strength to our constructions as too little. No machine can be stronger than its weakest part; and therefore to encumber it with the weight of a superfluous mass, is not only to occasion a costly waste of material, but seriously to diminish the strength of the whole fabric, by the unnecessary strain thus produced upon the parts least able to bear it. This fault is one which is most frequently discoverable in new machinery; and which when once adopted in practice, retains its hold with the greatest inveteracy. It requires no common powers of calculation, and not a little faith, for men to trust to the safety of structures which have apparently been deprived of half their former strength.

There can be no better proof of the difficulties which oppose the adoption in practice of any new principle of construction or configuration, than that exhibited in the history of ship-building. In no creation of human labour was it more necessary to secure the greatest possible strength from the minimum of material; as none were required to possess such vast bulk in proportion to their mass of resistance, or were exposed to more violent varieties of strain and shock, in the natural course of their service.

The men who superintended the public dockyards were often well versed in mathematical science; and were certainly acquainted theoretically with the common axiom, that among right-lined figures, the triangle alone will preserve its form invariable by the rigidity of the sides, without depending upon the stiffness of the joints. Yet none until a recent period, worked out the axiom into its very obvious practical development. For centuries were our ships constructed on principles which caused the whole frame-work to be divided into a succession of parallelograms. Every series of the timbers, as they were built up from the keel to the decks, formed right-angles with their predecessors and with their successors; so that the whole fabric would have been as pliable as a parallel ruler, but for the adventitious firmness given by the mortices, bolts, and knee-pieces. At least three-quarters of the available strength of the materials was possibly altogether thrown away. The safety of the whole was made to depend upon its weakest parts; and when decay commenced through process of time or the action of the elements, every successive stage in its advance made the progress more rapid, since the wear and friction increased in double proportion as the fastenings became weak and loose.

Among the properties of matter are some that we may term subsidiary or incidental: qualities which we may be said to discover rather than to comprehend; and whose agencies are of a secret, and as it were stealthy character, so that we cannot always predict their recurrence or calculate their force.

The fluid and gaseous bodies present many instances of these perplexing phenomena. While investigating the conditions under which solid substances enter into solution; the rise of liquids through capillary cavities; the motions of camphor and other bodies when placed on the still surface of water; the phenomena of crystallisation: the condensation of gases in charcoal; or the inflammation of hydrogen when in contact with minutely divided platinum—in these and similar cases, we encounter on every side a series of anomalies which as yet baffle all our efforts to group the incoherent facts into a consistent theory. For the present, therefore, we content ourselves with the functions of empirics and registrars. We must observe and collect the facts which may hereafter furnish a clue to the labyrinth; confident that when that clue is once seized, every step will not only bring us to some result of practical utility, but will reveal yet another example of the divine symmetry of nature.

The limits that are set to improvement by difficulties of construction, or the arrangement of mechanism, require a very different species of analysis from that which has for its object the properties of natural substances: and the terminal problems are susceptible, in general, of merely relative solutions. Seldom may we be able to say absolutely—'So far can we go, but no farther.' But we are often able to decide among the great objects for which machines are intended—economy, rapidity, and safety—how far the necessities of each can be accommodated, so as to produce the result of most advantage. Yet even here our verdict can seldom be considered as final. The introduction of a new material, or the suggestion of a new combination of parts, may at once render easy the improvements that have baffled the ingenuity of man for generations. The history of invention is full of such examples. It would be a curious inquiry to trace how many contrivances have been delayed for years from the mere want of knowledge or skill to execute the works; and obliged as it were to lie fallow until the cunning of the workman could sufficiently correspond with the ingenuity of the inventor. When Hadley first constructed the quadrant, still known by his name, for a long period it was perfectly useless in the determination of the longitude, as the indications could not be depended upon to a greater accuracy than 50 leagues. But after Ramsden had invented his "dividing-engine,", the graduation was so vastly improved, that even in the commonest instruments, an error of five leagues was seldom to be feared. The minute measurements of angular distances by the micrometer were long subject to similar difficulties. The instrument waited, as it were, for Wollaston's discovery of the means to procure platinum wire so fine that 30,000 might be stretched side by side within the breadth of an inch. The limit which was reached by this discovery was followed by another pause. Then came a new advance, owing to the beautiful invention of an eye-glass composed of double refracting spar, so mounted as to revolve in a plane parallel to the axis of refraction, and give, by the gradual separation of the two rays, a measurement susceptible of almost infinite delicacy.

So in the history of the steam-engine. Boulton and Watt had been long partners, and the theory of his great machine was almost perfect, when Mr. Watt still found that his pistons fitted the cylinders so ill as to occasion considerable loss from leakage. In 1774, Mr. Wilkinson, a large iron-master, introduced a new process of casting and turning cylinders of iron. Watt at once availed himself of them, and in a few months the inaccuracy of the piston "did not anywhere exceed the thickness of a shilling." The wonderful perfection since attained may be seen in a rotary steam-engine patented within the last few months. The steam-chamber presents a sectional plan, somewhat resembling five pointed Gothic arches set round a circle; the outline being formed by ten segments of circles, all referring to different centres. The piston has to traverse round this singularly formed chamber, preserving a steam-tight contact at both edges; and such is the accuracy of the workmanship, that the leakage is barely perceptible.

Steam, as applied to locomotion by sea or land, is the great wonder-worker of the age. For many years we have been startled by such a succession of apparent miracles; we have so often seen results which surpassed and falsified all the deductions of sober calculation,—and so brief an interval has elapsed between the day when certain performances were classed by men of science among impossibilities, and that wherein those same performances had almost ceased to be remarkable, from their frequency—that we might be almost excused if we regarded the cloud-compelling demon with somewhat of the reverence which the savage pays to his superior, when he worships as omnipotent every power whose limits he cannot himself perceive. It is not surprising that inventions, designed to improve the forms and and applications of steam-power, should constitute a large per centage of the specifications which are enrolled at the Patent Office. Even in France, we learn that within a period of four years, the following number of patents, connected only with railway construction, had been obtained:—In 1843, 19; 1844, 22; 1845, 88; 1846, 131; total 260. Of these we are told that not above three or four have been carried out so as to realise advantage to the inventors, and all of those were of English origin.

The number of English patents is, of course, considerably greater; but we doubt whether the proportion of successful ones has been at all higher. Ingenious men have never expended their energies upon a subject where the splendour of past or possible successes has so effectually dazzled their imagination, and rendered them unable to perceive the great difference between the relative and the absolute limits of possibility. Because science had failed to predetermine the point at which higher performances became impossible, they too often began to consider it superfluous to invoke her aid at all—forgetting that the problems are quite different ones—to decide between the relative merits of two modifications of mechanism, and to define the ultimate capabilities of either. There is no more striking example of this tendency than is exhibited in the controversy between the two great systems of railway traction—the locomotive and the atmospheric. This controversy has already cost the public incredible sums; and has, moreover, been so dexterously managed, that even now, if the money markets were to return to a very possible state of plethora, a plausible prospectus and a new patentee would find it no difficult task to organise another company, and to get subscribed fresh hundreds of thousands towards carrying out an experiment which ought never to have required more than a few months' trial and a short length of working line for its final settlement,—for the principles according to which the experiment must succeed or fail, had been determined long since; and it is a fact equally sad and strange, that among the very numerous patents relating to the atmospheric railway, there is not one that touches upon the real turning point of the question. What was called the "longitudinal valve" or opening, through which was established the connection between the piston travelling within the exhausted tube and the train of carriages, formed the *pièce de resistance* for the inventors; and very many and clever are the contrivances we find specified for improving or dispensing with this valve. And yet the valve itself entered but as a subordinate function into the equation by which success or failure was to be determined. Granting that its construction was theoretically perfect, and all friction and leakage annihilated, the main principle, which depended upon the laws that govern the motions of elastic fluids, was left wholly untouched. The history of science, nevertheless, contained records which should have prevented this mistake. One hundred and sixty years ago, M. Papin, one of the earliest inventors of steam machinery, invented a motive apparatus involving this identical principle, and which, when tried, was found wanting. The machine alluded to was described by the inventor as "an engine for pumping the water out of mines by the power of a moderately distant river." His plan was to erect upon the stream or waterfall a series of force-pumps by which air was to be condensed into a reservoir. From this reservoir a close tube, some miles in length, was to be carried over hill and valley from the brink of the river. It was supposed that the condensed air would travel along this tube, and could be applied at the mine, through appropriate mechanism, to keep the pumps going. M. Papin is said to have tried his invention upon a large scale at Westphalia; and it is certain that a similar engine was erected in connection with one of our own Welsh mines; and in both cases with equally ill success. The machines at the useful end could never be got into motion. The condensers on their side worked powerfully, but the blast of air at the distant extremity would hardly blow out a candle; and although it had been calculated that the condensation would be transmitted along the tube in less than a minute, it was found upon trial that the slight impulses which arrived at last had been three hours on the road. As a last attempt, the motion of the air-pumps was reversed, and the effect tried of employing an exhausted tube. But this mode proved as inefficacious as the other; and the experiments were finally abandoned.

In the process of weaving by the power-loom we find an analogous example of velocity limited by the broken or alternating motion of the acting forces. The rapidity with which the shuttle can be thrown from side to side between the threads of the warp, is limited by the strength of the woof-thread it carries across. When the strain is so great as to cause more than a certain average number of breakings, the net product of the machine will be increased by working at a lower velocity. By a recent improvement, the shuttle is made at every vibration or 'shot' to commence its motion slowly and increase in velocity as it proceeds; thus diminishing the strain upon the thread and economising time, even in the four or six feet that constitute the average extent of each 'shot' And by this means the looms are sometimes worked at a rate of 180 threads per minute, or 3 in every second. This will constitute the absolute limit of speed under the existing form of construction. To extend it we must introduce a new principle, and discover some method of weaving the tissue in a cylindrical web; when the oscillation of the shuttle might be transformed into a continuous revolution, and the strain upon the woof, arising from the perpetual stoppage and change of motion, be annihilated.

RIGHT OF ARBITRATORS TO COPY PLANS ENTRUSTED TO THEM.

ROYAL ITALIAN OPERA-HOUSE, COVENT GARDEN.

[We have been requested to give insertion to the following letter, and to give our opinion as to the practice. We must decline saying one word as to the award; but with regard to the right of the umpire to copy any plans or drawings that are laid before him we must deny, and consider that it is a breach of duty.]

SIR—Under a deep sense of the duty I owe to the profession at large, as well as to myself, I feel bound, however reluctantly, to expose the following facts, which, if tacitly sanctioned, I consider would be derogatory to my professional character, and highly prejudicial to the ends of justice; and I hope to meet at your hands the candour and support that my case deserves, and which it is well known you never withhold.

The lessees of the Royal Italian Opera-house chose, about a year after its completion, to contest two-thirds of my bill of 2,300*l.* for superintending the erection of it, &c., obliging me to institute legal proceedings to recover the balance of it, when, after paying into court 825*l.* more than they had offered me just before going to the jury, they begged a reference (which I had originally offered and they refused.) To this I acceded, and Mr. T. L. Donaldson and Mr. T. Bellamy were appointed referees, and by them Mr. Samuel Angell was named as umpire, and, as the referees could not agree, Mr. S. Angell became the sole arbitrator, and the depository of all my original designs and documents necessary to substantiate my claim.

On Mr. Angell's award being delivered (of which, as you have perhaps properly, refused to admit any comments on it, I must say nothing, whatever I may think), I applied at his office for my papers, and found to my astonishment that the most complete of my designs, working drawings, and papers, were missing from the portfolios and tin boxes, and that many had been copied in Mr. Angell's office by two of his assistants, one of whom being found by me in the act was obliged to admit that it was by Mr. Angell's order that he had done so. Such proceedings seemed to demand an explanation, and I wrote to him, that after the solemn assurance he had given to me in the presence of Mr. Donaldson, Mr. Smith, and others, as to the safety of my papers when delivered into his hands, I could not but regard his conduct as wholly unjustifiable, inasmuch as he was acting as umpire in the performance of a professional and judicial duty, and I requested him to deliver to me the other documents in his possession, and to render to me the most explicit explanation on the subject. Mr. Angell's reply was, that the documents I claimed of him remained in his strong closet during his absence from town; but he admitted that my drawings and extracts of my papers had been copied in his office by his authority; and that he considered he had a perfect right to have any copies or extracts made from any documents or drawings put in by me as evidence in support of my claim, in order that his memoranda might be complete, should there be hereafter any occasion to refer to it; and he went on to assure me that I need be under no apprehension whatever, and that he was quite prepared at any time to show the tracing made from my drawings to Mr. Donaldson, or to Mr. W. Cotterill (my solicitor), in expectation of satisfying them as to his mode of acting.

These explanations cannot be regarded as offering anything like satisfaction; and as to his giving explanations to Mr. Cotterill, or Mr. Donaldson, I have only to refer to these gentlemen's letters, in which Mr. Donaldson says, that "the award has caused great surprise and disappointment to him, particularly as regards Julian's salary; and that after much thought he could not understand why copies of my drawings were taken by Mr. Angell, they not being necessary to substantiate any point in the award, and that in so doing he had erred in judgment in this case altogether;" while Mr. Cotterill, the other gentleman referred to, wrote to me that "he had read over my correspondence with Mr. Angell, but did not see any use in examining the copies he had taken from my drawings. Certainly," Mr. Cotterill says, "I cannot see any possible use in Mr. Angell's copying any of them for any purpose of the arbitration."

To these opinions of the gentlemen to whom he appealed, and of a great many more professional men to whom I have mentioned the circumstances, it is necessary to add, that one of the copies made from my designs, and on which his assistant was discovered, is marked No. 52, the title of which runs thus—"Longitudinal section of the new theatre, saloons, stage, &c., from the foundations to the roofs, complete as executed." On this copy Mr. Angell's assistant has written as follows:—

> "Copies of this and some other drawings of Mr. Albano's works of Covent Garden, by Mr. Angell's order, were taken by me and Mr. Wood, and are in Mr. Angell's possession.
>
> (Signed) G. Judge, jun."
>
> "September 27, 1848,"

The law affording me no redress at this stage, I am obliged to state now what otherwise I would under no other circumstances bring forward. I have been a member of the profession of civil engineers for a quarter of a century in this my adopted country, and have been engaged upon various works, which I presume have sufficiently established my claim to some ability; if not I would willingly allow my reputation to be estimated by what I have done at Covent-garden Theatre, the manner in which it has been accomplished, the very short period in which it has been effected, and the smallness of the expenses attending it, considering that it required fifty-four original and elaborate designs, and above a hundred working drawings, specifications, &c., &c. (all put in evidence), besides daily and nightly attendance to the extent of from sixteen to twenty hours a-day, directing and superintending from the very foundations the construction and decoration of the new theatre, her Majesty's apartments, and the improvement of the whole establishment; converting at the same time the whole of the old materials, on which were daily engaged from 1,000 to 1,600 workmen of all trades, as well as the attendance of six of my assistants and a clerk of the works, all their expenses and salary being defrayed by me during above six months up to the opening of the theatre, and for about eight months afterward the expenses of myself and two assistants. I can confidently appeal to Mr. Hosking, who, in his official capacity as official referee, inspected most minutely all my designs, and in his evidence declared that he saw the whole of the works and foundations, and that, to the best of his judgment, they were executed in an admirable manner, and displayed great ability without extravagance, and that he should not have allowed the theatre to have been opened unless it had been properly done. I could also appeal to the evidence of Mr. Allison, Mr. Braithwaite, Mr. Godwin, Mr. C. H. Gregory, Mr. W. Laxton, and Sir John Rennie, who had often visited the works during their progress, and unanimously declared it to be a very creditable work; and considering its great intricacy and the short time allowed, it was executed in a scientific, workmanlike, and economical manner, and as a work of art carried on with great skill and success; and they all spoke very particularly as to my indefatigability and the fairness of the amount of my charges for a work unequalled for the great sacrifice and exertion it demanded, and which had been admired by all impartial judges, to whom, as well as for the favourable unanimous opinion expressed by the public press, I owe a deep debt of gratitude.

I consider myself in duty called upon, on public as well as on private grounds, to appeal to the judgment of my profession, either as engineers or architects, to the members of which I look with confidence, satisfied that their high character and honourable feelings will induce them to form a right estimate of these proceedings, and will not allow my professional rights to be trampled on with impunity. I contend that Mr. Angell had neither right nor pretext whatever to take copies of my designs; his duty in the office to which he was appointed was to determine on the remuneration, which, in equity, I was entitled to upon my claim, without having any further duty to perform; and certainly nothing which could render it necessary or proper for him to retain copies of my drawings; and I leave it to the profession and to the public to form their opinion, both as to his conduct and the motive which may have influenced him on this occasion to copy my papers, which he still retains in his possession—conduct which I contend is wholly unprofessional and indefensible; and I refer it to the profession and to the public, on whose well-known love of impartial justice and hatred of oppression I can confidently rely. I am, Sir, &c.,

B. Albano.

Office, 22, King William-street, Strand, Feb. 1849.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

Feb. 5.—A. Poynter, Esq., in the Chair,

Mr. Scoles read a paper "*On the Topography and Antiquities of the City of Jerusalem.*"

In the course of it, the writer alluded to Mr. Fergusson's published theory as to the Mosque of Omar and the Church of the Holy Sepulchre, and that gentleman being present, an interesting discussion ensued. Mr. David Roberts, R.A. (some of whose capital sketches were amongst the illustrations of the paper), joined in questioning Mr. Fergusson, who stood gallantly and good-naturedly a cross fire of objections.

Mr. Fergusson's views, as we gathered, may be briefly stated thus: namely, that the building known as the Mosque of Omar is, in truth, the Church of the Holy Sepulchre, and that what is called the Church of the Holy Sepulchre, and was burnt in 1808, was a building not earlier than the 12th century. His principal reasons for the first part of this belief the that the so-called Mosque of Omar is unquestionably a circular Christian building of the time of Constantine, and is built over a rock standing up 15 feet from the floor, with a cave in it; further, that it could not have been a mosque, its shape and arrangements being contrary to the requirements of the religion. In reply to the question, at what period was the truth lost sight of and the title of Church of the Holy Sepulchre given to the edifice which now bears it, Mr. Fergusson said about 150 years before the Crusades. Mr. Scoles did not believe that the (so-called) Mosque of Omar *was* of the age of Constantine; the main arches were slightly *pointed*. He had never seen a pointed arch as old as Constantine. He considered that the columns used were from a more ancient building, but the structure itself was of a comparatively recent period. Mr. Fergusson contended that the arches being pointed, in no way weakened his opinion; he had elsewhere shown that the pointed arch, from 800 years B.C., had been the arch of that country—that is, the horizontal arch bracketted inward to a point.

Mr. Henry Garling, Fellow, presented a valuable donation, of 20 folio volumes, consisting of an early edition of Palladio (1570); Hamilton's Vases; Original Designs, by Lewis; Chambers' Civil Architecture, 3rd edition, with autograph of the author; W. Adams's designs (of Edinburgh); Gibb's works; and Rondelet's *Traité Théorique et Pratique de l'Art de Bâtir.*

SOCIETY OF ARTS, LONDON.

Jan. 17.—W. Tooke, Esq., F.R.S., in the Chair.

The first part of a paper "*On Improvements in Electric Telegraphs, and new plans for Printing by Electricity,*" was read by E. Highton, Esq., C.E.

Perfect as telegraphs at first sight appeared (observed the author) when Professor Wheatstone applied the discovery of Œrsted to telegraphic purposes, and used the attractive power of soft iron (discovered by Arago), for releasing or guiding the mechanical operations requisite for the purpose of either pointing to or printing letters, still imperfections were found to exist, and those to a very serious extent—so much so indeed, as to render in practice many of the proposed plans useless.

Previous to pointing out the imperfections alluded to, Mr. Highton made a few remarks relative to the action of electricity and magnetism generally.

He then proceeded with the object of the paper, and considered the subject under the following heads:—1st, the Instruments; 2nd, the Batteries; 3rd, the Conducting Wires; and 4th, the action of Atmospheric Electricity, Lightning, the Aurora Borealis, and Electrical Fogs.

The first *Instrument* Mr. Highton noticed was the Bell. The ringing of a bell at a distant point, under the latest improvement of Messrs. Wheatstone and Cooke, is effected by means of the attractive power developed in masses of soft iron. The improvement consists in removing a detent from the wheels of a piece of clockwork, by the momentum obtained from a falling weight, the weight falling by the force of gravity on the catch of the wheelwork of the bell when the detent is withdrawn, by the attractive power of magnetism developed in an electro-magnet of soft iron.

The method employed by the Messrs. Highton differs from the foregoing, as regards the mechanism, in the same manner that a watch differs from a clock—a watch being capable of continuing its action in any position. The plan consists in making a spring act by a connecting-rod on the circumference of a wheel; attached to this wheel is the catch detained by the electromagnet armature.

The removal of the armature detent is effected by electro-magnetism, developed in the metal nickel. The alarum may also be rung by magneto-electricity, by merely removing the armature from a magnet.—Messrs. Highton propose using the metal nickel as an electro-magnet in all step-by-step motions, owing to this metal producing little or no residual magnetism.

Having thus alluded to the bell, the author next described the first and most simple form of telegraphs; and as an instance of the class, described the needle instrument of Messrs. Wheatstone and Cooke. The signals with this instrument are given by the deflection of one or more magnetic needles. In the arrangement of the coil and needle of Wheatstone and Cooke, the wire of the coil passes in every convolution twice over the middle or dead part of the magnet. In Messrs. Highton's plan, a horse-shoe magnet is used instead of a needle, and the wire is placed near the poles only. By this arrangement, the resistance offered to the current of electricity in having to pass over the dead part of the magnet is entirely got rid of, and the centre of oscillation and percussion brought much nearer to the centres of gravity and motion; hence less electric power is required, and the oscillation of the needle at the same time removed.

The next class of instruments alluded to was that in which a step-by-step motion is employed. The evil attendant on the use of these forms of telegraph is, that when one error is made in the transmission of a sentence, subsequent errors are entailed throughout the message, until by preconcerted signals the instruments are re-set by all the operators in the circuit. Messrs. Highton's improvements consist in the application of an additional electromagnet, by means of which the step-by-step movement may at any instant be thrown out of gear, and the hand, pointer, or disc progress at one bound to zero or starting point.

This arrangement doubles the speed of transmitting information, and also enables any number of words or sentences to be added to the end of the alphabet without increasing the time requisite for sending a message by letters only; and at the same time gives absolute security to the working of this class of instruments, and prevents any error in the transmission entailing subsequent errors in the message.

The third class of telegraphs alluded to were those which instantly expose to view any desired letter when a corresponding key is touched. Previous plans require twenty-six wires to effect this: in Messrs. Highton's plan three wires only are requisite. The letters are shown by the single or combined motion of *three screens*; no weights or wheels, or similar description of mechanism, is employed, but each screen can, by motion to right or left, be made to assume any one of three positions: and thus, by the combination of three screens, any one of twenty-seven positions can be produced.

Mr. Highton then proceeded to describe the application of this property to printing telegraphs, and showed how, with three wires only, any one of twenty-six letters could be printed instantly at distant stations, and that as rapidly as the corresponding keys could be played on. The arrangement of the mechanism in these printing telegraphs is such, that no error or inaction of any of the parts of the instruments can entail subsequent errors in the message.—Mr. Highton described six different kinds of printing telegraphs, suited respectively to one, two, or three line wires, and combining several of the above improvements.

Feb. 7.—Mr. E. Highton read the second portion of his paper on the above subject. After a brief recapitulation of the various instruments described at the previous meeting, the author proceeded with his investigations of the remaining part of the subject.

The action of the *Galvanic Battery* was first treated of, and the peculiarities attending this mode of producing electrical power were investigated. Two specimens of common green glass cells were exhibited, and the peculiar effects produced by arranging a series of galvanic batteries in various order were noticed; and an arrangement of galvanic batteries, producing what the author called the Electrical Paradox, was exhibited. In this arrangement it was shown how that the power from a galvanic battery, however large the area of the plates of that battery were, might be entirely stopped, or the current even reversed, by another battery so small that it would pass through the eye of a needle. The application of this principle, and the effects that would thereby be produced on certain arrangements of electric telegraphs, were briefly stated. The author then alluded to the rapid oxidation of the iron railings in the squares of London, and showed how that the effect was due to a galvanization arising from the use of lead for connecting the iron with the stone walls.

The author then exhibited the Gold Leaf Telegraph, and remarked on the very small amount of resistance offered to the electric current by this arrangement. This telegraph was then exhibited at work by electricity developed from a burning taper. It was observed that the Gold Leaf Telegraph was selected by the commissioners appointed by the government of Baden to report on the kind of telegraph best suited for the use of that government, and that its practical use in Germany during the last year-and-a-half had given every satisfaction.

The next subject treated of was the *Conducting Wires.* Here the author remarked on the laws of the transmission of the electrical power over the wires, and showed how the peculiarities attendant on the use of electricity in connection with line wires for telegraphic purposes might be most advantageously employed.—Various modes of insulation in use were also noticed.

The author then alluded to the action of natural displays of the electrical power in the form of *Lightning* and the *Aurora Borealis.* Specimens of parts of telegraphic instruments, burnt and melted by the action of lightning, were exhibited. A description was also given of the effects observed on the telegraph wires in the Kilsby Tunnel, on the London and North-Western Railway, during a violent thunderstorm in 1848. Various modes of counteracting the effects of lightning on electric telegraphs were investigated, and new plans for preventing damage or danger therefrom were suggested. The author then described a very remarkable effect produced on the telegraphic instrument on the London and North-Western Railway, on the 24th September, 1847, and said the cause of such effects was as yet enveloped in mystery. The manner in which the electric telegraphs were affected during the beautiful auroreal display of the 17th of November, 1848, were minutely described, and the action upon the wires where the greater portion of their length was in the inside of a tunnel, was noticed.

Various experiments were made by the author during the evening; the paper was illustrated by numerous diagrams; and a series of new electric telegraphs were exhibited at work.

Jan. 31.—W. Tooke, Esq., F.R.S., in the Chair.

Robert Hunt, Esq., read a paper "*On the Photographometer, for measuring the intensity of the Chemical Action of the rays of Light on all Photographic preparations, and for affording a means of comparing the Sensitiveness of the same.*" By A. Claudet, Esq.

The art of photography, observes the author, is founded on the property with which light is endowed—namely, of producing a photographic effect when it strikes upon certain chemical compounds. The effect being in proportion to the intensity of the light during a given space of time, it is necessary, for the success of the operation, to be able to ascertain the exact power of the light at any particular moment, and the only means of so doing hitherto possessed by the photographer, is the effect it produces on the eye. A few only of the rays which emanate from the sun are capable of producing on the chemically-prepared surface, an effect which is the cause of the photographic picture; and if it were possible to admit into a room only the rays which are endowed with the power of affecting the photogenic preparation, the objects in the room would not be visible to the eye, as the room would appear to be plunged in darkness, while the objects in it would reflect some invisible rays which are capable of producing the photographic image.—This fact the author illustrated by a series of specimens, in which the effects of rays of light were reflected from the various colours used on porcelain.

The property of absorption possessed by red, orange, yellow, and green glass being known to photographers, and the power of admitting through blue glass nearly all the photogenic rays which are not luminous, combined with the improvements which have taken place since the discovery of the art by Daugerre, enable the photographist of the present time to employ a very soft light, and to place the sitter in the shade.

The action of the blue and yellow rays was shown by covering a large print, one half with dark blue, and the other half with yellow glass. That portion of the print which was visible to the eye through yellow glass, was rendered invisible by the action of the ray on the photographic plate; while the ray reflected from the blue glass, which entirely obscured the picture, was rendered perfectly clear and distinct.—Several specimens, intended to show that the luminous and photogenic rays are not the same, were also exhibited.

Several philosophers are of opinion that the photogenic rays are as independent of the light as heat is, although they are sent forth from the same source, and travel together at the same velocity, and are subject to the same laws of reflection, refraction, and polarization. The actinic or photogenic rays are situated as the most refrangible part of the prismatic spectrum, and are thus refracted to the same degree as the blue, indigo, or violet rays. A series of experiments on various colours obtained by artificial means were next exhibited, the whole tending to prove that the atmosphere of London with its smoke and fog, is too often for the photographer like the ray from the yellow glass.

As the result of the photographic operation depends on the intensity of the actinic rays, and also upon the degree of the sentiveness of the chemical preparation, M. Claudet has constructed an apparatus which is not only capable of measuring the photogenic light, but of testing the sensitiveness of the chemical preparation of the Daugerreotype plate. This instrument is constructed so that a plate being placed upon an inclined plane, will always fall with the same rapidity. For each operation, the plate has seven vertical slits or openings cut in it; these are placed parallel to each other, the first being 1 millimetre wide; the second, 2; the third, 4; the fourth, 8; the fifth, 16; the sixth, 32; and the seventh, 64 millimetres. The photographic surface is placed at nearly the bottom of the inclined plane, under a metallic plate, pierced with seven circular holes, corresponding with the openings of the moveable plate containing the proportionate apertures. When the moveable plate passes before the photogenic surface covered with the seven circular holes, the light strikes upon the spaces left open by the circular holes, in various intensities. The space lighted by the opening of 64 millimetres will be affected by an intensity double that which is lighted by 32 millimetres; quadruple that of the next under the opening of 16 millimetres; and so on, until the last opening, which being only 1 millimetre, will have received 64 times less light than the first; so that after the operation seven round figures, or less, according to the intensity of the light, are represented upon the photographic plate. The photographer is thus enabled to ascertain how long it will be necessary to submit the plate to the action of the light on the camera by the length of time required to develope the seven round figures. Let us suppose that he waits ten seconds, and he finds only six instead of seven of the round figures, it would prove that the light is one-half less intense than he required, so that he must wait 20 seconds instead of 10; if only five, 40 seconds; if four, 80 seconds; if three, 160 seconds ;if two, 320 seconds; if one, 640 seconds. This is quite sufficient for general purposes of photography; but for scientific investigations, M. Claudet has continued the geometrical progression, and instead of from 1 to 6, he has continued the progression from 1 to 8192. This is effected by having two plates and four series of holes in each plate, and shutting one series after every fall of the moveable plate. By repeating the falls, the intensity is doubled, trebled, quadrupled, and so on; and after the operation each plate represents four series of round figures, showing the various effects of all the intensities, from 1 to 8192.

M. Claudet's Photographometer enables the operator to compare the sensitiveness of two different preparations, so that the photographer can constantly by experiments improve the sensitiveness of the surface.

Mr. T. B. Jordan gave a short account of Mr. Cochran's machine for sawing timbers with curved and bevelled faces, and a working model was exhibited to the meeting.

INSTITUTION OF CIVIL ENGINEERS.

Feb. 6.—J. Field, Esq., President, in the Chair.

The paper read was a "*Description of the Abbattoirs of Paris.*" By Mr. R B. Grantham, M. Inst. C.E.

The subject treated of was chiefly in connection with the sanitary question, at present occupying so much attention; the author being of opinion that much public benefit would be derived from the introduction of similar establishments into the city of London. The paper commenced by pointing out the advantages resulting from the method in which the butchers' trade was carried on in Paris. It was stated that this trade was regulated by a number of restrictive enactments, and conducted under the control of a syndicate or guild, who advised with the government upon all questions relating to the abbattoirs and markets.

It appeared from the account that, previous to the opening of the abattoirs, in 1818, slaughter-houses existed in the crowded and populous districts of the city; and that (as at present in London), the passage of the cattle through the streets, and the consequent nuisances, were found to be intolerable. The five abbattoirs were designed with great care, to obviate these evils, and were generally allowed to have fully accomplished the purposes for which they had been constructed; they had been of great public service, in rendering Paris free from those nuisances which were still permitted to exist as such blots on the general cleanliness of the city of London. The abbattoirs were erected within the Barriers, opposite Montmartre, Menil-Montant, Grenelle, Du Roule, and Ville Juif, at an average distance of a mile and three quarters from the centre of the city.

The paper, which was accompanied by detailed plans of each abbattoir, and a general drawing of their arrangement, described minutely their construction, as well as the mode of slaughtering the cattle, the melting the tallow, and other details connected with the trade carried on therein. All the buildings were stated to be abundantly supplied with water, well ventilated, and kept in the highest state of cleanliness.

Tables were given of the number of cattle, sheep, and pigs killed, and the amount of tallow melted during the last four years; and a statement was appended, from which it appeared that the revenue (derived from tolls, charged upon all the meat killed at per kilogramme), amounted during one year to 47,608*l.* 16*s.*, that the total expenses were 4,958*l.* 12*s.*, leaving a profit to the city of Paris of 42,650*l.* 4*s.*, or about 6¼ per cent. upon 680,000*l.*, the original cost of all these establishments. The paper argued that if this revenue was obtained from the tolls, &c., for slaughtering meat for a population not exceeding one million souls, who did not consume anything like the amount of animal food that Englishmen habitually indulge in, how much greater would be the profit of such establishments for London, where there was a population nearly approaching three millions of souls, in whose behalf such strenuous exertions were now making for the increase of sanitary regulations and more ample supplies of water, and everything tending towards a higher state of cleanliness and health.

Remarks.—In the discussion which ensued, and in which Mr. E. Chadwick, Professor Owen, Messrs. Leslie, May, Allen, Ransome, Elliott, Armstrong, and others, took part, very interesting statistical facts were given in connection with the present state of the Smithfield Market, and the evils attendant upon the animals being driven through the streets, and then killed in a state of fever, when the blood was in a condition to induce rapid decomposition of the meat, and render it unfit for food. In proof of this, it was stated that, in the summer, quantities of fine meat were frequently obliged to be thrown by the butchers upon the offal heap, within thirty hours from the time of the animals being slaughtered—putrescence being so rapidly induced by the deleterious atmosphere of the slaughter-house pervading the place where the meat was kept.

Among the numerous advantages of a new and spacious establishment, like that of Islington Market, to which public slaughter-houses are to be attached, would be the direct contact of the cattle sellers with the butchers; and by thus avoiding the intermediate profit of the middle men, the latter would be enabled to sell their meat in better condition, and at a more reasonable rate, to the public.

The present objectionable state of Smithfield appeared to be upheld merely as a question of revenue to the city, for which the public not only paid heavily, but suffered severely by common annoyance and by the deleterious effect on public health.

Modifications of the Paris system wre shown to be perfectly adapted even to the actual state of the butchers' trade in London; that the internal arrangements of the slaughter-houses would not in any way interfere with the employment of the servants of the butchers, nor could any inconvenience arise from their congregating at such places—nor any loss from theft. All these preventive arangements had been fully explained by Mr. Grantham, in his recent Treatise on Public Slaughter-houses. (reviewed *ante* p. 51.)

The opinion of the meeting appeared to be pointedly in favour of so desirable a measure as the establishment of Islington Market; and hopes were expressed strongly, that, by showing to the trade that their interest was so intimately connected with the measure, their co-operation would be obtained, to their ultimate profit, as well as for the public good.

ROYAL SCOTTISH SOCIETY OF ARTS.

Jan. 8.—John Clay, Esq., F.R.S.E., President, in the Chair.

"*The Aneroid Barometer*" was exhibited and described, by Alexander Bryson, Esq.—Mr. Bryson stated that on trial he had found the barometer to correspond with the common barometer, within the ordinary limits, say from 28 to 31 inches, to within a tenth of an inch, so that for all ordinary purposes it might be trusted to. It has the advantage over the common barometer, in being easily transported, having no liquid in its interior. It is of a circular shape, like a watch, and is about five inches in diameter, having an index hand which points to the weight of the column of air.

Jan 23.—The following communications were made:—

"*Description of an Improved Window-sash, allowing the outside of the Window to be cleaned or glazed without danger.*" By Mr. Charles Deans.—This safety window effectually prevents all chances of accident, as the glass of both upper and lower divisions may be cleaned with perfect ease and safety by a person standing on the floor inside of the window. The principle is applicable to every form of modern window, and consists in the panes of glass being contained in a separate frame, which is to be exactly adjusted to and fitted in the sash, to which it is to be attached on one side by hinges, the other side remaining free, and opening inwardly like a door. In appearance it can scarcely be distinguished from the present window, and the expense is not materially different.

"*Description of the Wax Candle Safety Mining Lamp*" By Mr. John Crane, Lee Crescent, Edgbaston, near Birmingham.—This lamp was stated to be of simple but safe construction. Coal-pits being subject to the presence of an explosive gas called fire-damp, which, upon contact with flame, is exploded, the necessity of lighting coal-pits with non-exploding or safety lamps becomes evident. Coal-pit explosions are all the result of negligence, and therefore, by means of proper care, are avoidable. That to work coal-pits safely it is not only necessary to use safe lamps, but also to take care to use such lamps properly Many terrible explosions have occurred during the use of safety lamps, because the men (with a view of obtaining more light) have interfered with their lamps and rendered them unsafe. If the common safety lamps afforded a better light than a naked candle, there would then be no inducement to tamper with them, and the prime cause of many explosions would be removed; and if they were constructed so that they could not be tampered with by any thoughtless miners, then (supposing that no naked lights were used in pits, but in every case safety lamps of proper construction) coal-pit explosions would be no more heard of. The author's wish was to accomplish so desirable an end by designing lamps possessing such advantages, and by recommending the adoption of a more careful mode of working pits. He thinks in few cases it will be advisable to entrust the miners with the care of the lamps; but that in most cases fit persons be appointed to keep and manage the lamps, who must be held responsible for any neglect of care on their part. The Wax Candle Safety Lamp is stated to afford a good light, and it is fitted with a padlock and staple, so that it may be securely fastened up. It is put into the hands of the collier ready lighted and locked, and will need no interference till the candle is consumed, when he must apply to the lamp-keeper for a fresh one. Wax candles (such as are used in many carriage lamps) are burnt in this lamp. The front is made of thick glass, the sides and top of wire gauze, and the body of the lamp of tin plate. The candle is inclosed in a tin tube secured at bottom by a stopper, which is screwed and unscrewed with a key. After the candle is lighted the top is shut down and locked, and both keys kept by the superintendent of lamps. The same keys will unlock any number of lamps, if they be made similar. A helical wire spring inside the tube keeps the candle always at the same height. Over the two wire sides are hinged two tin covers which effectually protect the flame from the evil influence of wind. This lamp can be made of various sizes to suit different candles; those which the author has had made are four inches square, and about eleven and a half inches high. A large ring is fixed to the top of the lid, by which the lamp is suspended when in use. The wire gauze inside the lid must be cleaned with a brush when necessary. The lamp is strong, and is not likely to be put out of order. The author's wish and desire are to see an end put to explosions, and thereby to render the occupation of the collier—arduous and unpleasant as it always will be—less dangerous by ridding it of its greatest terror.

Feb. 12.—David Rhind, Esq., F.R.S.E., V.P., in the Chair.

The following communications were made:—

1. "*Description of a method of Preventing Accidents at Coal Pits.*" By Mr. William Alexander, mining engineer.—The breaking of the winding-rope, or continuous movement of the machinery beyond its proper place, are two circumstances rife with accident and loss of life in mineral workings. Mr. Alexander avoids the first by an improved catch in connection with the cage; and the second, in consequence of winding by friction, which becomes self-acting, in preventing the rise of the cage past a given point.

2. "*Description of an Hydraulic Bramah Press, with Improved Safety Valve.*" By Mr. Hay Dall, brass-founder.—This improvement in the Bramah press consists in doing away with the heavy weight formerly hung on the safety or disengaging valves, and thus producing greater certainty of action, and a saving of expense, by preventing the liability to wear and break up, to which the present construction is exposed.

3. "*Description of a Machine for Dressing Straw Bonnets, or other matters where hot or cold pressure is required.*" By Mr. George D. Howell.—It is intended to reduce the labour and many inconveniences in the old mode of blocking straw bonnets, which, from the pressure required on the breast, often produced complaints in the chest, and consumptions. The machine has been in use for some time, and found to answer every purpose required in the art. The pressure which, in the old mode, was given by the breast and arm, is by this machine given by the lever worked by the foot, and counterpoised by the back weight, which instantly lifts the blocking iron when the pressure of the foot is withdrawn.

4. The Secretary read an abstract of the first part of a paper on Improvements in Electric Telegraphs, and new plans for Printing by Electricity, which was read to the Society of Arts, London, by E. Highton, Esq., civil engineer, on the 17th January.

NOTES OF THE MONTH.

The New Kremlin at Moscow.—The *Moscow Gazette* says:—The new Kremlin will shortly be finished. The gilded cupola sparkles already in the sun, and recalls to mind the palaces with their golden summits of the ancient Grand Dukes of Russia. In the St. George's-hall, that saint is to be seen on horseback, fighting the winged dragon. Eighteen statues, representing the submission of as many provinces now belonging to Russia, are scathed in complete armour with shields, which bear the date of the period. The Andrew's-hall, or the throne room, is ornamented with magnificent golden relief; the Alexander-hall is of red marble, and astonishes the beholder by its beautiful architectural ornaments. It is difficult to describe, so as to give a correct idea, the extraordinary grandeur of these halls, and the exquisite style of the workmanship.

The Oriental and Peninsular Steam Navy.—The Oriental and Peninsular Steam Company have added another first-class steam-vessel to their already powerful navy, which will shortly be equal to that of any of the continental governments, when we take into consideration the effective state the whole of the vessels are constantly kept in. The *Bombay* vessel which has just been finished was built by Mr. Pitcher, and is 1,200 tons burthen. The engines were constructed by Messrs. Miller, Ravenhill, and Co., and are collectively of 450-horse power; the cylinders are oscillatory. At the experimental trip made last month, they worked with great precision, owing to the beautiful workmanship and the accuracy of their finish. The performance of these engines clearly substantiates the opinion that was expressed in this *Journal* eight years since, when only oscillatory engines of 20 and 30 horse power were constructed, that with good workmanship oscillating engines of any power might be made.

Pierce's Pyro-Pneumatic Stove.—Mr. Pierce, the well-known stove manufacturer, has patented a pedestal stove, with an open fire and hot air chambers, formed of fire clay. The air is admitted at the bottom by a tube, brought from the exterior of the building and carried through the chambers, which are heated from the back and sides of the stoves, and also by the flue that passes out at the back. The air by this stove is not burnt, as is generally the case with hot-air stoves constructed of iron; and by having an open fire the room is ventilated, and the foul air carried off by the draught of the fire.

Dia Magnetism.—The investigations now proceeding in the hands of Œrsted, Plücker, Faraday, Weber, and other no less able experimentalists, into the phenomena of dia-magnetism are gradually developing facts that bear in a remarkable manner on all those less evident powers which are usually classed under the general term of molecular forces. We may hope within a short time to gain a more satisfactory knowledge of crystallisation, and the laws which determine the forms of crystallised bodies, into which the recent researches of Faraday and Plücker are conducting us. The curious observations of Plücker, which show that in the vegetable kingdom both the magnetic and dia-magnetic forces are, under varying conditions, in great activity, will in all probability direct us toward a solution of the curious problem of the influences of the solar rays on vegetable growth. That dia-magnetism is not another manifestation of ordinary magnetism is now proved by the single fact, that whilst a magnetic body is attracted throughout its mass by each of the two poles of a magnet, a dia-magnetic body is repelled by each pole throughout its mass.—*Athenæum.*

To prevent Metals corroding.—Dip the articles first into very dilute nitric acid, afterwards immerse them in linseed oil, and then allow the excess of oil to drain off.

Improvements in the Make of Iron.—The astonishing increase in the produce of the furnaces in the bituminous districts takes its origin from the application of steam and engine power to the production of a continuous stream or pillar of blast, in place of the puffing of the old-fashioned wind bellows; and, further, to a discovery of my highly-valued friend, Anthony Hill, Esq., of the Plymouth Works, Merthyr-Tydvil. It is to the science, energy, and research of this gentleman, that the iron-trade is indebted for the practical discovery that the cinders produced in the various stages of converting, in our forges, crude or cast-iron into wrought or malleable iron, were capable of being resmelted and reconverted in the blast-furnace, and the iron they contained (amounting to 50, 60, and 70 per cent.) profitably extracted from them. These cinders were formerly thrown away as refuse, or used only for the repair of our roads and thoroughfares—they are now eagerly sought after, and purchased at values as high as some of our richest iron ores. To Mr. Hill a debt of public gratitude, and something more, is due, which I should rejoice to see properly acknowledged and paid. Mr. Yates, of Rotherham, Yorkshire, has, at his works at Wingerworth, near Chesterfield, erected blast furnaces of an entirely different construction from those in use in this district, and the plan of which he has patented. They are about 20 feet in height, of a peculiar shape, and are blown with a soft fan-blast. When I visited them, a few months ago, they were working admirably, and producing excellent pig-iron, at the rate of 120 tons and upwards in a week, at each furnace. These furnaces, and their blowing apparatus and appendages, appeared to me so simple and inexpensive of construction, in comparison with the huge piles of masonry and ponderous machinery of our blast-furnaces and engines in Wales, that I imagined they would create a perfect revolution in the iron trade. In the anthracite districts of our mineral basin, the improvements effected by the late Mr. Crane, and the application by him of hot blast to the smelting of iron with anthracite coal, were acknowledged, certainly not more gratefully than they deserved to be, by those who are interested in the mineral productions of the anthracite districts, wherein the deposit of ironstone or ore is enormous, but its reduction with its accompanying fuel almost new. The recent improvements of Mr. J. Palmer Budd, adopted at his extensive works at Ystalyfera, near Neath, and patented by him, are worthy of the greatest attention. Mr. Budd, who read an admirable paper, explanatory of his improvements, to the chemical section of the meeting at which my address was delivered, and with the kindest liberality, invited the members of the association to visit and inspect his works, has succeeded in economising the use and consumption of an expensive and valuable fuel, and in preserving from positive waste, and applying to profitable use, volumes of heat evolved in the process of smelting, heretofore allowed to escape.

Mineral Resources of Epypt.—More Gold.—A recent number of the *Bombay Telegraph* contains an account, from a correspondent at Cairo, of an expedition of Colonel Kaveloveski, engineer of mines in Russia, who was sent to Egypt, at the desire of Mehemet Ali, to investigate the mineral resources of that country, which appears to have resulted at the discovery of a somewhat productive gold district. The expedition (it is stated) which left Cairo under Colonel Kaveloveski, arrived at Cassen on the 16th of March. The next day he commenced his researches, with his Siberian assistants, on the eastern side of the river Somat. The Egyptian soldiers dug wells to the depth of 200 feet, when water appeared; the sand or material was then submitted to the process of washing. In an hour's journey from the river the colonel came to a place encompassed by small hillocks, not higher than 40 or 50 feet. He immediately decided that veins of gold would be found there, and directed that they should be dug into about half their height, ordering the excavated materials to be afterwards carefully examined. He continued these operations for six or seven days, the Siberian workmen washing the sands upon a drum. On the eighth day he concluded from the results that these sands were richer than those in many parts of Siberia; for 100 poods of sand in Siberia produced but 25 habbhas, whilst 100 poods were yielding at Cassen from 50 to 52 habbas. On the ninth day the colonel directed his Russian workmen to prepare the machines for washing, whilst he departed to make new researches with about 1,000 Egyptian soldiers, using them occasionally for the works, and sometimes for personal safety. He made several experiments on the banks of the rivers Ramis, Dys, Gucka, and Benischangol, and afterwards at Sorgonti and Gamamil; this last river is about eight hours' journey south of Cassen. Here he found the sands considerably richer than those of Cassen. In his travels, the colonel found quantities of argillaceous iron, rock crystal, and zinc, but no other metals, nor any vestige or appearance of coal. On taking his departure from Cassen he left the works under the direction of two Arab engineers or mineralogists, who studied in Germany and Siberia. Colonel Kaveloveski pronounces his final and decided opinion that the richest sands are to be found on the eastern bank of the Somat; and he does not believe that any other place which he has searched will produce results so favourable.

Artificial Light.—Professor Brande delivered a lecture at the Royal Institution, "On the Theory and Practice of the Production of Light." Mr. Brande commenced by referring to the mould candles and single-wicked oil-lamps used in houses and streets at the beginning of the present century; and remarked that the vast improvement made in artificial illumination might be taken as a striking instance of the great influence of applied science on the comforts of life. He then proceeded to give a statement of the scientific causes of this improvement. In common flames the evolution of light results from two independent causes—*ignition* and *combustion*. *Ignition* is probably a mere transient physical state of matter, producing no change in the ignited substance. *Combustion* is essentially a chemical phenomenon,—the heat and light produced are the effect of successive chemical actions, and the substance is permanently changed. *Combustion*, then, may be regarded as the origin of the heat—*ignition* of the light afforded by flame. Mr. Brande demonstrated by many experiments that the luminosity of flame is due to solid matter existing in the combustible gas; and he noticed the expansive effect of heat in throwing down charcoal in the combustion of olefiant gas. The conditions of the fitness of bodies for purposes of common illumination were stated to be, that the matter from which the luminosity is to be obtained should be combustible; and that the product of its combustion should be *gaseous inodorous*, and *harmless*. The products of the combustion of oil; wax, tallow' and gas were contrasted with those of phosphorous, arsenic, &c.—which, but for the corrosive and poisonous matters resulting from their combustion, might be used as sources of light. It was also noticed, that though carbonic acid gas (which is one of the products of the combustion of coal gas, &c.), be in itself noxious, it becomes harmless when diffused through the atmosphere. The importance of an accurate adjustment of the solid matter of the combustible to the oxygen required for its combustion was next dwelt upon. It was shown by experiments with Leslie's burners that when too much air is admitted to a flame light is lost, and that in an insufficient supply of air the flame emits smoke, owing to the imperfect combustion of its carbon. The light of flame must be as nearly white as possible. This was proved by the obliteration of colour when viewed by a monochromatic flame. That artificial light may imitate that of the sun in purity was shown by the obtaining a Talbotype in less than a minute by the light of phosphorus burnt in oxygen. A brilliant light was exhibited, produced by a kind of petroleum. From 130 to 150 gallons of this substance are daily collected at Ridding, Derbyshire. By distillation it yields 5 per cent. of naptha, 5 per cent. of paraffine (mineral tallow), and 80 per cent. of mineral oil. This oil is worth above 4*s*. a gallon; and when burnt in a common argand lamp gives the light of seven candles at the cost of three-eighths of a penny per hour. In conclusion, Mr. Brande noticed the electric light. He mentioned that the notion of electricity, as a source of illumination, had been suggested by Davy nearly half a century ago, with whom it was a favourite idea. Mr. Brande stated that a mode of procuring cheap electricity must precede the economical use of such illumination; and that were this obtained, water might be decomposed, and its hydrogen napthalised and then burnt, so as to produce a vivid, bright, and steady flame in its other element—oxygen.

Loss of Lives in Mines.—A correspondent suggests, with regard to the recent lamentable colliery accidents, a mode whereby similar casualties may be materially prevented. From experiments just made with gutta percha tubing, he finds that its power of conducting sound is so extraordinary, that a conversation may be distinctly carried on at the distance of even three-quarters of a mile. If, therefore, this tubing be carried down the shaft to the various workings of the mine, and the extremities furnished with a mouth-piece and whistle, an instant communication, in case of danger, may be made between every part of the mine and the men at the mouth of the shaft.

Launch of the Vulcan Steam-Frigate.—This vessel, built of iron, by Mr. Mare, of Orchard Wharf, Blackwall, was launched on the 27th of January last. The following are the dimensions:—

	ft.	in.
Length between perpendiculars	220	0
Length of keel for tonnage	195	4½
Breadth for tonnage	41	8
Depth in hold	26	0

Burden in tons, 1,747 15·94.

The Vulcan was constructed to carry engines of 700-horse power, by Messrs. George and Sir J. Rennie, and to carry the following armament:—On the main deck, eight 32-pounder guns of 56 cwt each, 9 ft. 6 in. long, and two 68-pounder guns 112 cwt. each, 10 ft. 10 in. long. On the upper deck, two 8-inch guns 65 cwt. each, 9 ft. 6 in. long, and two 32-pounders of 25 cwt. each, 6 feet long. She has since been reduced to have only engines of 350-horse power, and converted into a troop-ship, capable of carrying at least 1,000 troops with every convenience for them. She has excellent room betwixt decks, and when fitted with her screw-propeller, which will occupy about two months in completion, will add a splendid troop-ship to the navy. Mr. Bellamy, master attendant at Woolwich Dockyard, was on board during the launch, and the Vulcan was navigated round under his directions, towed by the Monkey, to the East India docks, where her engines will be put on board. Her draught was 11 feet on launching, but when her stores are on board and complete for service she will draw about 16 feet.

Thames Steamboats.—Several experimental trips have been made with the new iron steamboat, the Emmet, of the Janus or double-headed build, and intended for the halfpenny passenger trade, in company with the Ant and the Bee. The engines are made by Messrs. W. Joyce and Co., of the Greenwich Iron-works, and are nominally of 20-horse power each; but their actual power, as given by the indicator card, is 88 horses. The whole of the engines, as well as the framework, is of wrought-iron. With regard to the performance on Friday, the 19th ult., the Emmet started, with tide, from Blackwall at ten minutes to one o'clock, and arrived off the Town Pier, Gravesend, at two o'clock, thus accomplishing the entire distance in one hour and ten minutes, or at the rate of 17 miles an hour. On her return, she ran a race with the Brunswick, and from Erith to Blackwall ran with her, the paddle-boxes not one foot asunder the whole of the distance. At another experiment, she ran against the tide about 14 miles an hour.

Steamboats for America.—Two new vessels, which will surpass all the others in size and splendour, are about being laid down by the British and North American Company, to replace the Acadia and Britannia, which have been sold.

War Steamers for Germany.—The steam-ships *Acadia* and *Britannia*, so celebrated in the British and North American Company's mail service between Liverpool and the United States, have recently been purchased from that company by one of the German governments. They are now in the Coburg Dock, Liverpool, undergoing the necessary alterations to their being converted into efficient war-steamers. The passengers' saloon, on the main deck, has been cleared off, so that they will be flush fore and aft. Their armament will be of the heaviest description.

The Tides in the German Ocean.—A striking example occurs to us of the happy connection of theory with observation, in the prediction that there must exist a spot in the German Ocean—the central point of an area of rotation, produced by the meeting and mutual action of two opposite tides—where no rise or fall of tide whatever could occur: a prediction actually verified by Captain Hewitt in 1839, without any prior knowledge that such a point had been supposed to exist. This is one among the many triumphs of like kind achieved by modern science.

To Split Paper.—Procure two rollers or cylinders of glass or amber, resin, or metallic amalgum; strongly excite them by the well-known means, so as to produce the attraction of cohesion, and then with pressure pass the paper between the rollers. One half will adhere to the under roller, and the other to the upper roller, and the split will be perfect. Cease the excitation and remove each part.

Mineral Oil.—In a coal-pit, near Alfreton, belonging to Mr. Oakes of Reddings, a valuable spring of a mineral oil, as naphtha, has made its appearance. The quantity varies according to the fall of the roof of coal from 150 to 30 gallons daily. The pit in which the spring occurs is said to be the deepest in that part of the country. Some years since a large spring of salt water, or nearly saturated brine, appeared in this pit, and has continued to flow uninterruptedly; latterly, the mineral oil has accompanied the salt spring. The oil as it issues is of a dark tarry colour; but, by distillation, yields first a very volatile liquid, which is found to be a good substitute for chloroform as an agent for acting on the nerves of sensation; and, secondly, a nearly colourless oil, which possesses very high illuminating powers, and possessing the advantage that it will not burn without a wick, thus rendering it free from the objection which has been found to attach itself to the use of camphine. As a final product of the distillation, abundance of solid paraffin is obtained; this substance being described by Reichenbach as invaluable for machinery, from its anti-frictional properties, and its unchanging character when exposed to air. It is understood that a house in Manchester has contracted for this mineral oil, with a view of introducing it for the purpose of house illumination. A similar spring is recorded to have occurred about a century since, near Birmingham. They are common in Persia and in Italy. Milan is illuminated with the product of a similar spring. We have been informed that a chemical examination of the various oils of which the Derbyshire spring consists is being made in the laboratory of the Museum of Practical Geology.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM JANUARY 25, TO FEBRUARY 22, 1849.

Six Months allowed for Enrolment, unless otherwise expressed.

Pierre Frederick Gougy, of Paris, in the Republic of France, gentleman, for improvements in apparatus and machinery for lifting and moving heavy bodies, and for raising or displacing fluids.—Sealed Jan. 27.

Richard Archibald Brooman, of Fleet-street, City of London, for certain improvements in the manufacture of artificial limbs. (A communication.)—Jon. 27.

James Green Gibson, of Ardwick, near Manchester, machinist, for certain improvements in machines used for preparing to be spun and spinning cotton, and other fibrous substances, and for preparing to be woven and weaving such substances when spun.—Jan. 27.

Ewald Riepe, of Finsbury-square, Middlesex, merchant, for improvements in the manufacture of soap.—Jan. 30.

Alexander Wilkins, brewer, and William Stacey, engineer, of Bradford, Wilts, for a certain improvement or improvements applicable to the heating and boiling of liquids of any kind or description.—Jan. 30.

Samuel Wellman Wright, of Chalford, Gloucester, civil engineer, for certain improvements in preparing various fibrous substances, for spinning, and in machinery or apparatus connected therewith.—Jan. 30,

William Kenworthy, of Blackburn, Lancashire, cotton-spinner, for certain improvements in power-looms for weaving.—Jan 31.

Henry Bessemer, of Baxter-house, Old St. Pancras-road, Middlesex, engineer, for certain improvements in the manufacture of glass, and in apparatus connected therewith.—Jan. 31.

Jean Adolphe Cartéron, of Paris, in the Republic of France, now of the Haymarket, Middlesex, chemist, for certain improvements in dyeing.—Feb. 5.

John Brown, late of Bond-street, now of Great Portland-street, Middlesex, gentleman, for improvements in constructing and rigging vessels: and improvements in atmospheric and other railways.—Feb. 6.

Edmund George Pinchbeck, of Fleet-street, in the city of London, for improvements in certain parts of steam-engines.—Feb. 6.

Thomas Snowdon, of Noel-street, Middlesex, engineer, for improvements in machinery for moulding and pressing artificial fuel and bricks.—Feb. 6.

Joseph Harrison, machine maker, William Harrison, cotton manufacturer, and John Oddie, assistant manager, all of Blackburn, Lancashire, for certain improvements in and applicable to looms for weaving.—Feb. 6.

Henry Fisher, of Upholland, Lancashire, gentleman, for improvements in coke ovens, and in machinery and apparatus for working the same, or connected therewith; and a mode or modes of applying certain portions of coke, or the residual products of coke, to heating and lighting.—Feb. 8.

Lawrence Hill, junior, of Motherwell Iron Works, near Hamilton, Lanarkshire, civil engineer, for improvements in the manufacture of iron, and in the machinery for producing the same.—Feb. 8.

Henry Headley Parish, of Eaton-place, Middlesex, gentleman, for improvements in safety and other lamps, and in gas-burners.—Feb. 8.

Richard Pannell Forlong, of Bristol, button manufacturer, for improvements in castors for furniture.—Feb. 8.

William Wilcocks Sleigh, of Stamford Brook House, Chiswick, Middlesex, doctor of medicine, for a means of preventing injuries to persons and property, from the sudden stoppage of railway carriages.—Feb. 8.

James Webster, of Basford, Nottingham, engineer, for certain improvements in apparatus for manufacturing gas.—Feb. 8

John Taylor, of Parliament-street, Westminster, architect, for an improved mode of constructing and fencing walls.—Feb. 8.

Joseph Barnes, of Church Lancaster, for an improved apparatus for bleaching, dyeing, cleaning, and steaming animal, vegetable, or fibrous substances, either in a raw or manufactured state.—Feb. 8.

Robert Brown, of Sadler's-wells, Middlesex, engineer, for improvements in machinery for perforating, sewing, stitching, pegging, and riveting.—Feb. 8.

William Tooth, of Broad-street, Lambeth, engineer, for improvements in water-closets and in chimney-pieces, in machinery for the preparation of clays, and in the manufacture of earthenware articles.—Feb. 8.

Thomas Charles Clarkson, of Bennett-street, Southwark, manufacturer, for certain improvements in the manufacture and application of leather, and certain vegetable substances to be used in combination with leather, India-rubber, canvas, silk, cotton, wool, or other fibrous substances, in the manufacture of certain waterproof articles.—Feb. 8.

John Giblett, of Trowbridge, Wilts, gentleman, for improvements in the manufacture of woollen cloth.—Feb. 10.

George Edmund Donisthorpe, of Leeds, manufacturer, and James Milnes, of Bradford, Yorkshire, for improvements in the apparatus used for stopping steam-engines and other first movers.—Feb. 10.

Jarvis Palmer, of Camberwell Surrey, merchant, for improvements in matches, lighters, and similar articles for igniting combustible bodies; in the mode or modes of manufacturing the same, and in machinery applicable thereto; also in match or other boxes, and in machinery for manufacturing the same.—Feb. 12.

William Harris, of Battersea, Surrey, shoemaker, for a new or improved mode of preparing leather.—Feb. 12.

William Brewer, of Malcolm-place, Clapham, Surrey, and John Smith, of Southville, South Lambeth, Surrey, manufacturers, for certain improvements in the manufacture of paper and card-board; and in producing water-marks thereon; and also in apparatus and machinery to be used for such purposes.—Feb. 12.

Christopher Nickels, of York-road, Lambeth, Surrey, for improvements in the manufacture of woollen and other fabrics.—Feb. 12.

Edward Newton, of Chancery-lane, civil engineer, for improvements in engines and apparatus principally designed for pumping water.—Feb. 12.

Matthew Townsend, and David Moulden, both of Leicester, framework-knitters, for improvements in machinery for the manufacture of looped fabrics.—Feb. 13.

Edward Newton, of Chancery-lane, civil engineer, for improvements in machinery for hulling and polishing rice and other grain or seeds. (A communication.)—Feb. 13.

Edward Lord, of Todmorden, Lancaster, machinist, for certain improvements in machinery or apparatus applicable to the preparation of cotton and other fibrous substances.—Feb. 13.

Achille Chaudois, of Faubourg du Temps, Paris, manufacturing chemist, for improvements in extracting and preparing the colouring matters for orchil.—Feb. 14.

William Chambers Day, of Birmingham, Warwick, iron-founder, for improvements in machinery for weighing.—Fec. 14.

Hugh Lee Pattinson, of Washington-house, Gateshead, Durham, chemical manufacturer, for improvements in manufacturing a certain compound or compounds of lead, and the application of a certain compound or compounds of lead to various useful purposes.—Feb. 14.

Richard Ford Sturges, of Birmingham, Warwick, britannia-ware manufacturer, for improvements in the manufacture of candlesticks and lamp pillars.—Feb. 14.

John Erwood, of Hoxton, Middlesex, paper-hanging manufacturer, for improvements in the manufacture of paper-hangings.—Feb. 15.

Charles Thomas Pearce, of Park-road, Regent's-park, gentleman, for improvements in apparatus for obtaining light by electric agency.—Feb. 16.

Charles Frederick Whitworth, of Hull, gentleman, for improvements in preventing accidents on railways.—Feb. 17.

John Bottomley, of Bradford, Yorkshire, manufacturer, for improvements in machinery for weaving.—Feb. 22.

reflection of it; whereas, we now content ourselves with reflected light alone, and are fain to plume ourselves upon reflecting Mediævalism, or Revivalism, or Sansovinism, or Palladianism, or Elizabethanism, or Louis-Quatorzism, or any other in the interminments in machines used for preparing to be spun and spinning [illegible] substances, and for preparing to be woven and weaving such substances [illegible] Jan. 27.

Ewald Riepe, of Finsbury-square, Middlesex, merchant, [illegible] nufacture of soap.—Jan. 30.

NTRAL RAILWAY STATION, NEWCASTLE-UPON-TYNE.

John Dobson, Esq., Architect.

(With an Engraving, Plate VI.)

g described this building in our number for last December, a ground-plan of it was given, we need now accompany of it with no more than some observations upon its ar- al merits.—In the separate features which go to make up n, there is nothing at all remarkable, they being such as g become common property; and, moreover, one compart- the elevation serves nearly as a specimen of the whole of ertheless it is anything than common-place in expression, mely monotonous in effect. The style is Romano-Italian, oric order upon a sufficiently dignified scale, but so ap- t those rigorists and formalists who deem it the essence ectural philosophy to admit of only one invariable method y purpose and occasion, may object to it two serious s—viz., that of coupled columns, and again, that of broken ures. To allege that the Greeks never employed coupled , is sheer frivolousness of argument; because there was whatever in their temples that required or at all motived position of them. Where, indeed, strict conformity with precedent and physiognomy is affected, as in a pedimented portico, coupled columns may fairly be condemned as im- ies; but a case like the present is altogether different. The them here was almost matter of necessity; for had the en proportioned to only a single column, while the columni- ould have appeared straggling and meagre, the general olidity which now marks the *ensemble* would have been de- Another defect which is now avoided is, that over single the breaks in the entablature would have been too much e bits; whereas, coming over two columns, they rather help all interfere with breadth of manner, while they tell pic- ely as touches in the general composition. With regard to , it is stamped by character in a more than usual degree, ding bespeaking its purpose very plainly: the composition er pervaded by a quality which is too frequently lost sight sign, as well as kept quite out of sight in an outline en- . As will be concluded, perhaps, from this last remark, de to vigour of architectural *chiaro-scuro*, and effective of light and shade; to which must be added, the very un- epth of the portico or arcade—not less than 70 feet in the division of it—presents a strong contrast to that air of flatness and want of relief which, whatever may be their in other respects, stamps so many of our buildings; and that shallowness which is the chief characteristic of most porticoes. In fact, design as it shows itself in geometrical on seems alone to be considered by our architects, while ition in its wider sense, which includes both *chiaro-scuro* spective, is comparatively disregarded.

us not, however, lose sight of the particular building under , but proceed by calling attention to some of those points in our opinion, have been judiciously considered, and hap- ated. It will, we think, be admitted to be expressive of e, and to present a well-combined *ensemble*, in which oppo- alities are reconciled to and made to set off each other— , unity and variety, picturesque play of plan and outline, gard to the more prosaic demands of purpose and con- ce. Although the order is continued uniformly through- t is so with some difference, the central portion being dis- shed by having insulated columns, while the two lateral ons of the façade have only engaged ones. Moreover, gh each division consists of seven intercolumns or compart- , it is also with a difference, the extreme one at either end façade being closed up; which circumstance, independently contributing to variety, produces a most valuable expression dity and repose. The ornamental masses of attic are in- ed with artistic feeling akin to that of Vanbrugh, and serve duce that movement and play of outline in which he not elighted but showed himself to be a master. All that we y further is: let it be understood that we speak entirely after rawing. Even should the architect's intentions have been ted from in execution—the design have been tampered with, ave suffered accordingly, our remarks will nevertheless hold good, and apply to the design, if not, unfortunately, to the structure itself.

CANDIDUS'S NOTE-BOOK,

FASCICULUS XCII.

> "I must have liberty
> Withal, as large a charter as the winds,
> To blow on whom I please."

I. A great deal of what has passed for architectural criticism is mere cant, or else dogmatic, arbitrary assertion, unsupported by either evidence or argument, and relying chiefly upon certain talismanic words and phrases. Among terms of the kind which have been bandied about, and uttered by rote till they have nearly lost all meaning, is "Simplicity," than which hardly any quality seems to be less understood. Indeed, as it is usually applied, that word would seem to be expressive of the mere absence and negation of all artistic quality, or synonymous with poverty and vacuity of ideas, and meanness of manner. How many buildings there are for which Simplicity has been arrogated, merely because there is nothing worth calling design in them. People used at one time to cry up as Simplicity, the poor, meagre, vapid, mannerisms of James Wyatt, whose designs were for the most part stamped very legibly with what may be called either cockney classicality or classical cockneyism. In fact, terms that ought to convey something like an accurate and conscientious critical meaning, are so bandied about by the vulgar of all classes, and by vulgar and unscrupulous writers, as to have nearly lost their meaning altogether, and have become no more than tawdry brummagem epithets. There is in this metropolis a building which has been spoken of as being "*simple* without meanness, and *grand* without exaggeration,"—a prettily-turned phrase, no doubt; but no mortal would ever guess the piece of architecture which is so remarkable for the rare combination which it presents of Simplicity and Grandeur, since "littleness" and "gingerbread" would have been far more appropriate expressions. Reader, if you have been struck by the Grandeur of that architectural phœnix, you deserve to have been knocked down also; and if you have admired its Simplicity, you may set yourself down for a confirmed simpleton. Truly, there is Grandeur and Simplicity with a vengeance in the front of the "Society of Arts," in the Adelphi. Nay, the Adelphi-terrace itself has been characterised—not in a mere newspaper puff, but in a grave and authoritative encyclopædia—as "a most magnificent mass of building"! Pity that the most refined Simplicity was not claimed for it also, since it has just as much of the latter quality as of the other. Really after such specimens of it, one is actually ashamed of penning anything in the shape of architectural criticism,—for it seems to require only the brass of a bawd, and the *steel* of a pickpocket.

II. If not sickened of Grecian, or Anglo-Grecian, architecture before, we have got a complete sickener of it now, in the façade of the British Museum. Sir Robert Smirke has given the finishing stroke to that style by giving it its *quietus*. There may, perhaps, be some merit even in doing that,—so be *that* his praise; although we had much rather the experiment had been made *in corpore vili*, instead of being made on an edifice which ought to have been rendered a noble and worthy production of architectural design,—yet is no more than what any drawing-board tyro or any stonemason could have produced, the dimensions of the columns being given. With many blunders for which a tyro would deserve to be rapped on the knuckles, there is not one single artistic touch in the whole design,—not one that, as the French say, *accuses* the artist, although very much that accuses Sir Robert of being one of the most prosaic gentlemen in the whole profession. Even if we do not consider the wings as at all belonging to the main building, but merely as two ranges of street houses that happen to be so placed with regard to it, they manifest a most dull and chilling coldness of manner, that contrasts very strikingly with the ornateness now affected even in second-rate public buildings and in street architecture generally, at the present day.

III. If, as supposed, it be a fact that the Greeks borrowed the idea of their Doric style from the Egyptians, and founded it upon that of Egypt, they most assuredly pursued a very different course from that of the literal copyists, architectural transcribers, and plagiarists of the present day. What they adopted they made their own by educating it—so to say—and training it up in their own habits of taste. Greek architecture may have been kindled by Egyptian light, but it was very much more than the reflection of it; whereas, we now content ourselves with reflected light alone, and are fain to plume ourselves upon reflecting Mediævalism, or Revivalism, or Sansovinism, or Palladianism, or Elizabethanism, or Louis-Quatorzism, or any other in the interminable list of *isms*,—the most fatal one of all among which is Copyism.—Assuming the Doric to be the offspring of the Egyptian style, the differences between it and its parent are far more obvious than are the resemblances, which extend to very little more than the general system of construction with massive architraves resting upon round columns, closely spaced, and of few diameters in height. Yet, without proceeding further, we find here at once a marked dissimilarity both as to form and taste; because, although in each style the columns are round, in the Egyptian their shafts are almost invariably cylindrical, while in the Greek-Doric they taper very visibly,—more especially in the earlier examples, which, if the derivation of the latter style from the other be not a mistake, would, it may be supposed, have retained what is so strong a characteristic of their prototype. With respect to general proportions, indeed, and to *quantity* independent of form, a decided analogy exhibits itself; but no more than that. The comparison of the two styles might be pursued, and they might be confronted with each other in all their several points of resemblance and disparity; but to do so would require many pages, whereas the object of the present note is chiefly to remark that pursuing a course very different from the practice of the present day, the Greeks made what they borrowed, or borrowed the hint of, altogether their own by infusing into it, upon artistic principles, a new and quickening spirit.

IV. We, on the contrary, have made of Grecian architecture nothing better than a sort of motley manufacture, compounded of Greek columns and entablatures literally transcribed from one or two hackneyed examples, and stuck upon buildings which have nothing whatever in common with those from which such examples are derived: so far from it that they are altogether at variance with Greek physiognomy and Greek taste. People seem to judge of architecture by their ears rather than their eyes, columns "after the Parthenon"—or whatever else it may be—having ere now ensured admiration for some of the most tasteless architectural botchings that can well be conceived. As one instance, though not the worst, of the preposterous mania for *soi-disant* Greek porticoes, the front of Bethlehem Hospital may be referred to. As to *mania* itself, it is there—no doubt in a very proper place for it, and it shows itself very strongly; *au reste*, it was the height of preposterousness to think of "a noble portico," and attempt thereby to give a sort of palatial air to an hospital of that description, or indeed to any hospital at all. That absurdity, however, gross as it is, is not the only one, absurdity being heaped upon absurdity even to ridiculousness. To drag it in for the nonce, in defiance of propriety, of character, and of decent congruity of design (what nothing short of extreme necessity could have excused in the particular case), was absurd in the extreme. While classical taste was meant to be displayed, the very reverse of it is betrayed; for in proportion as any one has intelligence of and relish for Greek architecture, must he feel it to be degraded and disgraced by such application of it. Even taken by itself, without reference to the rest of the structure, the portico is but a very humdrum thing of the kind, whose bigness stands in lieu of artistic greatness and gusto. The most that can be urged in favour of it is, that although it added to the expense of the building, it was a very great saving in another respect—inasmuch as it saved the architect, good easy man, all study, the portico being the alpha and omega of his automaton design.

V. I do not, I find, stand quite alone, for there are some who begin to be pretty much of the same opinions as myself, and to give utterance to them rather freely. One reviewer has lately spoken of "heavy pedantry, verbal prosing, and hectoring dogmatism," as constituting "the literary etiquette of nearly all architectural writing." Whenever they take up the pen, even architects themselves let it be seen that they have just as confined and confused notions of their art as the rest of the world. Rarely do they show themselves to be either artists, or competent critics of art: in fact, they eschew criticism—critical comment and explanation—nearly altogether; contenting themselves with merely asserting what has been before asserted over and over again. Never do they attempt to set received opinions in a fresh light, in order to see how they will bear examination when so viewed. On the contrary, they touch them so tenderly, not to say superficially, that they appear to consider them of a very cobwebby nature. They do scarcely anything to recommend and facilitate the study of architecture, by endeavouring to render it more generally attractive and interesting; and yet they are apt to complain that the public do not sufficiently appreciate and sympathise with their art.

VI. By way of setting one matter in a new light, myself, I will remark that extravagantly as the Greeks have been extolled for their skilful combination of sculpture with architecture, it is in some respects open to objection. It has been said of the Parthenon, that the structure itself seems to have been treated as secondary to the sculpture, and made the frame-work for the latter. Certain, however, it is that the sculpture was made to adapt itself to the architectural forms, and forced into schemes of composition too cramping and confined to be particularly favourable to it. If we put prejudice, authority, and association aside, it must, I think, be admitted that the triangle or pediment is of all shapes the one least suited for framing in a composition consisting entirely of figures. Considered with regard to situation, and as far as general effect is concerned, a pediment no doubt affords a surface that very properly admits of sculptural decoration, because as *decoration* it there displays itself very conspicuously and effectively; but the subject considered as a composition of figures, suffers more or less, if only because the same general arrangement must in every case be adopted alike, and must comply with the general form prescribed by the outline of the end of the roof. A gable, especially a semicircular one (answering in its shape to a *lunette*), would be a much better field for sculpture than the low Greek, or comparatively low Roman, pediment. This is of course very heretical, and will perhaps be set down by some as calling in question, with equal ignorance and impudence, the acknowledged supremacy of Greek sculpture. Do I forget the Parthenon? (I have heard its name till I sicken at it)—or have I never seen the Elgin marbles? Yet, so far from depreciating sculpture, my remarks rather go to vindicate it, and to claim for it as sculpture some more honourable post than that of mere architectural embellishment and filling-up; which might be supplied equally well and far less expensively than by ambitious figure compositions. Such application of sculpture externally is at all events not suitable for our climate, because our climate is so unfavourable, that be its merit what it may as a distinct work of art, a *figure composition* very soon becomes more or less defaced, if not effaced, so that it is only with some pains that the subject can be made out,—which is, however, perhaps in most cases an advantage, because the more indistinguishable it is, the better; and the best that can be said is, that an expression of richness is given to the architecture—as might be done equally effectively at infinitely less cost, because in many instances a few random scratches of the chisel would show just as well as positive design. I have touched upon this matter just before in paragraph IX. of my last Fasciculus; still, the present remarks are not therefore quite superfluous, the matter itself not having been, as far as I am aware, touched upon by any one else. As to statues introduced in external situations as adjuncts to architecture, they are now seldom applied by us at all, and seldomer with anything like the effect they might be, they being put where they do not tell only as pinnacles. The usual *secundum artem* practice—for I cannot call it principle—is to hoist up statues as far above the eye and as much out of sight as possible, so that they must be looked out for before they can be loooked at; whereas, placed in the lower part of a building, statues would become important objects, and lead to effects in architectural composition that are now never aimed at or even thought of. Either single statues or groups placed on the pedestals enclosing the steps of such porticoes as those of St. George's, Bloomsbury, the London University, and the Royal Exchange, would show as admirably as they would distinctly. Were I ashamed of anything, I might be ashamed of quoting such authority as the Colosseum in the Regent's Park, for placing statues with equal propriety and effect. Though merely cheap ornamental figures or casts, those which are there placed on each side of the building so as to extend the ground-line of the general composition, serve as valuable artistically put-in accessories. Still those who bother both themselves and other people about the imaginary curved lines of the Parthenon, are by far too dignified to take a hint from such example.

THE ARCHITECTURAL EXHIBITION.

Again and again have we urged the policy of establishing a separate annual exhibition of architectural designs, drawings, and models, so that such subjects might have fair play, and fair chance for attention, which they certainly have not at the Royal Academy, where they form the fag-end of an over-crowded exhibition of pictures; and where space is so limited that not above a third of what architectural productions are received and hung up, can be at all properly seen. At length, our wish is partly fulfilled: a beginning has been made—but it is not, we very much fear, an auspicious one. It is rather to be apprehended that auspices are entirely against it. Originating as it does with a junior body of the profession (the Architectural Association), totally unaided by the slightest show of patronage from any quarter, the scheme is in a manner pre-doomed. To say that it is all the more meritorious on the part of the "Association," to have entered upon it unencouraged as well as unaided, avails nought as to actual success. In this country, people are apt to look as much to the movers of any scheme as to the merits of the scheme itself, unless indeed it happens to be one that holds out to them strong pecuniary advantages. The Association—be it said without the slightest disrespect towards them—are assuredly not in a position to command public attention. With the Institute the case had been widely different: they would have been considered *authorised* to make an attempt like the present one; whereas, originating where it does, it is likely to be set down by many as mere presumption. The Institute possess ampler means and resources, but unfortunately they totally lack the requisite spirit; while the Association show that they possess the spirit, or *pluck*, as a contemporary calls it, but lack the requisite resources, *status* in public opinion or public prejudice, included. There are, besides, some extraneous circumstances that are anything but propitious. One of them is, that the Exhibition is ill-timed—that is, it is too early in the year, and will be closed before the general season for exhibitions, and when the town is at the fullest, begins. So far, the Association have launched out at ebb-tide. Besides this, liberal and spirited as it is on their part, the making their exhibition a perfectly free one for five days in the week, is exceedingly questionable policy. As it is the first instance of the kind on the part of any society of artists, it looks very much like a confession that an architectural exhibition is not worth paying for, and is likely to be so interpreted by people in general. Undoubtedly, such an exhibition has no attraction for the many. Wherefore we think they will not have a single visitor the more in consequence of there being no charge for admission,—that is, not a single visitor the more who might not just as well have stayed away. A few idlers may perhaps be induced just to "look in," since there is nothing to pay; but that class who have any taste for, or intelligence of architecture, and to whom it must look for patronage, would have gone just the same, or perhaps even more readily, had there been the usual charge of a shilling. It is true, they may pay their shillings now, on Saturdays, if so disposed; but then, people don't care to pay for seeing what others are admitted to behold gratuitously. With the Westminster Hall exhibitions, the case was altogether different; for there was on the free days such a squeeze of the "unwashed," that their absence was cheaply purchased by a Saturday shilling. In Pall-Mall, on the contrary, the pay-day brings with it no greater convenience than the free ones. So far then, it appears to us, a serious error in judgment has been committed. In other respects, too, sufficient consideration does not seem to have been given to an undertaking whose issue may negative, for a very long while to come, any similar experiment. The Association should have announced their intention very much earlier than they did; and they should have carefully mustered their own forces before going into the field. Of their having done so, however, there is no sign. In fact, one of their leaders—the very individual whom we expected to put himself foremost, has left them in the lurch. Not so much as a single contribution to the exhibition—neither drawing nor sketch of any kind, is there by the Association's late President, Mr. "Fine-Art-Architecture" Kerr; although others as well as ourselves would, no doubt, like to behold a specimen of that gentleman's talent in design. Whether he at all promoted the Exhibition project by his eloquence we are unable to say; but that he should have shrunk from participating in it actively, is passing strange. Still, whatever the exhibition may have lost by his absence, his example might with great propriety have been followed by several of the others. When people cannot show any *forte*, the next best thing they can do is not to display their want of it. Coming forward as they have done, and challenging public notice, we certainly looked for greater evidence of talent on the part of the Association. Youthful extravagances and excesses of wanton fancy we could gladly have made allowance for, and excused; but the dreary dulness—the utter want of either spirit or taste, and of anything like fermentation of ideas, which marks so many of the things here hung up, is the reverse of promising. There are several things which, as designs, do not rise at all above those usually exhibited at the windows of estate-agents and auctioneers. It is true, we are not compelled to look at them—but where is the use of showing them? or rather, how contrary to all sound policy, or even ordinary discretion, it is to do so; more particularly in what is a first and specimen exhibition, and likely therefore to affect the credit of the whole scheme.

As regards the present exhibition itself, one of the most favourable and satisfactory circumstances is, that the room is an excellent one for the purpose, and all the drawings so hung as to be well seen, they being confined to two rows nearly upon "the line,"—none of them below the eye, nor any too much above it, except perhaps in one or two instances, where a drawing in the second row would have been better placed in the first one. As to number, too, there are quite enow,—as many subjects as can be inspected without fatigue; and provided they all contained something to detain attention, one hundred and seventy architectural drawings are more than can be examined in one or even two visits. First appearances on entering the room are certainly prepossessing, and contrast most agreeably with the squeeze and helter-skelter array of drawings and oil-pictures in the Architectural Room at the Academy. There is another judicious departure from Academical and the usual exhibition regulations, frames not being made a *sine-qua-non* for admission. Yet, although the exhibiting rames as well as drawings was properly enough left optional, there is a *sine-qua-non*, or what should have been considered such, that should have been pretty strictly enforced—namely, positive interest or merit of *design* itself. There are, unfortunately, too many things which are not at all up to exhibition-mark as architectural productions, although some of them may be unexceptionable for their manual execution as mere drawings. Proofs of poverty of ideas and vacuity of mind are by far too frequent; therefore, it is in one respect a disadvantage here that there are no obscure holes and corners into which things that will not bear inspection and consideration might have been thrust.

Although the Association have been aided by very few contributors in the ranks of the profession, their exhibition is greatly indebted to those few; since, were it not for the able productions of Allom, Collmann, Lamb, and one or two others, the show would have been very much poorer than it is. The members themselves, therefore, play only secondary parts; and there is, moreover, one drawback attending a large proportion of the drawings and subjects sent in by others—namely, their having been before exhibited, and some of them very recently. We admit that there are among them several (especially those by the parties above-named) with which we are not displeased to have the opportunity of renewing acquaintance; still, as far as the undertaking generally is concerned, it is a disadvantage that some of the most brilliant and redeeming points in this exhibition have previously shone upon us elsewhere. Be such the case or not, at all events our labour is abridged, since we need not here specify and repeat our praises of drawings and designs which we have spoken of at the time with deserved commendation in our notices of "Architecture at the Royal Academy." We may remark, that Mr. Collmann's "Hall and Staircase at the British Museum" (No. 24) operates as an extinguisher upon all the other interiors. Of that class of subjects there are several, but all of them decidedly poor, and one or two in the most flagitiously vulgar and tawdry taste. Attending one of them (No. 74) there is a curious and even comical circumstance, for it was in the Academy last year, and then described as "An Entrance Saloon adapted to the English climate," but is now called "A Design for a *Library*"!—adapted also, we presume, to the English climate, by its being without book-shelves or book-cases. Mr. Collmann's "Design for a Sideboard" (No. 137) causes us to marvel much how the rival subject by Mr. T. Seddon, jun. (No. 91) could possibly have obtained "the First Prize of 20*l.* and Silver Medal" from the Society of Arts, it being not only greatly inferior, but positively bad,—a coarse assemblage of the arrant frippery dignified by the name of the Louis Quatorze style. If such be the taste of the Society of Arts, let them stick to the useful and mechanical arts, for the less they interfere with Fine Art the better. Among the more remarkable designs, and a truly remarkable one it is, is No. 56: "Entrance front of a Villa designed for Mr. Alderman Moon," by Owen Jones. Its pretensions to design and style consist only in flowering over the surface of the walls with a sort of Alhambra pattern—a species of decoration more akin to paper-hanging than architecture: however, we do not suppose that it will ever be realised. Mr. Leeds has supplied five subjects, which, although they do not recommend themselves by comeliness of appearance or any charm of execution—three of them, in fact, are little more than sketches, or else only in a state of progress, as their being sent in upon drawing-panels seems to indicate—will, on being looked into, be found to contain some good and fresh artistic stuff. The least novel of them is No. 109, which being an "Idea for Improving the Façade of the National Gallery," is of course only a *rifacciamento* of Wilkins's building, and therefore *obligato* in style and composition. Although the idea of attempting to correct or improve that façade has been scouted by many, this "Idea" shows that even partial alteration might do very much for it. At present, the whole is too much broken up into separate little bits, so as to be marked by a very straggling appearance. This defect it is here proposed to remedy, and also to produce positive grandeur and richness of composition, by merely building out from the present front, advancing all but quite up to the front of the portico, as much as would nearly correspond in extent with the terrace and inclosed area of Trafalgar-square,—so as to obtain architectural focus, and produce an important mass that would display itself decidedly, and seem properly adapted to its particular situation in connection with the "Square." As a separate feature the portico would, perhaps, lose something, because it would not, as at present, project out from the rest. It would no longer be a *diprostyle*, but it would be greatly extended by the addition of a hexastyle *in antis* on each side of, and in immediate connection with, the present octastyle,—forming altogether a continuous range of colonnade, terminated and inclosed by two pavilions brought forward from those portions of the building in which are the thoroughfare passages through it. An effective and well-proportioned composition would thus be obtained,—one which being more compact would gain in loftiness, more especially as a deeper cornice is substituted for the present too feeble and diminutive one. With greater continuity of colonnade, there would also be greater variety of it, the additional colonnades being—as is shown by the plan, although not apparent in a geometrical elevation—double ones, that is, consisting of two open rows of columns, between which would be covered-in flights of steps leading up to the portico. The perspective effect attending those second or inner rows of columns would be equally striking and novel. The least satisfactory part of the design is the dome,—an improvement upon the present one, but still requiring re-consideration. For bestowing what may be thought disproportionate notice on this particular subject our excuse must be its particular interest, since it shows what may be done to reform a structure which is more universally than perhaps altogether justly condemned; and for which alteration has been repeatedly talked of, if never seriously intended. At any rate, here is a step beyond mere talking—a fairly embodied idea; and if a better one, not pirated from it, can be produced—by all means let us behold it.—While that subject can at all events claim to be considered a production of *design*, there are too many others which are mere portraits of either buildings or parts of buildings, without particular novelty or other interest to recommend them as such, and without that positive pictorial merit which would make amends for the want of the other kind of attraction. One exception there is—viz. No. 14, a view of Wollaton Hall, in which Mr. Arthur Allom shows that he inherits his father's artistic *forte* and *bravura* of pencil. A few more such pictures would have ingratiated the exhibition with the public; whereas Nos. 64 and 76, a pair of elevations of the Banquetting House, Whitehall, might very well have been spared. Even one of them would have been rather *de trop*, but two of them are overwhelming.

The show of Models—for exhibiting which class of subjects the room affords convenient space—is very poor. With one exception, they are all upon so diminutive a scale as to have a very toy-like look, as is the case with that of the "North-west corner of the Bank of England," whose size fits it better for an ornament upon a chimney-piece, than for an architectural exhibition. The one just alluded to as an exception—and it is a model upon a rather unusual scale—is called in the catalogue merely a "Study for a Façade," although it is actually that of Mr. Fripp's design for the Army and Navy Clubhouse. As so intended, we certainly did not consider it very germane to the purpose; but taking it in itself, and as it is now named, we see in it considerable merit and artistic feeling: not but that it might be improved not a little by only a little more study. Yet the subject itself hardly required a model; for except the open entrance loggia and ascent up to it, there is nothing that might not just as well be expressed in a mere elevation. No. 109, on the contrary, stands very much in need of the assistance of a model, and to be shown in actual relief.

PUBLIC ENTERPRISE, NATIONAL LAW, AND NATIONAL PROGRESS.

In all rightly-constituted communities, the subsistence, and therefore the employment, of the population must be held the first duty of the governing body. This is a trite saying to begin with, and England is a country in a high state of civilization; but so far as the governing body is concerned, the discharge of the primary duty we have named is not carried out. Provision, it is true, is made, that people shall not die of starvation, but since the time of Queen Elizabeth, the duty of superintending the employment of the population may be said to have been abandoned by the government. The economists may perhaps have contributed to this result while reclaiming the freedom of enterprise, but they ought not to be held blameworthy for the retention or institution of any shackles on employment.

It may seem a monstrous assertion that the employment and provision of the population are not duly looked after in England in the nineteenth century; but it is one, the truth of which, though it may not meet ready acceptance, cannot unhappily be gainsaid. At this stage we shall content ourselves by referring to our waste lands and our fisheries, to show that something is left undone, and the fault of which lies with our law-makers only; and we say, moreover, that it matters not how far they may have gone, if they have allowed other nations to get ahead of us in the competition for employment. The experience of late years has too fully proved to us that Germany, France, the United States, and Belgium, have in many branches of trade so gone beyond us, and lessened the earnings of our manufacturers and workmen. Therefore, we say it is well worthy of inquiry, what is the state of industry, not only in this country, but abroad; and what are the causes of our advancement or our backwardness, wherever such may have taken place. This is of national interest; but our readers have a special interest in such inquiries, because their bread depends upon the national prosperity, and on the healthy condition of national industry.

If we say that legislation has its influence upon industry, we do not put aside, nor put away altogether the influence of other causes. We are very well aware that laws alone cannot make a trade and cannot make a people, and that a people may shape their course for good or evil to a great degree, in despite of law. However perfect a system of laws may be, though they may influence they cannot absolutely determine the every proceeding of each individual; for it is impossible that the ceremonial law of a Moses or a Confucius, however minute in its dictates, should embrace every action of life. Indeed, if laws alone were sufficient for the promotion of industry, then the special legislation of the French being so much better than ours, so should they be in a higher degree of industrial advancement than ourselves, which they are not.

It is the want of discrimination as to the true value of each cause in operation, which leads to the want of correct views on the legislation affecting industry in this country; but it is most important that a greater degree of attention should be bestowed on these investigations, the more particularly since the altered political condition of Western Europe promises to give a greater development to individual character. If we take the laws as affecting partnerships, patents, and commercial transactions, those of the English are bad, and of the French are good: if we take the men, the Englishman is enterprising, but the Frenchman is wanting in enterprise, in independence, and in self-reliance. Much of this resolves itself into influences of legislation; but then it is not legislation as affecting industry, but legislation directed to political organization. The police system of France has perhaps more to do than anything else with the commercial habits of the population, and the want of freedom of locomotion, and the perpetual reference to the will of others in many of the operations of life, destroy the self-reliance of the individual, impair his energy of character and industry, and most surely limit his enterprise. We say nothing as to the political hierarchy, the corruption of patronage, and the pervading centralization, because their influence is more ambiguous, and there are set-offs against them here and in other countries; but we refer confidently to the police and passport system as counteracting most efficiently in France and Germany the good tendency of industrial legislation. We shall advert to this again at a further stage; meanwhile, we bring it forward here to remind the reader that we cannot be limited to consider the narrow operation of patent laws, registration acts, companies' clauses consolidation laws, or partnership suits in chancery. The diseased constitution cannot be fully demonstrated from the dissection of individual limbs.

The dereliction of duty on the part of the English government has been imitated by others, and it has perhaps as much as anything contributed to the peculiar character of the present revolutionary movement, the beginning only of which we now see. The agitation is no longer directed by political dogmas only; nay, it has not so much an agrarian character, but its sects of socialists and of communists attest its connection with the absorbing question of the present day—the employment of the people. It is because governments have neglected their duty in providing for the employment of the people that a re-organization of society is so readily sought after; not one which shall pull down the rich only, but which shall give comforts to the many. There are more socialists and more social agitators than the Owenites or Fourrierites; the effects of many contribute to the movement—Louis Napoleon, Lord Ashley, and Lord John Manners, as much as Proudhon and Cabet; the *Times* as much as the *National:* and unless the work be taken up thoroughly by existing governments, it is impossible but that it will be carried out in a much rougher fashion by the strong hands of the suffering masses. Emigration, again, is only another exemplification, another symptom of the paramount disease. As the *Times* said the other day, all classes feel a want of room; it is not perhaps that there is a greater competition than there was in the fifteenth or the tenth century; it is not perhaps that the population are really in a worse condition, but because they are better acquainted with the evils of their condition, and have a surer knowledge how far they are remediable. If ignorance be bliss, they have lost it; but they have likewise lost hope.

In these islands are six or seven millions of men able to work; but of those, not less than two millions, more likely three millions, and perhaps more, are for the greater part of the year without work. We do not say they are not fed, but they do not do the work which they are able to do, which most of them are willing to do, and which under a good system they would do. The power of work of two millions of men is greater than that which raised the pyramids of Egypt, laid out the Chinese canal and wall, covered the Roman empire with roads and aqueducts, and saved Holland from the sea. It is greater than that which has been bestowed upon the public works of which we are so proud. So enormous a waste of power, in a country which so much requires its application, is the strongest condemnation of our system of government. Politicians may soothe their consciences by saying that they keep the people from starvation; but while such vast means exist of adding to the comforts of the people, no excuse can be admitted. With the means we have, the whole country could be drained as a garden, the waste lands reclaimed, houses, schools, libraries and churches be built. Fuel might be supplied to every household, lime and agricultural manures be spread on every acre, our shores be lined with harbours and piers, and the fisheries yield an abundance of food. These are quite within the limit of the vast resources available. Indeed, the power to be had is as great as that now employed in growing food in the island of Britain.

If we wanted to show how the material resources are wasted, we need not go to Ireland, and follow Sir Richard Kane through his enumeration; we need only point to the millions of acres of improvable land, now left untilled. Nay, in this great city, manure enough to grow corn for a million of people is yearly wasted.

All this shows that there is something wrong, and we have no hesitation in putting it down to the laws affecting industry. Whether the economists did any great good by the abolition of apprenticeships and of corporate restrictions, is open to question; but they certainly left the main things undone, and if there be any good in free trade, still that is but little. Freedom to trade without may be good, but we want freedom within; and the more, as we have to compete with nations abroad, who are now wiser than ourselves.

Two prominent evils in the legislation affecting industry are the laws relating to patents and those relating to partnerships; and the two cannot be dissevered in any consideration of the question in its bearing on those classes with which our readers are connected. If we were discussing this simply as a political question, we could show that the evils are not so limited; but as we want to show its bearing on a class, its practical operation, and how much it operates to the injury of every man, working either with his head or his hand, we are contented so to limit it. We have taken the two subjects together, moreover, as they are most intimately connected, and work as efficiently for the injury of every industrious man in the country, as if they were planned with that express and specific object, and not, as laws are generally supposed to be, for the good of the commonwealth.

We give a prominence to the patent laws, because an agitation is now going on for their amendment, and a commission of inquiry into the fees of the government offices has been appointed, before which evidence has been given. In Newton's *London Journal* for February and March, will be found able articles on Patent Law Reform, showing the interest which is excited among those engaged in the promotion of useful inventions. In these articles our readers will find many practical exemplifications of the ill-working of the patent laws, as coming within the ken of the professional men engaged in their administration.

None of our readers will, we believe, gainsay that the patent laws and laws affecting joint-stock companies do not work well; and with this assumption we shall start, wishing to show the national importance of the subject before we consider its details. It has been sometimes said that the welfare of England depends upon her keeping twenty years ahead of other nations in the practice of mechanical arts; and in this there is very much truth. The *Quarterly Review* (December) says there is no question that a fearful proportion of our fellow-citizens hold their prosperity upon no other tenure. Let us therefore see how this works.

It is to the mechanical classes we naturally look for the best opportunities of promoting the practice of mechanical arts. In these classes we find great masters with great wealth, small masters with small wealth, professional men well to do in the world, and younger ones with their living to get; but above all, thousands of working-men. The number of rich men is very small, the number of poor men is very great; but their share of skill has nothing to do with their share of wealth. *A priori* it must be looked upon as incontestable that the mechanical classes cannot pay a heavy tax for leave to exercise their genius, and that a heavy tax would have the effect of preventing a great many men from applying their inventive skill.

We now trace a poor working-man in England. He has what seems to him, and what is, a valuable invention, and with great difficulty from his scanty means makes a working-model, the results of which offer every inducement to go on with his undertaking. One of his first wishes is very natural—that he should reap the reward of his ingenuity; and it might be supposed that in any civilised country he has the property in his own labours. The writer has so in his books, the painter in his paintings, and no one may steal his work: the mechanic himself has a property in his trade-mark, or the name of his firm, but he has none in his mechanical discoveries or inventions. No one may take his name in vain, or use his stamp; but they may freely use his inventions, unless he can pay the heavy price of a patent. They may copy the whole tool or machine, except the words, "Fairbairn, Manchester," or "Joseph Rodgers, Sheffield." The law is very tender as to this.

There is no reason *à priori* why he should take out a patent. The patent itself is no adequate protection. It may be said, that without a patent, other parties may claim the invention. They do now; and they have to prove before a court of law, as they would then, that they have a better title than the inventor: that it was invented before, or known before. Other questions of copyright do not involve a preliminary patent; neither should copyright of mechanical inventions. Give a man the property in his own works, and grant him the same protection as he would have for other property.

If a man cultivates a piece of waste land, or if he finds out a mine, he acquires in most countries the property, without expense of patent, on the ground that he has done great good to the commonwealth. Some governments exempt such lands from taxation; there are few that require a heavy tax to be paid before waste land is cultivated or a mine is worked; the utmost exaction is commonly a royalty from the earnings. In England, a man is not allowed to have the protection of the law for the property in his mechanical inventions, until he has paid a heavy sum, before he has earned one single penny, and without the certainty of earning one single penny; while, if he earns anything, he must pay in addition the ordinary taxes for the preservation of property.

The author can assign his copyright to as many people as he pleases, can dispose of it for a time, can pass it by will. The author of a mechanical invention cannot assign his copyright as he pleases, and if it can be worked only by a great company or partnership, he must obtain an act of parliament to enable him to assign it. A flaw in the assignment of the copyright of a book does not destroy the copyright; a flaw in the patent of copyright of a mechanical invention does destroy the copyright.

Prince Albert, or any other man, may have an injunction to prevent any one man from publishing his writings and engravings, which are unregistered and untaxed, but a mechanic has no protection against the publication of his invention, unless registered and taxed.

The author of a book can reap the profits of his invention at once; the author of a mechanical invention must wait six or nine months for specification, during which he is liable to fraud, piracy, and extortion, on the part of unprincipled adventurers, who may avail themselves of the delay to specify part of his invention as their own. The *London Journal* well shows this.

The author of a book, painting, or piece of music, the inventor of the name of a firm or of a trade-mark, the cultivator of waste land, or the worker of a mine, pays no special tax to give him his property. The author or worker of a mechanical invention does pay a very heavy special tax for which he gets no benefit.

The men who are authors of valuable inventions, in the great majority of cases, from the poor being in the greater number, do not necessarily possess 200*l.* or 300*l.*, and cannot readily get it. One man is a barber, another a postilion, and a third an engine-tenter, and so on; the better taught may be a poor scholar or parson. These men are called upon to pay the tax, and they have it not. They have several courses open to them. To work the invention without fee or reward; if practicable to work it secretly for profit; to get some one to advance the money and to take part of the profits; to register the invention instead of patenting it; to keep the invention secret in the hopes that the means may come for taking out a patent. The great majority of inventors there can be no question are reduced to one of these several courses; of the patents taken out, the majority are on similar conditions.

If a working-man is very lucky, he may get some one to advance the money to take out a patent for him; but in most cases he cannot, and the invention slumbers for many years, or is perhaps lost. This, it is evident, is to the very serious injury of the people at large.

We will not take a remote case, nor an obscure one; but we have one which has been pointed out by a writer in this *Journal*—that of George Stephenson. In 1814, little more than thirty years ago, George Stephenson was a working-man, and invented a locomotive engine and a safety-lamp; for neither was he able to take out a patent, being too poor, and was forced to publish them without any protection. For the safety-lamp he got no direct return, but was fortunate enough to get a public subscription: we say fortunate; for Dr. Clanny only got a small subscription a few years ago, and Mr. Robert William Brandling, the inventor of another safety-lamp, died last year without having received any reward. For the locomotive, Stephenson got no return; and it was perhaps fortunate for him that he had no patent, for he would have been 300*l.* out of pocket, as the only engine constructed suggested improvements, which led to its being superseded. Had the engine been perfect, Stephenson would have had no protection, and the great manufacturers would have got the profits from such a valuable invention.

In the next year, Stephenson fell in with that great schemer, William Henry James, and he introduced him to another great schemer, Ralph Dodd; which latter found the money for taking out a patent, receiving a considerable share in the patent, and William Henry James receiving a share for bringing the parties together. Ralph Dodd had not the requisite capital for working the patent, so that the share given up was for obtaining the patent or title to the property, and nothing else. This is the usual case with patents; and there are very few in which the inventor has not given up a share for obtaining the patent.

We may here stop for a while, and examine a little at our leisure the case before us. The author of Paradise Lost was not obliged to take out a patent before he could offer his immortal Paradise Lost to a bookseller for five pounds. The late Sir Walter Scott did not have to pay out of his large earnings 300*l.* per work, or above 10,000*l.* for patents. We know of many men who have paid thousands for patents. At the time we are speaking of, Stephenson was maintaining his aged parents out of his earnings, was mending clocks and watches in what he called his spare time, to provide the means for educating his son, and was jeopardising his life in the fire-damp in experiments on the safety-lamp, as witnesses now living have stated. Yet, before this poor man could be in the position to reap any reward from one of his inventions, he had to assign away a great share.

Our readers will not feel astonished if we take them one step further. So far from an adequate return being got from the patent with Dodd, in the next year Stephenson had to take out another patent for the locomotive, into which he crammed sundry other inventions for rails and chairs. For getting this patent and working it, the means were found by Mr. Losh, a manufacturer of Newcastle, who of course had a share in the patent. It is not wonderful that Stephenson had contemplated leaving a country so very unpropitious to poor inventors, and emigrating to the United States. If he died a rich man, no thanks to the patent laws.

We do not think it necessary to accumulate examples, for one practical example is better than a hundred theories as to how the patent laws might work, and the case of George Stephenson never ought to have occurred in a country claiming to be civilised. Instead of taking other cases, we shall make some further remarks suggested by the case of Stephenson.

In looking at the history of the locomotive, it seems very clear that the patent laws were the great obstacle to the practical introduction of the locomotive fifty years before it took place. In 1758 or 1759, Dr. Robison conceived the plan of a locomotive engine, but did not think it worth his while to take out a patent. In 1784, it was named by Watt, in a patent, so that the idea of a locomotive carriage was then made public. About that time, William Murdoch, then at Redruth, made a working model of a steam-carriage, but could not take out a patent. Murdoch was likewise one of the inventors of gas lighting, in which he had the same hindrance. In 1802, Trevithick, helped by Captain Andrew Vivian, took out a patent for a locomotive; but it never paid the patent fees. Oliver Evans wanted to take out a patent for a steam-wagon, but could not. Before 1818, at least 1,000*l.* were paid for patent fees for locomotives, without one penny of profit being earned; and the said patents proving utterly worthless and unprofitable, except in preparing the way for others. The history of the steamboat, as lately published by Mr. Bennet Woodcroft, is only another tale of the same kind.

In the course of his life, Stephenson must have paid 2,000*l.* or 3,000*l.* for patent fees. Of course Watt, Trevithick, Sir Mark Brunel, and other great inventors have paid similar sums. Many men have paid such sums, who have not earned anything, and have died in a state of beggary. A special tax of this enormity upon men of genius, it is left to the English government to levy. Other governments, as unprincipled, but not so extortionate, give time for the patentee to earn the money, or levy their tax upon his earnings. They too, at least, put the fees into their own coffers; but of the yearly tax of 100,000*l.* levied on the mechanical genius of England, very little goes into the Consolidated Fund, but is intercepted by the Attornies and Solicitors-General of England and Ireland, the Lord Advocate of Scotland, and a number of officers appointed for the sole purpose of getting incomes out of inventors. A more gratuitous system of wickedness and oppression is seldom found out of England: eastern tyrants get paid for their villanies.

If the mischief limited itself to levying a tax of thousands upon Watt, Trevithick, and Stephenson, and of hundreds upon smaller men, it would not be so bad; but it is a prohibitive tax, by which the mechanical skill of the country is kept down. There is no profession so heavily or injudiciously taxed as that of the patentee; no trade pays such heavy license dues for its exercise. The attorney pays a heavy stamp duty for a special monopoly, but he can only be once articled; the banker pays only thirty pounds a-year for coining paper money. The attorney and the banker have especial immunities; the mechanical inventor has none, and yet we question whether for utility the priest or the physician can claim a superiority over the inventor, who finds bread for thousands, perhaps for hundreds of thousands.

We are not now about to complain that honours and rewards are not given to patentees, in order to stimulate them, though we have a right to do so; for if the honours and rewards of literature and science are small, yet the professors of either of these get more baronetcies and knighthoods, and figure in greater numbers on the pension list, than patentees do. The list of patentee-pensioners on the civil-list must be very small; and Sir Mark Brunel, Sir Samuel Brown, and Sir Joseph Huddart, form the meagre list of patentees who have received the title of knighthood, and even these rather as civil engineers than as patentees. So little is the merit of the patentee valued in this country, that he has no claim to be put on the civil-list pensions, and there is no public subscription to relieve him, his widow, or his orphans. Other workers with the brain have their Literary Fund, or their Artists' Fund; even the player receives liberal contributions from the public: but there is nothing for the patentee, though a Scientific Fund, as it might be called, is well worthy of public support, and would relieve many deserving persons, who, after spending thousands in the public service, are left penniless.

The true picture we have painted shows that the position of the patentee is more beset with difficulties than the proverbially poor one of the poet and the painter; but we have not yet done with the career of the working-man who has the good hap to get a patent by the sacrifice of a large part of his property, for a copyright which others get for nothing. He has got this patent to work.

There are very few inventions, however inconsiderable the object to be effected, which do not require costly machinery; nay, they may entail the outlay of many thousands to produce an article, the sale price of which may be a farthing, or even less. In many cases the invention can only be carried out by the association of a great number of persons. In very few cases can a patent be worked by licenses granted by the inventor, involving no outlay of capital on his part.

We have heard it stated by some persons experienced in such transactions, that it is a fair division to give one-third of the patent to the inventor, one-third to the party finding the money to take out the patent, and one-third to the party finding the money for working it; but we believe there are few cases where an inventor, whether having found the funds for the patent or not, gets one-third of the patent for his share, independently of the share for taking out the patent; therefore it may be considered as a general rule, that the cost of the patent to the inventor is not the money cost for the patent fees, but the share of profit which he loses, and this may be taken at a third; and there are persons who have thus been mulcted on profitable patents, of 10,000*l.* 20,000*l.*, 30,000*l.*, or even more. It would be therefore more merciful, if the government wants money, to levy it from the yearly earnings, as is done elsewhere, and not force the patentee to sell part of his property at an enormous sacrifice.

Under all circumstances, the cost of the patent is a deduction from the capital available for commencing the undertaking and making the trial machine. In the case already cited of Stephenson and Dodd, the sum paid for the patent was probably nearly as much as that for constructing the only engine made under the patent, and may have been raised by Dodd at interest; and being a total loss, contributed to those embarrassments, the pressure of which led him to commit suicide. It is very well known that those who advance money for patents often borrow it themselves, so that the money cost for patents becomes more than the fees. Considered in the point of view now before us, a fund of more than 100,000*l.* yearly, contributed by the private enterprise of the country for the encouragement of useful inventions is fraudulently diverted from it by the government, who are trustees of the public interests, and is wasted in the maintenance of useless placemen—the chaffwax, the sealer, the train-bearer, the clerks of the signet, the receivers of signet fees, and a swarm of sinecurists, deputies, and assistants.

We may therefore very fairly assume that the first two hundred or three hundred pounds which the inventor might obtain towards beginning business, is directly taken from him by the government: as if, when a pains-taking writer has finished a book, the government should take from him the sum which he could obtain for printing it. In many cases, and more particularly of the less profitable inventions, the cost of the patent would be sufficient for working the invention; and it may cease to be profitable if burthened with double the amount.

It will be seen that the patent-tax must act as a direct prohibition on the prosecution of many inventions. Taking the estimate already given as to the distribution of the shares of a patent, and supposing that it is necessary to go to a cost of 300*l.*; then the party making such advance must look to a probable return of twice that sum to reimburse him, and that, multiplied by three, will give very nearly 2,000*l.* as the profits which must be realised on an invention to justify a patent being taken out for it. Thus the inventor and the manufacturer are to be deprived of the opportunity of making a profit of 500*l.* or 600*l.* a-piece, that the government may waste 300*l.*, and the miserable chaffwax may get his fees. If 200*l.* profit only can be made, instead of 2000*l.*, the patent is quite out of the question.

It must not be forgotten that, however good his invention may be, there is a limit on the inventor, besides that imposed by the government tax. If the capital required to be laid out in manufacturing is too great in proportion to the profit to be got, then the invention is financially impracticable. At all events, it is quite clear that the patent-tax is as much an oppression on the capitalist and manufacturer, as it is on the inventor; and being an oppression on these, so is it on the working classes, who are deprived of employment. It is not to be assumed that because a patent is taken out it is therefore worked, for many a patentee exhausts himself in taking out a patent, and therefore it falls to the ground. It often happens that terms cannot be come to with a capitalist, as the share he requires will not leave enough for the inventor and the party who has advanced funds for taking out the patent. The legal status of this latter creates, too, an additional impediment in the way of the inventor.

We may here recall the reader to the very important results of the prohibitory patent-tax, the delay of inventions. The patent law makes it imperative that an invention must be kept secret until a patent is obtained; and therefore there are few cases in which less than three years elapse between the beginning of an invention and its being brought into practical working. If we reckon the extra time required in finding a capitalist to work the patent, in consequence of the unnecessary outlay for a patent, the time must be rated as three years before the public can get any benefit; and this without any reference to what we may call the natural difficulties to be overcome. The time lost where a patent is obtained and worked, is however seldom so short as three years, and may extend over very many years: we know of cases of valuable inventions delayed twenty years from want of means to take out patents. In many cases the invention is never divulged; and the inventor sinks into the grave without giving a hint, leaving it to some other person, perhaps a long series of men of science, to go through the same course of experiment and research.

We have instanced in the locomotive engine and the steamboat, the practical result of the prohibitory system and the serious national evils which result from it; but the history of every branch of invention yields the same lesson, and nothing could be more humiliating to our national pride than an analysis of such history, showing these facts in detail. These, however, are not matters of the past, recorded only in the pages of the historian, known only as having been remedied, as in progress of extinction, or as already extinct; they are going on daily, their evils increasing, and no attempt made to allay them,—nay, the march of intellect only aggravates their enormity. While general prices have fallen since the war, the cost of patents remains the same, and is therefore heavier. As the progress of improvement is more rife, so does the number of inventions increase, and a tax is imposed upon them, which, at war prices, would directly and indirectly represent a vast burthen upon the inventive skill and industry of the nation. This evil is going on, and any branch of invention will show it: the railway system is suffering from it, the electric telegraph, the manufacture of gutta percha—thousands of busy minds are kept back by a tax beyond their means of payment, which damps their energies, and blights their exertions.

In the peculiar circumstances of this country, nothing can be more injurious than a system so wicked as the patent laws, which check employment in the earliest stage, and the spirit of which, propagated in the laws regulating partnership transactions, is continued throughout. With the development of the practical working of the patent laws, we must now leave off, entreating our readers to give their earnest attention to remedy an evil, so serious in its operation on the industry and well-being of the country.

(To be continued.)

LIFE OF GEORGE STEPHENSON.

(Continued from page 72.)

XII. THE SHARE MANIA OF 1825.

We have already shown that everything was ready to enable the railway system to start, and that it awaited only the fitting time. This was given by the mania of 1825.

This mania has been the most spoken of, because it was the greatest known to the generation which had sprung up since the peace, and it may be almost called the first. There had been times of share speculation during the war, in which the first railways, the docks and bridges of London, and some canals had been begun; but the war sucked up most of the wealth of England.

To make way for 1825, there were good harvests, taxes seemingly lighter, a high price of stocks, and therefore low income to stockholders; a field was therefore wanted for the overflowing wealth of the middle classes. A great spur had been given to trade abroad, by the starting of the new commonwealths of America; and there were strong hopes from the fresh opening of the gold and silver mines, to which the steam-engine in the hands of Trevithick had given new life.

Had there been right knowledge on the side of the law-makers and the people, the wealth of the higher classes would not have been wasted as it was; for the only way in which it could be rightfully brought to bear would have been better understood. What, indeed, was this wealth which they had to lay out? It was not wholly in the shape of gold, for gold does not grow, and there could be only more gold than was wanted by its having come in from abroad. It was not in the shape of corn, for there was little more corn than was needed for feeding the people. What then was it? It was the means of commanding the labour of the people at home, by having a hold on their food. This wealth, however great at home, could not be taken abroad, and could only be made fruitful at home.

Had this been understood, time should have been taken by the forelock, and undertakings should have been brought forward by which works would have been made at home, which would have been gainful to the shareholders, and a mine of wealth in all time to come. This, however, was little thought of. Most of the bills for mines, gasworks, waterworks, and docks were thrown out,—and it may be said all the railway bills.

Undertakings abroad were not hindered by acts of parliament. The Pasco-Peruvian Mining Company, or the Columbian Pearl Fishery Company, could be started without acts of parliament; while the Liverpool and Manchester Railway could only go on by an act of parliament, to get which needed a great outlay of money and time, and a struggle against all that landowners, innkeepers, and canal-holders could do with their friends in the Lords and in the lower house. It was no wonder therefore if American mines and loans were most sought after.

What was the stock of wealth utterly lost in these undertakings cannot be reckoned up; for we have no good measure for it. It was made up in several ways. There was what was spent at home among people here, and that must be taken off from the whole loss. Then goods were sent abroad, which, so far as the raw material was not of home make, would be a loss; but would not, so far as the work goes, nor so far as the raw material which was of home growth. Thus on cotton goods sent out, the utter loss could only arise on the cotton which was of home growth, but on English woollens there would not be an utter loss of the capital of the country. There must, however, have been a great deal of gold sent out, and therefore lost, and there was a loss of the gains of the traders of former years.

The loss in capital was therefore a small one, and did not weaken us, as indeed the end shows; but the loss when rightly measured will be found to be a very great one; but then in another way altogether from what it is commonly said to be. Our loss was not by sending capital abroad and getting nothing back; by lending money to the Peruvians and Buenos Ayreans, and not being paid; not by working silver mines in Mexico, gold mines in the Brazil, and laying out ten pounds to get one pound's worth of gold: but our loss was of a kind which never can be made up, as the time for doing so will never come over again.

Our loss is this. It is a loss of all the railways, docks, havens, bridges, canals, gasworks, and waterworks which might have been made; which would have set us ten years a-head of all the nations in the old world and the new, and would have given to our fathers and ourselves some of the fruits now our children only will see. By giving a help to the building of steam-ships it would have spread our trade abroad, and we should have made those settlements which we are now only beginning. Then, too, how much hangs on this, how much the healthy growth of mechanical skill is hindered from want of a field for its exercise. George Stephenson was as ready for the locomotive race in 1823 as in 1829; the screw-propeller might as well have been tried then as some years later; and the steam-ship driven its way across the broad Atlantic.

Shareholders were as willing to go into undertakings here as abroad; indeed, the greater number of undertakings were meant to be worked at home, but then they were knocked on the head by the House of Commons. More useful undertakings were shipwrecked there than useless ones were shipwrecked on the American shore; but then if a man wished to do something he was driven into some undertaking abroad, from there being no chance for him at home. Therefore, the blame lies wholly on our law-makers, who lost the best time for making up forthwith the losses the commonwealth had undergone during the war; and by hindering the healthy growth of trade, threw the greatest hindrance in the way of the suffering people of England.

The people rushed into the share undertakings of 1824 and 1825 with all the more madness, as the the thing was new to them. Since the canal works of fifty years ago, never had there been so many new undertakings brought forward. For twenty years, William Pitt and his followers had yearly come forward with some new loan or lottery, in which all the savings of the thrifty were swallowed up, while most were so squeezed with taxes that they could not in any way save. James and Dodd might weave their webs fruitlessly in the war time, for William Pitt held out to those who had money six or seven in the hundred forthwith, under the name of omnium, scrip, consols, navy fives, long annuities, short annuities, lottery tickets, and so forth. Therefore, the boldest getters-up of new undertakings had the ground cut from under them. There were, it is true, new undertakings, as we have said, brought forward from time to time; but in the whole they were small. The canals were done and at work, and few shares came into the market. There were, however, as already said, docks, harbours, gas and waterworks, and bridges, and these were still going on. The copper and tin mines of Cornwall had been wrought throughout the war, but then they were not advertised in the newspapers, and their shares had a market of their own. It is therefore fair to say, that so many share undertakings as were thenceforth set up was something new for the people.

The gambling houses set up by the government under the shape of lottery-offices were about to be closed; one pound notes were under the ban, and gold had come back again after being lost sight of for twenty years. The Stock Exchange drew therefore every one to it.

Neither must it be lost sight of that the people had no longer the war to beset their thoughts. They had not to think when peace would come, to wait for the news of the next fight, to grieve over the last friend slain, or to grumble about the newest tax threatened. The time of the government was no longer taken up with such cares. The thoughts of all were on peace, and what peace brought before them, of the means of upholding peace. They were now as earnest to keep up the peace as before to keep up the war. Hence, too, a greater freedom of mind, a greater wish for learning, a greater readiness to welcome the works of the great masters of knowledge. What was the steam-carriage of Trevithick when Napoleon thundered at the gates of kings, and warned the lords of earth to hide their heads and flee?—what was the safety-lamp of Davy whilst Wellington and Napoleon fought for the lordship of the world? Brunel might be listened to when offering a new block machinery, Sir Samuel Brown for his chain cables, or Sir Joseph Huddart for his rope patent; but then these were helpmates of the war, and their more peaceful works met with less welcome. The minds of men of learning and skill had been much given to inventions useful in war time, and now they were free from such calls.

What ought to have been done, as already shown, was to set the people at work at home; but this was lost sight of, and besides the loss before reckoned up, further harm was done. In the war time, there was, it is true, a great outlay for poor-rates, but that was mostly spent on women and children. An idle man had a hard time of it; for he was laid hold of in one way or another, and sent off to be a soldier or a sailor. Thus all were doing some kind of work, or what was called work; but after the war, the thousands upon thousands of soldiers and sailors were no longer wanted, and they were therefore left idle, and many able-bodied men came upon the poor-rates,—a thing most hurtful to them, by giving them pauperised habits. On the other hand, nothing has done more for stopping this evil than the great railway works which have of late years been carried on; and we may hope in time that pauperism will be utterly rooted out, and every man be set to some useful work.

This may seem to have very little to do with George Stephenson, but it has very much; for the great good there is in looking at the life of such a man is to think thoroughly over the circumstances which thus come before us. By so doing, we are enabled to see what errors have happened, and how far the deeds of any one man are able to cure them or soften them. It was certainly one end of Stephenson's labours, that he did very much mitigate the evils that have been here shown, while he was very much kept back by them. How much more indeed might he not have done, if at an earlier time he could have begun his full career, while he had all his health and strength?—and how much, too, is it to be wished that other men should not be kept back by the like stumbling-blocks!

It is mere speculation as to whether Stephenson was moved in his labours by any earnest wish to give employment to the working classes, but there is nothing more likely than that he had that feeling, for it was that which stirred him to the finding out of his safety-lamp; and James and Gray most strongly dwelt in their writings on the good which would flow from railways, as a means of setting the people to work. Gray indeed brings forward the want of employment as one of the greatest reasons for adopting his plan of a general iron-way.[1]

The madness which set in for share undertakings reached its height in 1825; and to show in what way it worked itself out, the following from the *John Bull*[2] newspaper may be of use.

Canals	£19,000,000
Docks	10,500,000
Assurance companies	43,000,000
Waterworks	3,500,000
Bridges	2,000,000
Gas companies	11,000,000
Roads............	500,000
Railways	21,500,000
Mines............	15,000,000
Miscellaneous	40,000,000

This makes altogether 166,000,000*l*., and does not take in the

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[1] "Observations," p. 5, 7, and 40.

[2] Feb. 13, 1825.

foreign loans. The 166,000,000*l.* is, however, only the sum named in the prospectuses, and does not therefore show the real capital which would be wanted to carry out the undertakings. This the writer makes out to be about 55,000,000*l.*; but as very few of these undertakings went any further than the beginning, the outlay was very small. Therefore, so far as to its lasting effects, the mania of 1825 was of much less importance.

Of the canals set forth above very few were made; but there were some few docks, gasworks, waterworks, and bridges made. The railways carried out were likewise few. Many of the assurance companies went forward, but there was no outlay upon them.

On the mines a great sum was spent, though much less than is commonly believed.

Most of the undertakings of 1825 turned out worthless because they were not rightly taken up. The British iron-works, the Thames Tunnel, the foreign and Irish mines are well-known cases of large capitals which met with a small return, nor did the smaller undertakings come better off. The Steam Washing Company and the Alderney Dairy Company both ran their race, and came to an untimely end. The best undertakings were stopped in the House of Commons, those only getting through which no one thought worth opposing.

If the excitement in 1825 was very great, it did not go the lengths of the canal mania of 1790, when speculators forced their way through the windows of inns and offices to reach the subscription lists for canals, breathless with anxiety to enroll their names.[3] Such, too, was the eagerness, that a number of farmers were drawn together at midnight to a lonely inn on a common, being told that the concoctors of a new canal or navigation were about to allot the shares among themselves: the victims of the hoax becoming of course the prey of the landlord of the inn in which they were compelled to harbour.

More real loss must have happened from the mania of 1825, because more real property was hopelessly sunk.

XIII. THE FIRST RAILWAY MANIA.

1835 is commonly named as the First Railway Mania, but the true one was, as may be seen from what has been just said, ten years before. Thus there have been three of these episodes in railway history.

The railway mania of 1825 brought forward undertakings for which a capital of above twenty millions was wanted, and by which lines many hundred miles in length were to be made.

William Henry James seems to have begun with a great railway for the south of England, on which he wrote a pamphlet, with a map. It was to start from London and to go to Rochester and Shoreham, to be worked by locomotives.[4]

Whether however James first brought forward this or the Liverpool and Manchester Railway, we are not able to say.

By 1824, the Liverpool and Birmingham had been surveyed, and others all over England; and by 1825, they had spread to Ireland.

The following will show some of the lines brought forward, with the capital proposed, though it must be remembered that more than one company was sometimes proposed for the same line, and that therefore the number of railway companies of 1825 will be greater than that of lines:—

*Liverpool and Manchester railway, £400,000
*London, Rochester, and Shoreham railway, £500,000[5]
*Birmingham and Liverpool railway, afterwards Grand Junction, £600,000[6]
*Bristol and Bath railway, £100,000[7]
*London and Birmingham railway, £1,500,000
*London and Bristol railway, afterwards Great Western, £1,500,000[8]
*London and Northern railway, £2,000,000
*London, Portsmouth, and Southampton railway, afterwards South-Western, [£1,000,000
*Manchester and Leeds railway, £500,000
*Manchester and Bolton railway, £150,000
Limerick and Waterford railway, £300,000[9]
*Newcastle and Carlisle railway[10]
*Garnkirk and Glasgow railway
*Edinburgh and Glasgow railway[11]
*London and Brighton railway, or Surrey, Sussex, and Hants, £750,000[12]
Grand Junction railway, £2,000,000[13]
*Taunton railway, £200,000
*Norfolk, Suffolk, and Essex railway, since Eastern Counties, £1,000,000
*Leeds, Selby, and Hull railway, £500,000[14]
London and South Wales railway, £1,000,000
*Birmingham and Bristol railway, £80,000
Kentish railway, £1,000,000
Grand Western railway, £3,000,000
East London railway, £100,000
*Canterbury and Whitstable railway, £25,000
Severn and Wye railway, £131,670
Stroud and Severn railway, £50,000[15]
Hibernian railway, £1,000,000
Colchester and Halstead railway, £40,000
Ipswich, Diss, and Eye railway, £200,000
Exeter and Exmouth railway, £35,000
*Cromford and High Peak railway, £150,000
*Duffryn Llynvi and Porth Cawl railway, £30,000
*London and Edinburgh railway
*London and Newcastle railway
*Maidstone and Tunbridge railway
*Manchester and Oldham railway
*Bolton and Leigh railway
*Rhymney railway
Berwick and Kelso railway
East Lothian railway
*Edinburgh and Dalkeith railway[16]
West Lothian railway
Glasgow and Rosebank railway
Kelso, Melrose, and Dalkeith railway
Dundee and Strathmore railway
*Monkland and Kirkintilloch railway
Galligate railway
Tees and Weardale railway
Kennet and Avon and Old Sarum
*Dublin and Kingston railway
*Dublin and Belfast railway
*Brighton and Shoreham railway
Wormsley railway
Flintshire railway
Portland railway
Festiniog railway
*Huddersfield and Wakefield railway
Redworth railway

The above gives a list of about sixty railways, to which others were afterwards added.

The capital of those companies which had published the amount they would require was above 20,000,000*l.*; and as much may be taken for the other thirty companies, which would give a capital proposed of 40,000,000*l.* The writer in the *John Bull* reckoned that 11,500,000*l.* would be enough to make a complete railway system. It was to be thus laid out:—

Grand Junction	£2,000,000
London and Birmingham	1,500,000
Liverpool and Manchester	400,000
Manchester and Leeds	500,000
Manchester and Bolton	150,000
London and Bristol	1,500,000
Bristol and Bath	100,000
London and Portsmouth	1,000,000
London and Northern	2,500,000
Miscellaneous	1,850,000

The actual cost of these lines has been nearly as follows:—

	Estimated as above.	Cost.
London and North-Western	£3,900,000	£10,000,000
Manchester and Leeds	500,000	2,500,000
Manchester and Bolton	150,000	620,000
London and Bristol	1 600,000	4,000,000
London and South-Western	1,000,000	2,000,000
London and Northern	2,500,000	10,000,000
	9,650,000	29,120,000

What is called the Grand Junction in the above estimate, most likely includes the lines as far as Carlisle. If so, more must be added to the cost.

Nothing will show more strongly than the above how little was understood of the railway system, and how little way it has made.

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[3] Finger-Post, p. 28.

[4] Report on the Engine Railroad, by William James, 1823. (In the Library of the Institution of Civil Engineers.)

[5] Report on the Engine Railroad.

[6] Cumming on Railways. London: Baldwin, 1824. p. 42.——Statement of the Claim of the Subscribers to the Birmingham and Liverpool Railroad to an Act of Parliament. London: Baldwin, 1825.

[7] John Bull newspaper.

[8] Observations on the General Comparative Merits of Navigations and Railroads.

[9] Report by Alexander Nimmo, C.E., M. Inst. C.E., on the Limerick and Waterford Railway. Dublin: 1825. (In the Library of the Institution of Civil Engineers.)

[10] Reports of Wm. Chapman on the Newcastle and Carlisle Railway.

[11] Vallance's Pamphlet, p. 23.

[12] Vallance's Pamphlet, p. 30, 32.

[13] Vallance's Pamphlet, p. 99.

[14] Hill's Pamphlet on Leeds and Selby Railway.

[15] Stroud and Severn Railroad, a Fallacy; quoted by Vallance, p. 24.

[16] Whishaw on Railways.

The cost for locomotives and plant is nearly as much as the whole estimate in 1825: the cost for stations must come near it. The London and North Western workshops have cost more than it was thought would make a long line.

Of the sixty railways named, all those thus marked (*) have been made, besides others which cannot be identified. There are very few indeed which have not been made.

These lines were not however made in 1825, and some of them not for twenty years after. The historian will ask why is this? and the answer is, not that there was any want of means to make the railways, but because the House of Commons chose to throw the bills out to please the land-owners and shareholders in canals; thereby hindering the labouring classes from employment, which in ten years cannot be reckoned at less than twenty millions, or two millions yearly. How much more forward should we be had the great lines been finished, as they might have been, in 1830, instead of 1840, and if the other lines likewise had been so far before-hand. It would have done more for the trade of England than all the measures of Huskisson, Peel, and Russell.

As several of these lines will not again come before us, it may be as well to look at some of the remarks made by the writers of pamplets and reports in 1824 and 1825.

In the Report on the Engine Railroad, James gives some account of his employment as a land surveyor (p. 7). He advocates the use of the locomotive, and points out the great good which would be done by a railway from the southern counties to London (p. 20). This is one of the first pamphlets describing a line of railway, and had its beginning in the intercourse between James and Stephenson.

The "Statement of the Claim of the Subscribers of the Birmingham and Liverpool Railroad to an Act of Parliament," was written in December 1824, in answer to the opposition of the canal companies, and is a very elaborate pamphlet, in which the subject is investigated by the help of political economy and statistics.

The pamphlet in opposition to the railways started between London and Bristol is by some one on behalf of the Kennet and Avon Canal Company, and is written with some care, knowledge, and skill. The writer acknowledges there is great good in railways, but thinks that canals can, under most circumstances, work better and cheaper. He holds that in frosty weather in winter, and in dry weather in summer, the locomotives will not stir, because they have no bite on the rails. One of his speculations is, "What is to become of the engine-driver in a trip all the way on one of the supposed long railways. Is a wagon to be fitted-up as a moveable house, or is he to lodge at inns on the road, or only to go a given stage." The writer thought the engine-driver was to be held answerable for the goods carried.

In his report on the Limerick and Waterford Railway, Alexander Nimmo did not rely upon the locomotive. He thought that six or seven miles an hour was speed enough for a locomotive.

Chapman's reports are curious; for in them he discusses the whole railway question as he understood it in 1824. The fastest locomotive, he thought, could go at 4½ to 5 miles per hour;[17] but without a continuous line of teeth on a railway, a locomotive cannot in every description of weather be calculated to move against the retarding stress upon it.[18] He is not fully satisfied that locomotives are better, unless when horse-keep is dear. Chapman liked the stationary-engine system better, though he was not without hopes that a light locomotive might be found useful.[19] He wished that country carts should travel on the railway, as thereby it would be more useful. Chapman likewise preferred cast-iron rails.[20]

Vallance's pamphlet is a general onslaught on locomotives, on behalf of his own atmospheric system. It contains some wild assertions, but some curious facts. He gives many reasons to prove that locomotives cannot safely be driven beyond six miles an hour, nor could a locomotive be run from London to Brighton in six hours. He gives a list of railways proposed,[21] which has been made use of here.

Before leaving the railway mania of 1825, it should be said that it was not felt here only, but spread abroad. Mr. Sanders says[22] that the Americans were already alive to it, and that the subject of railways was undergoing discussion at the seat of government. Letters received from Washington were full of inquiries about railways in England. He says, likewise, that the Emperor of Russia had got a model of a locomotive, and had then a professional agent investigating the railways of the north of England. It is on these grounds that he urges on the House of Commons to lose no time in carrying out the railway system, a recommendation the wisdom of which has now been fully established. Mr. Maclaren says[23] that the French were employed in the same way, and that he had before him a work by M. Cordier, a French engineer, on railways. It was merely an abstract of various tracts published on railways in England. The French do not, however, seem to have made much way, and it was not till 1828 that anything was done.[24]

XIII. BEGINNING OF THE LIVERPOOL AND MANCHESTER RAILWAY.

Thomas Gray seems to have been the first who thought of a railway between Liverpool and Manchester, for as early as 1821 he set it forth in his "Observations on a General Iron Railway." He says (p. 5): "In times like the present, it behoves every one to assist as much as possible in the alleviation of public distress. When this can be done by a work of national utility it is still more desirable, and no time is so favourable for such an undertaking as one of general peace. It has frequently occurred to me of late, that an iron railway from London to Edinburgh (passing near to all the commercial towns of Leicester, Nottingham, Sheffield, Wakefield, Leeds, &c., with branch railways to Birmingham, Bristol, Manchester, Liverpool, &c.), would be productive of incalculable advantage to the country at large; and here I would suggest the propriety of making the first essay between Manchester and Liverpool, which would employ many thousands of the distressed population of the country."

Again, Gray says further on (p. 15): "The plan might be commenced between the towns of Manchester and Liverpool, where a trial could soon be made, as the distance is not very great, and the commercial part of England would thereby be better able to appreciate its many excellent properties, and prove its efficacy: in consequence of the number of cotton factories in Lancashire, the present severe times are as much felt there as in any part of the kingdom; therefore, the project before us would, by the abundance of labour it may yield, greatly assist in relieving that distress too prevalent in all manufacturing towns; and provided that success attend my plan, which nothing but impracticability will prevent, all the great trading towns of Lancashire and Yorkshire would eagerly embrace the opportunity to insure so commodious and easy a conveyance, and cause branch railways to be laid in every possible direction."

This is a distinct announcement of a locomotive railway between the two towns, and could hardly fail to be known to James. In 1822, James went to Liverpool, taking a letter of introduction to Mr. Joseph Sandars,[25] an eminent corn merchant there, and a man ardently fond of science and of art, and a great encourager of their deserving professors. James could hardly have applied to a better man.

James was introduced to Mr. Sandars upon the Exchange, at Liverpool, and the latter gentleman agreed to grant him an interview in the evening, when James showed his drawings and explained the working of the locomotive on his friend Stephenson's plan. Mr. Sandars, who was most earnest to find some better way for carrying goods between the two towns, asked James for how much he would make a preliminary, or as it was called ocular survey, for a railway between Liverpool and Manchester. James said ten pounds a mile; and taking the length at thirty miles, this made three hundred pounds. Mr. Sandars, with great liberality, said that he would at once agree to pay this sum; and not only that, but would enter into a written agreement to that effect. Thus Mr. Sandars became the father of the Liverpool and Manchester Railway.

The survey was begun,[26] but not without great delay on the part of James, and the outlay of more money than he had first wanted; indeed Mr. Sandars had some trouble in getting him to go through the work. This line of road laid down by James was not that afterwards made, but it was the beginning of the undertaking, and on which Mr. Sandars went forward with it.[27]

What made Mr. Sandars the more earnest in the undertaking was the grinding monopoly of the canal companies, by which the trade of Liverpool was shackled. The freight of goods was made so high it was unbearable, and there was the greatest need that it should be forthwith lowered. In the "Letter on the subject of the Proposed Railroad between Liverpool and Manchester," which Mr. Sandars afterwards wrote, he unmasked this fearful monopoly, and thereby helped to break it down, no less than by bringing

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[17] Report, p. 11.
[18] Report, p. 12.
[19] Report, p. 15.
[20] Report, p. 20.
[21] Page 99.
[22] Page 24.

[23] Railways, p. 47.

[24] In 1828, a memoire was published on the Andrezieux and Roanne Railway, which is in the Library of the Institution of Civil Engineers, and in 1830 one on the Roanne and St.-Etienne Railway,— both of which have been carried out. In the former memoire are quoted three works on railways, published in Paris in 1828, by M. Mallet.

[25] Booth's Account of the Liverpool and Manchester Railway, p. 3.

[26] Weale's Ensamples of Railways.

[27] Booth, p. 4.

forward the railway. He showed that the canal owners had raised the freight of corn from 6*s.* 8*d.* per ton to 12*s.* 6*d.*, and cotton from 6*s.* 8*d*, to 15*s.*; indeed they had done all they could to strangle the growing cotton-trade. The freight in 1822 was thrice what it was in 1795. In April 1822, the corn-dealers of Liverpool had sent to the Duke of Bridgewater's trustees, begging the freights on corn might be lowered; but this was flatly refused. Thus the traders of Liverpool were quite ready to welcome the proposal of a railway, which moreover made the length between the two towns 33 miles, instead of 50 by water, which saved water risks and wrecks, and gave greater speed.

(To be continued.)

NOTES ON ENGINEERING.—No. XIII.

By Homersham Cox, B.A.

THE VIBRATORY STRAINS OF SUSPENSION BRIDGES.

In the tenth of these Notes of Engineering (p. 258, Vol. XI.), an investigation was given of the dynamical strains of girders arising from the rapid passage of loads over them. In the present paper it is proposed to continue the subject of the effect of moving loads upon structures, by investigating the strains to which suspension bridges are most usually subject when in a state of vibration.

The greatest uncertainty has hitherto prevailed respecting the effect of vibration in straining the chains of suspension bridges. The almost entire absence of all theoretical or experimental knowledge of this part of engineering has left the engineer without the means of forming even a wide conjecture respecting it. It is generally assumed in practice that a suspension bridge ought to have four or five times the strength theoretically required for the greatest load that can rest upon it; and the excess of strength is a provision partly against the effects of vibration, and partly against accidental flaws and imperfections in the metal. But it is clear, that upon a rule so vague, and so entirely empirical, little dependence is to be placed—it may in some cases direct an enormous and unnecessary expenditure of metal, and in other cases provide an insufficient degree of strength.

Before proceeding to the direct consideration of the subject, we shall briefly and partially notice its history. The advantages arising from a historical view of scientific questions are unfortunately underrated in England. Continental writers almost universally preface their memoirs by some notice of the efforts of predecessors; and this custom has the threefold advantage of enlisting the confidence of the reader in the labours of one who exhibits a knowledge of the state of the scientific question discussed; of rendering merited homage to earlier essays; and lastly of putting the subject itself in a clear light, by indicating its real difficulties and the errors most naturally incidental to it.

The laws of vibration of flexible chains have from a very early period attracted attention. Galileo detected the isochronism of the oscillations of chains hanging from the roof of the Cathedral of Pisa and sustaining lamps, by comparing the time of the swinging of the chain with the beating of his own pulse. In the year 1732-3, Daniel Bernouilli published in the sixth volume of the St. Petersburg Transactions, a memoir entitled *Theoremata de Oscillationibus Corporum Filo flexili connexorum et Catenæ verticaliter suspensæ*, in which he gives, without proof, the length of the tantochronous simple pendulum, corresponding to cases where two or more bodies are attached to a fine thread suspended at one extremity: throughout this paper the extent of the oscillations is supposed to be indefinitely small, and experiments in confirmation of the results are instanced. It is also shown that, generally, *oscillationes contrariæ*, or oscillations where all the bodies vibrate in contrary ways, are much quicker than *oscillationes conspirantes*, or those in which the bodies move all to the right or all to the left at the same time.

The theory of the oscillation of flexible chains has been intimately connected with a principle laid down by Huyghens in his *Horologium Oscillatorium*, which asserts that the centre of gravity of any oscillating system acquires a descending velocity sufficient to raise it to a similar altitude. In the *Phoronomia* of Hermann, published in 1716, the principle is laid down that in the bodies forming a compound pendulum the impressed forces of gravity are in equilibrium with the effective forces applied in the opposite direction. This principle was generalised by Euler, and employed by him to determine the oscillations of flexible bodies, in a memoir printed in 1740 in the seventh volume of the St. Petersburg Transactions.

Numerous analogous researches by the Bernouillis, Clairaut, and Euler are scattered over the earlier volumes of the Transactions of St. Petersburg, Berlin, and Paris, the works of John Bernouilli, and the *Opuscula* of Euler. The problems proposed are, to determine the movements of heavy bodies attached to cords or rods, and moving by mutual constraint or that of fixed curves, &c.

Lagrange, in the *Méchanique Analytique*, 2de partie, sect. vi., has given a general investigation of the small oscillations of any linear system, by the method known as the Variation of Arbitrary Constants. He includes the celebrated problem of the vibrations of a stretched elastic cord; but it is not necessary to notice the other investigators of that problem, as it is almost entirely different from the problem of the vibrations of an inelastic chain or cord. With respect to the latter, Lagrange confines himself to the case of very small oscillations. The small oscillations of a cord suspended at one fixed point and charged with any number of equal weights placed at equal distances, he shows to be susceptible of determination; but when the cord is fixed at both extremities, the solution involves a certain general expression which, he says, cannot be determined by any known methods.

It will be seen, then, that the investigations above noticed afford very little assistance in solving the problem here proposed. We cannot safely assume, with respect to a suspension bridge, that the oscillations are "very small," in the sense in which that phrase is employed by mathematicians. A single foot passenger passing over the Hungerford Suspension Bridge, will produce sensible vibrations throughout the structure; that is, the passage of a weight of 10 or 12 stones produces considerable motion in a mass of 1,000 tons, or 16,000 times as great. What, then, must be the effect of the marching of a troop of soldiers, the action of a storm of wind, or the transit of a railway train? But, although we can not avail ourselves of the simplifications which arise where the oscillations are considered small, we have, on the other hand, this immense advantage—that, in order to find the tension of the chains, there is no necessity to integrate the equations of motion.

The cases of vibration to be examined in the following investigations are those where all the parts of the chain reach the extreme extent of their motion simultaneously, and simultaneously begin to return. At the instant of retrogression, the velocity of every part of the chain is zero, and the whole is in a state of *instantaneous rest.*

Periodic vibrations, in which the chain at recurring intervals reaches a position of instantaneous rest, are perhaps those most frequently observed. The present investigation will apply, whether the centre of the chain moves with vertical or with horizontal motion, or both, and whether the two points of suspension be, or be not, of the same altitude. The motion is supposed to take place wholly in the vertical plane, and the tension is made to depend on an assigned form assumed by the chain in the position of instantaneous rest.

Funicular Polygon.

In the first instance, we will consider the problem of n bodies of equal mass, connected by $n+1$ fine inextensible strings of equal length, of which the first and last are fixed at their extremities,—the whole forming a funicular polygon of $n+1$ equal sides.

Taking one end of the polygon as the origin of co-ordinates, let $(x_1\, y_1)$, $(x_2\, y_2)$, $(x_3\, y_3)$ .... (x_n, y_n) be the co-ordinates of the bodies at the time t; x being measured vertically downwards, and y horizontally. Also, let a be the length of each side of the polygon, and (b, c) the co-ordinates of its further extremity. Then the co-ordinates are connected by the following system of relations:—

$$\begin{array}{rcl} x_1^2 + y_1^2 & = & a^2 \\ (x_2-x_1)^2+(y_2-y_1)^2 & = & a^2 \\ (x_3-x_2)^2+(y_3-y_2)^2 & = & a^2 \\ \&c. \qquad \&c. & & \\ (b-x_n)^2+(c-y_n)^2 & = & a^2 \end{array}$$

Now, when t becomes $t+dt$, the same relations will hold among the new co-ordinates of the several bodies. Consequently, the differentials of the above equations with respect to t express true relations. Hence, differentiating the equations twice with respect to t, and in the resulting equations of second differentials putting

$\frac{dx_1}{dt}, \frac{dy_1}{dt}, \frac{dx_2}{dt}$ &c. $= 0$, since by our hypothesis the velocities are zero, we have :—

$$x_1\frac{d^2x_1}{dt^2} + y_1\frac{d^2y_1}{dt^2} = 0 \quad (1)$$

$$(x_2-x_1)\left(\frac{d^2x_2}{dt^2}-\frac{d^2x_1}{dt^2}\right) + (y_2-y_1)\left(\frac{d^2y_2}{dt^2}-\frac{d^2y_1}{dt^2}\right) = 0 \quad (2)$$

$$(x_3-x_2)\left(\frac{d^2x_3}{dt^2}-\frac{d^2x_2}{dt^2}\right) + (y_3-y_2)\left(\frac{d^2y_3}{dt^2}-\frac{d^2y_2}{dt^2}\right) = 0 \quad (3)$$

$$(b-x_n)\frac{d^2x_n}{dt^2} + (c-y_n)\frac{d^2y_n}{dt^2} = 0 \quad (n+1)$$

Now, the second differentials express the accellerations of the several bodies parallel to the axes of x and y. Also the forces acting on each body vertically downwards are the difference of the resolved vertical parts of the two tensions acting on it, and the force of gravity. The horizontal force on each body is the difference of the resolved horizontal parts of such tensions.

Let $T_1, T_2, T_3 \ldots\ldots T_{n+1}$ be the tensions of the 1st, 2nd, 3rd...... $(n+1)$th side of the polygon respectively.

The resolved vertical parts of these tensions are

$$T_1\frac{x_2-x_1}{a},\ T_2\frac{x_3-x_2}{a}\ldots\ldots T_{n+1}\frac{b-x_n}{a} \text{ respectively.}$$

The resolved horizontal parts of these tensions are

$$T_1\frac{y_2-y_1}{a},\ T_2\frac{y_3-y_2}{a}\ldots\ldots T_{n+1}\frac{c-y_n}{a} \text{ respectively.}$$

The equations of vertical motion are (m being the mass of each body, and g the force of gravity)

$$m\frac{d^2x_1}{dt^2} = mg - T_1\frac{x_1}{a} + T_2\frac{x_2-x_1}{a} \quad (1)'$$

$$m\frac{d^2x_2}{dt^2} = mg - T_2\frac{x_2-x_1}{a} + T_3\frac{x_3-x_2}{a} \quad (2)'$$

$$m\frac{d^2x_3}{dt^2} = mg - T_3\frac{x_3-x_2}{a} + T_4\frac{x_4-x_3}{a} \quad (3)'$$

&c. &c.

$$m\frac{d^2x_n}{dt^2} = mg - T_n\frac{x_n-x_{n-1}}{a} + T_{n+1}\frac{b-x_n}{a} \quad (n)';$$

and the equations of horizontal motion are

$$m\frac{d^2y_1}{dt^2} = T_2\frac{y_2-y_1}{a} - T_1\frac{y_1}{a} \quad (1)''$$

$$m\frac{d^2y_2}{dt^2} = T_3\frac{y_3-y_2}{a} - T_2\frac{y_2-y_1}{a} \quad (2)''$$

$$m\frac{d^2y_3}{dt^2} = T_4\frac{y_4-y_3}{a} - T_3\frac{y_3-y_2}{a} \quad (3)''$$

&c. &c.

$$m\frac{d^2y_n}{dt^2} = T_{n+1}\frac{c-y_n}{a} - T_n\frac{y_n-y_{n-1}}{a} \quad (n)''.$$

We have then, in all, $(3n+1)$ equations, involving $3n+1$ unknown quantities—namely, the n differentials $\frac{d^2x}{dt^2}$, the n differentials $\frac{d^2y}{dt^2}$, and the $n+1$ tensions T. Our object is now to eliminate the differentials, and so obtain $n+1$ equations involving no other unknown quantities than the T's.

If $\theta_1, \theta_2, \theta_3 \ldots\ldots \theta_{n+1}$ be the angles at which the $n+1$ sides of the polygon are respectively inclined to the vertical, it is easy to see that $\frac{x_1}{a} = \cos\theta_1$, $\frac{y_1}{a} = \sin\theta_1$, $\frac{x_2-x_1}{a} = \cos\theta_2$, $\frac{y_2-y_1}{a} = \sin\theta_2$, &c. $\frac{b-x_n}{a} = \cos\theta_{n+1}$, $\frac{c-y_n}{a} = \sin\theta_{n+1}$. Substituting these values in the $3n+1$ equations, we shall obtain, after some trigonometrical operations which are here omitted for the sake of brevity, the following symmetrical results:—

$$\left.\begin{array}{l}
mg\cos\theta_1 - T_1 + T_2\cos(\theta_2-\theta_1) = 0\\
T_1\cos(\theta_2-\theta_1) - 2T_2 + T_3\cos(\theta_3-\theta_2) = 0\\
T_2\cos(\theta_3-\theta_2) - 2T_3 + T_4\cos(\theta_4-\theta_3) = 0\\
T_3\cos(\theta_4-\theta_3) - 2T_4 + T_5\cos(\theta_5-\theta_4) = 0\\
\quad \&c.\\
T_{n-1}\cos(\theta_n-\theta_{n-1}) - 2T_n + T_{n+1}\cos(\theta_{n+1}-\theta_n) = 0\\
T_n\cos(\theta_{n+1}-\theta_n) - T_{n+1} - mg\cos\theta_{n+1} = 0
\end{array}\right\} (a)$$

The first and last of these equations might have been obtained independently, by applying with respect to the first and the last of the moveable bodies the consideration that when a body begins to move, the sum of the forces resolved at right angles to the initial direction of motion must be zero.

It is theoretically possible to effect these solutions of $(n+1)$ equations of the first degree, involving $(n+1)$ unknown quantities. The law which the values of the unknown quantities of a general system of equations of the first degree follow, was first observed by Cramer, and subsequently expressed in a somewhat more convenient form by Bezout in his *Théorie Generale des Equations*. The first rigorous demonstration of the rules was given by Laplace in the Memoirs of the *Academie des Sciences* for 1772 (*2de partie, p.* 294). A very elegant demonstration is also given by M. Gergonne in his *Annales*, vol. IV. p. 148; and a subsequent paper by him on the same subject is to be found in vol. XII. p. 281, of the same periodical. These investigations do not, however, present the required values in the form of general expressions, but merely furnish rules for constructing such an expression by writing down in a system of $(n+1)$ equations, the $1.2.3\ldots n+1$ permutations of $(n+1)$ quantities.

It is, therefore, necessary to adopt an independent method in the present instance, in order to determine the unknown quantities in the series (a) of equations just given. The solution requires considerable care in order to avoid an excessive complexity of the results.

$$\text{Let } \tfrac{1}{2}\cos(\theta_2-\theta_1) = u_0;\ \tfrac{1}{2}\cos(\theta_3-\theta_2) = u_1;\ \tfrac{1}{2}\cos(\theta_4-\theta_3) = u_2;\ \&c.$$
$$\tfrac{1}{2}\cos(\theta_{n+1}-\theta_n) = u_{n-1} \ldots\ldots\ldots\ldots (A)$$

Then omitting for the present the first and last of the equations (a) just given, the remainder may be put in the following form :—

$$T_3 = T_2\frac{1}{u_1} - T_1\frac{u_0}{u_1}$$

$$T_4 = T_3\frac{1}{u_2} - T_2\frac{u_1}{u_2} = T_2\frac{1-u_1^2}{u_1u_2} - T_1\frac{u_0}{u_1u_2}$$

$$T_5 = T_4\frac{1}{u_3} - T_3\frac{u_2}{u_3} = T_2\frac{1-u_1^2-u_2^2}{u_1u_2u_3} - T_1\frac{u_0(1-u_2^2)}{u_1u_2u_3}$$

$$T_6 = T_5\frac{1}{u_4} - T_4\frac{u_3}{u_4} = T_2\frac{1-u_1^2-u_2^2-u_3^2+u_1^2u_3^2}{u_1u_2u_3u_4} - \frac{T_1u_0(1-u_2^2-u_3^2)}{u_1u_2u_3u_4}$$

&c.

$$T_{n+1} = T_n\frac{1}{u_{n-1}} - T_{n-1}\frac{u_{n-2}}{u_{n-1}} = T_2\frac{\mathbf{a}}{u_1u_2u_3\ldots u_{n-1}} - T_1u_0\frac{\mathbf{b}}{u_1u_2u_3\ldots u_{n-1}}$$

The second values of T_4, T_5, and T_6, above given, are obtained by substitution of the previously-ascertained values of T_3, T_4, and T_5, respectively. Our object is now to ascertain the law of the co-efficients of T_2 and T_1 on the right-hand side of the above equations—that is, to find general expressions for $\mathbf{a}$ and $\mathbf{b}$.

Let u_1^2 be written $= 1'$; $u_2^2 = 2'$; $u_3^2 = 3'$; &c. $u_m^2 = m'$. Then we shall find, by continuing the process of substitution, that

for T_7, $\mathbf{a} = 1-(1'+2'+3'+4')+1'(3'+4')+2'4'$

for T_8, $\mathbf{a} = 1-(1'+2'+\ldots 5')+1'(3'+\ldots 5')+2'(4'+5')+3'5'-1'3'5'$

for T_9, $\mathbf{a} = 1-(1'+2'+\ldots 6')+1'(3'+\ldots 6')+2'(4'+\ldots 6')+3'(5'+6')$
$+4'6'-1'3'(5'+6')-2'4'6'$.

The law observed by the above successive values of $\mathbf{a}$ is tolerably obvious; and from the manner in which they are derived, is evidently continuous.

In order to indicate the law by a general expression,

Let $1'+2'+3'+\ldots m' = S(m)$ *the sum of the quantities* $1', 2', 3'$, &c.

Let $1'(3'+4'+\ldots m')+2'(4'+5'+\ldots m')+3'(5'+\ldots m')+\ldots\ldots\ldots$
$+(m-2)'m' = S(m-2, m)$ *the sum of the products of every two of them omitting those products in which any one of the quantities is multiplied by the next in numeral order.*

Let $1'\left\{3'(5'+6'+7'\ldots.m') + 4'(6'+7'+\ldots.m') + 5'(7'+\ldots.m')+\ldots\ldots+(m-2)'m'\right\}$

$+ 2'\left\{4'(6'+7'+8'\ldots.m') + 5'(7'+8'+\ldots.m') + 6'(8'+\ldots.m')+\ldots\ldots+(m-2)'m'\right\}$

$+ 3'\left\{5'(7'+8'+9'\ldots.m') + 6'(8'+9'+\ldots.m') + 7'(9'+\ldots.m')+\ldots\ldots+(m-2)'m'\right\}$

$+$ &c. $+ (m-4)'(m-2)'m'$

$= S(m-4, m-2, m)$ *the sum of the products of every three with like omission.*

Similarly, let the series of which the last term is

$$(m-6)'(m-4)'(m-2)'m' = S(m-6, m-4, m-2, m)$$

and that of which the last term is

$(m-8)'(m-6)'(m-4)'(m-2)'m' = S(m-8, m-6, m-4, m-2, m)$.

Then, for the general value of a in the equation for T_{n+1}, where $m=n-2$, it will be found that

$$\mathsf{a} = 1-(Sn)-2+S(n-4,n-2) - S(n-6,n-4,n-2)+\ldots\ldots\ldots$$

$$\left.\begin{array}{l}(-)^{\frac{n-2}{2}}u_2u_4u_6\ldots\ldots u_{n-2} \text{ when } n \text{ is even}\\ (-)^{\frac{n-1}{2}}u_1u_3u_5\ldots\ldots u_{n-2} \text{ when } n \text{ is odd}\end{array}\right\}$$

In the same way b may be determined; and it will be found that the expression for b is identical with that for a, except in that the quantity $1'$, and all terms multiplied by $1'$, are to be omitted.

If we suppose the quantities $1'$, $2'$, $3'$, &c. to follow a general law; that is, if the inclination of the sides of the polygon be expressed by a general formula dependent on the order of their succession, the series for a and b involve Finite Differences, and if the operations be not too complicated may be summed by the calculus of Finite Differences.

We will take the most simple case—that where the polygon is inscribed in the arc of a circle. Here by the geometry, $\theta_2-\theta_1 = \theta_3-\theta_2 = \theta_4-\theta_3$ &c., or $1'$, $2'$, $3'$, &c. are all equal $(=u^2$, suppose).

In this case, by the meaning assigned to $S(m)$ $u^2+u^2+u^2\ldots.$ (m times) $= S(m) = u^2m$,

$$S(m-2,m) \text{ becomes } (m-2+m-3+m-4+\ldots.1)u^4 = \frac{(m-2)(m-1)}{2}u^4$$

Or reversing the order of the terms, we have series of the respective forms

$$S(m-2,m) = u^4(1+2+3+4+5+..m-2) = u^2\Sigma(m-1),$$

$$S(m-4,m-2,m) = u^6\{1+(1+2)+(1+2+3)+..+(1+2+3+..m-4)\}$$
$$= u^6\,\Sigma^2(m-3),$$

$$S(m-6,m-4,m-2,m) = u^8\{(1+1+2)+(1+1+2+1+2+3)+\ldots.$$
$$+(1+1+2+\ldots.1+2+3\ldots.m)\} = u^8\Sigma^3(m-5),$$

&c.

where Σ is the symbol of integration in the Calculus of Finite Differences. The numbers expressed by these series are technically known as the *figurate numbers.*

Now by the principles of the Calculus

$$\Sigma m = \frac{(m-1).m}{2};\ \Sigma^2 m = \frac{(m-2)(m-1)m}{2.3};\ \Sigma^3 m = \frac{(m-3)(m-2)(m-1)m}{2.3.4} \text{ \&c.}$$

$$\therefore\ \Sigma(m-1) = \frac{(m-2)(m-1)}{2};\quad \Sigma^2(m-3) = \frac{(m-5)(m-4)(m-3)}{2.3};$$

$$\Sigma^3(m-5) = \frac{(m-8)(m-7)(m-6)(m-5)}{2.3.4} \text{ \&c.}$$

Substituting these values in the series for a, and putting $m=n-2$, we have

$$\mathsf{a} = 1-u^2(n-2)+u^4\frac{(n-4)(n-3)}{2} - u^6\frac{(n-7)(n-6)(n-5)}{2.3}$$
$$+u^8\frac{(n-10)(n-9)(n-8)(n-7)}{2.3.4} - \text{\&c.}$$

In the same way the value of b may be determined.

The equation $T_{n+1} = T_2\dfrac{\mathsf{a}}{u_1u_2\ldots u_{n-1}} - T_1u_0\dfrac{\mathsf{b}}{u_1u_2u_3\ldots u_{n-1}}$, combined with the first and last of the series (a) of equations, suffices to determine the tensions in terms of the known quantities.

Vibrating Catenary.

We have hitherto considered the chain as a funicular polygon with the weights arranged at finite distances. When the chain assumes the form of a continuous curve with the weight uniformly distributed along its whole length, the method of Finite Differences is replaced by the Differential Method, which, as is usually the case in investigations of this kind, simplifies the results in a most remarkable manner.

It has been shown in the preceding investigation, that where x, y and x^1, y^1 are two adjacent points of the polygon, the geometrical connection of the system furnishes the relation

$$\left(\frac{x^1-x}{a}\right)\left(\frac{d^2x^1}{dt^2}-\frac{d^2x}{dt^2}\right)+\left(\frac{y^1-y}{a}\right)\left(\frac{d^2y^1}{dt^2}-\frac{d^2y}{dt^2}\right) = 0.$$

Now, when the two points in question are indefinitely near each other, $a=ds$, where ds is an element of curve assumed at the time t, and x^1-x and y^1-y are replaced by the corresponding differentials dx and dy respectively. So that

$$\frac{x^1-x}{a} = \left(\frac{dx}{ds}\right);\quad \frac{y^1-y}{a} = \left(\frac{dy}{ds}\right).$$

The parentheses indicate that the differential co-efficients are partial, the time t not being supposed to vary. Also, if $\dfrac{d^2x}{dt^2}$ be a function of s, $\dfrac{d^2x^1}{dt^2}$ is the same function of $s+ds$. Or expanding by Taylor's theorem, and, in the limit, neglecting all the terms of the expansion subsequent to the second

$$\frac{d^2x^1}{dt^2}-\frac{d^2x}{dt^2} = \left(\frac{d}{ds}\right).\frac{d^2x}{dt^2}ds = \frac{d^3x}{ds\,dt^2}.$$

Similarly, $$\frac{d^2y^1}{dt^2}-\frac{d^2y}{dt^2} = \left(\frac{d}{ds}\right).\frac{d^2y}{dt^2}dy = \frac{d^3y}{ds\,dt^2}.$$

So that the above geometrical relation becomes

$$\left(\frac{dx}{ds}\right)\frac{d^3x}{ds\,dt^2}+\left(\frac{dy}{ds}\right)\frac{d^3y}{ds\,dt^2} = 0 \ldots\ldots\ldots\ldots\ldots\ldots (A).$$

To proceed now to the mechanical equations of the problem, let T be the tangential tension at the point x, y. The vertically and horizontally resolved parts of this tension are respectively

$$T\left(\frac{dx}{ds}\right),\ \text{and } T\left(\frac{dy}{ds}\right),$$

since $\left(\dfrac{dx}{ds}\right)$ and $\left(\dfrac{dy}{ds}\right)$ are the cosine and sine respectively of the inclination of T to the vertical. Now, $T\left(\dfrac{dx}{ds}\right)$ and $T\left(\dfrac{dy}{ds}\right)$ depend for their values on the place in the curve where they act—that is, are functions of s, the distance from the origin measured along the curve; consequently, at the adjacent point $s+ds$,

$T\left(\dfrac{dx}{ds}\right)$ and $T\left(\dfrac{dy}{ds}\right)$ become, expanding by Taylor's Theorem,

$$T\left(\frac{dx}{ds}\right)+\left(\frac{d}{ds}\right).T\left(\frac{dx}{ds}\right)ds+\ldots \quad \text{and } T\left(\frac{dy}{ds}\right)+\left(\frac{d}{ds}\right)\left(T\frac{dy}{ds}\right)ds+\ldots$$

and the differences between these and the former values are, in the limit,

$$\left(\frac{d}{ds}\right).T\left(\frac{dx}{ds}\right)ds,\ \text{and } \left(\frac{d}{ds}\right).T\left(\frac{dy}{ds}\right)ds, \text{ respectively.}$$

Let μds be the mass of the element ds. Then the acceleration of that element vertically is the weight + the difference of the vertical tensions, and the horizontal acceleration is the difference of the horizontal tensions. Whence the following mechanical equations:—

$$\mu\,ds\frac{d^2x}{dt^2}=\frac{d}{ds}\left(T.\frac{dx}{ds}\right)ds+\mu g\,ds;\quad \mu\,ds\frac{d^2y}{dt^2}=\frac{d}{ds}\left(T\frac{dy}{ds}\right)ds;$$

or performing the differentiation of the quantity in the brackets, and omitting the common factor ds,

$$\mu\frac{d^2x}{dt^2}=T\left(\frac{d^2x}{ds^2}\right)+\left(\frac{dT}{ds}\right).\left(\frac{dx}{ds}\right)+\mu g;\quad \mu\frac{d^2y}{dt^2}=T\left(\frac{d^2y}{ds^2}\right)+\left(\frac{dT}{ds}\right).\left(\frac{dy}{ds}\right)\ldots.(B)$$

Differentiating these equations with respect to s, we have

$$\mu\frac{d^3x}{ds\,dt^2} = T\left(\frac{d^3x}{ds^3}\right)+2\left(\frac{dT}{ds}\right)\left(\frac{d^2x}{ds^2}\right)+\left(\frac{d^2T}{ds^2}\right).\left(\frac{dx}{ds}\right)$$
$$\mu\frac{d^3y}{ds\,dt^2} = T\left(\frac{d^3y}{ds^3}\right)+2\left(\frac{dT}{ds}\right)\left(\frac{d^2y}{ds^2}\right)+\left(\frac{d^2T}{ds^2}\right).\left(\frac{dy}{ds}\right)$$

Multiplying these equations by $\left(\dfrac{dx}{ds}\right)$ and $\left(\dfrac{dy}{ds}\right)$, respectively, and adding the results, we have from (A) (remembering that $\dfrac{dx^2}{ds^2}+\dfrac{dy^2}{ds^2}=1$, and that the differential of this equation, or $\dfrac{d^2x}{ds^2}.\dfrac{dx}{ds}+\dfrac{d^2y}{ds^2}\dfrac{dy}{ds} = 0$),

$$\frac{d^2T}{ds^2}+T\left(\frac{d^3x}{ds^3}\frac{dx}{ds}+\frac{d^3y}{ds^3}\frac{dy}{ds}\right) = 0.$$

The co-efficient of T in the bracket is equal to $\dfrac{1}{r}$, where r is the radius of curvature. Hence the expression assumes the following very simple form:—

$$\frac{d\,\mathrm{T}}{ds^2} = \mathrm{T}\frac{1}{r^2} \text{ .... (C)}$$

Which equation gives the tension at any point of the chain in terms of its curvature and length.

Before proceeding to show the application of this result to ascertain the tension of a suspension bridge, deflected from its position of equilibrium, it may be remarked that the equation applies in all cases where the velocity is zero at every point. The case of actual equilibrium ought, therefore, to be included by the equation. And this will be found to be the case: for the curve of equilibrium being the common catenary, we have from the known formulæ for the catenary, m and c being constants—

$$\mathrm{T} = m(c^2+s^2)^{\frac{1}{2}} \quad \therefore \frac{d^2\mathrm{T}}{ds^2} = \frac{mc^2}{(c^2+s^2)^{\frac{3}{2}}}$$

$$\text{Also,} \frac{1}{r^2} = \frac{c^2}{(c^2+s^2)^2} \text{ and } \mathrm{T}\frac{1}{r^2} = \frac{mc^2}{(c^2+s^2)^{\frac{3}{2}}}$$

So that the equation (C) is satisfied.

The integration of the equation (C) will involve two constants, which are to be determined by the conditions that as the two extremities of the catenary do not move, the accelerations at those points are zero. To ascertain the tensions at the extreme points, we must recur to the equations (B). Multiplying the first of these equations by $\frac{dy}{ds}$, and the second by $\frac{dx}{ds}$, putting the accelerations equal to zero, and subtracting, we find that at the extremities of the chain,

$$\mathrm{T}\left(\frac{d^2y}{ds^2}\frac{dx}{ds} - \frac{d^2x}{ds^2}\frac{dy}{ds}\right) = \mu g\frac{dy}{ds}; \text{ or, } \mathrm{T} = r\mu g\frac{dy}{ds} \text{ .... (D)}$$

Whence the following simple rule :—

When a uniform chain fixed at its extremities is in a position of instantaneous rest, the tension at either extremity is to the weight of the chain as the length of the radius of curvature at that point, multiplied by the cosine of the angle of horizontal depression of the curve at the same point to the length of the chain.

For example, if the whole chain weigh 500 tons, and the radius of curvature be three times the length of the chain, and the angle of horizontal depression at the point of contact = 15°, of which angle ·96592 is the cosine, the tension will be 500 tons × 3 × ·96592 = 1448·98 tons.

We will now proceed to determine the value of the chain when the curve of instantaneous rest is a circle, and r therefore a constant in equation (C). In this case the complete integral of that equation is

$$\mathrm{T} = c\epsilon^{-\frac{s}{r}} + c'\epsilon^{\frac{s}{r}} \text{ .... (E)}$$

where c, c' are the two constants of integration.

When $s = 0$ let T′ be the tension. When $s = \mathrm{S}$ the total length of the chain, let T″ be the value of the tension. T′ and T″ may be at once determined by the rule given above. Substituting successively these values of T in the last equation, we have two equations for determining the two constants; and substituting their values so determined in the equation for T, the value of the tension at any point will be completely determined.

If the two extremities of the chain be in the same horizontal line, the values of T′ and T″ become equal. It may be easily shown that in that case the tension at the lowest point is a maximum or minimum. Also at the same point, $s = \frac{1}{2}\mathrm{S}$. Substituting in equation (E), we have the tension at the lowest point

$$= 2\mathrm{T}'\left(\epsilon^{\frac{\mathrm{S}}{2r}} + \epsilon^{-\frac{\mathrm{S}}{2r}}\right)^{-1} = 2\mathrm{T}'\left(\epsilon^{\alpha} + \epsilon^{-\alpha}\right)^{-1}$$

Where α is angle between radii of curvature meeting respectively the centre and extremity of the arc S. And substituting this value in equation (E), it will be found that

$$\mathrm{T} = \mathrm{T}'(\epsilon^{\theta}+\epsilon^{-\theta})(\epsilon^{\alpha}+\epsilon^{-\alpha})^{-1},$$

where θ is the angle between the radii meeting the extremity of s and the centre of S respectively. From this equation the tension of the chain at every point may be immediately determined.

To illustrate these results by a numerical example, let us suppose that they are applied to a suspension bridge of which the semi-span is 338·25 feet, and the deflection 50 feet, which are the dimensions of Hungerford Bridge. By the geometrical properties of a circle,

$$radius = \frac{(semi\text{-}chord)^2 + (versed\ sine)^2}{2\,.\,versed\ sine} = \frac{(338{\cdot}25)^2 + 50^2}{2 \times 50} = 1169 \text{ feet.}$$

The tension at the highest point is determined by equation (D). The cosine of the angle of horizontal depression of the curve at that point is equal to (radius—versed sine) ÷ radius = $\frac{1119}{1169}$ = ·95808 = cos 16° 39′ nearly. Therefore the value of T in (D) is 1119 μg, or the tension at the highest point is to the total weight of the chain as 1119 feet to the total length of the chain. α = 16° 39′ = ·290597. Hence by the tables, ϵ^{α} lies between 1·33 and 1·34, and $\epsilon^{2\alpha}$ lies between 1·78 and 1·79. It follows that the tension at the lowest point of the chain lies between $\frac{133}{278}$T′ and $\frac{134}{279}$T′.

When the radius of curvature is variable, the equation (C) must in general be integrated by a series from which the tension at every point may be ascertained with any required degree of accuracy. The tension at the fixed points will be immediately and exactly ascertained from equation (D).

THE PHILOSOPHY OF NATURE AND ART.*

(Continued from page 77.)

There is too little known of Assyria and Babylon to justify us in discussing Mr. Fergusson's remarks, and more particularly as they have been written in anticipation of the publication of Mr. Layard. The subject of Mr. Fergusson's theory of the site of the Temple of Solomon has been very lately before the Institute of British Architects, so that we are exempt likewise from that. We cannot, however, dismiss Phenicia without expressing our surprise that Mr. Fergusson should assert that the Phenician alphabet is of Pelasgic invention, when the characters and their names are significant in Hebrew, and some of them have been traced to the Egyptian, as the Eye [*ayin*], and the Water [*mem*]. The *beth*, too, is the Egyptian plan of the House. It seems much more reasonable to suppose that some one Phenician or Hebrew, perhaps Moses, availed himself of the Egyptian phonetic system to construct a new alphabet. Perhaps this alphabet had more than one phonetic for the same sound; and perhaps in writing the pentateuch, pictorial emblems were used for words, where easily understood. The waving M for Water [*mem*], the Ox's head for A [*aleph*], the Camel for G [*gimel*], the House for B [*beth*], the Hook for V [*vau*], the Hand for Y [*yod*], the Eye for O [*ayin*], are all common objects, easily remembered and alliterative in Hebrew, and afford a curious confirmation of the legend of the Cadmean introduction from Phenicia, for the Greeks took the name and the form without understanding the allusions. *Alpha*, *beta*, &c. have no significancy in Greek. The practice of writing from the top to the bottom would very naturally be applied to a mixture of phonetics and hieroglyphics. The *βουστροφηδον*, or *bull-ploughing* up-and-down line is only an attempt to get continuity evolved from the other practice of writing in single columns—namely, having gone down one column, to join on and go up the next. Βουστροφηδον was doubtless written horizontally as well as vertically, and would be more convenient to read than when written vertically. From horizontal *βουστροφηδον*, the next step would be to writing in horizontal lines, either from the right hand or the left.

Mr. Fergusson's remarks on the Lycian and Halicarnassian monuments include a very ingenious, and as it seems to us very justifiable restoration of the celebrated Mausoleum at Halicarnassus, in which he has availed himself of his Indian experience.

The Third Chapter of the First Part brings us to Greece, a subject of particular interest to our readers.

The writer takes a very candid view of the influence of Puginism on Greek art. The Puginists have taught the public to admire styles produced in our hitherto proscribed climate by our English race, which we agree with him has done good. Mr. Fergusson does not, however, think that the absurd copying of medieval examples can hold its ground any more than the copying of Greek examples, and in the end the field will be left clear. In the meanwhile, Greek art is left to its own merits and demerits; not believed in as the sole faith in art, and as the sole vehicle of beauty, but candidly acknowledged in its beauties as in its deficiencies. Thus we shall reach a fair and right standard of criticism for all styles of art.

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* "An Historical Inquiry into the True Principles of Beauty in Art, more especially with reference to Architecture." By JAMES FERGUSSON, Esq., Architect, author of "An Essay on the Ancient Topography of Jerusalem," "Picturesque Illustrations of Ancient Architecture in Hindostan," Part the First. London: Longmans, 1849.

Mr. Fergusson's theory is that there are in Greece two distinct and separate civilizations, one of which succeeded, and to a great extent superseded, the other. The first he calls Pelasgic—that is, Ibero-Pelasgic, which began with the foundation of Argos, about the year 8200 of the Decimal Era, and continued down to the return of the Heraclidæ, eighty years after the fall of Troy, or about the year 8900.

After a long night of four centuries, the second Hellenic, Indo-European civilization begins to dawn on us, and continued to grow towards perfection till the time of Alexander; and after languishing for about two centuries longer, at last sank beneath the star of Roman influence.

This is quite consonant with what happened elsewhere in Europe, in Italy, in Spain, and perhaps, as Mr. Fergusson suggests, in Western Asia.

Mr. Fergusson, as already stated, holds that those he has here called Pelasgic were a race closely allied to the Etruscans, speaking a similar language and practising the same arts; and that therefore they were a people who came, like the latter, from Asia Minor, and spoke a tongue having no likeness with the Indo-Germanic tongue we now know as Greek.

In the case of Greece, Mr. Fergusson does not think that the Ibero-Pelasgi constituted the bulk of the population, but were only settlers. We do not see any reason for this limitation, as an Ibero-Pelasgic occupation in mass would not be inconsistent with the historical results in Greece, any more than in Etruria.

The writer takes the opportunity to draw attention to a distinction very seldom observed between the settlement of a whole country and the subjection of a ruder people by a more civilised race. When, as he says, in the latter days of the Roman empire, whole bands moved into thinly-peopled countries, bringing with them their wives and households, they brought likewise their speech, laws, and customs; and where they were the more numerous and more powerful body, they obliterated those of the previous inhabitants. But when the immigrants are only a few adventurers, or a band of soldiers, they adopt wives from among the conquered races, and their children learn to speak literally their mother tongue, and soon lose their own. To this may be added, that this likewise takes place where the dominant caste is spread over a wide district, and not concentrated in separate districts, however small. Of the first case there is an example in Britain, by the settlement of the English tribes—the English, Warings, Saxons, Jutes, Frisians, Danes, Bructuars, Vandals, &c. Of the latter cases there are examples in the settlement of the Franks in France, Burgundians in Burgundy, Goths in Spain, Longbeards in Lombardy; Warings, Russians, and English in Russia; Normans in Britain, Normandy, and Sicily,—where although, except in the case of the Goths and Noringens in Spain, the invading tribe was strong enough to impose its own name upon the conquered country, it gave up in the end its language, laws, and manners for those of the conquered. The settlement of the English in Ireland, and of the Magyars in Hungary, is that of the partial occupation of the country by a conquering tribe, the imposition of laws, and the plantation of the language, though not its general adoption. The settlement of the Flemings in Gower; of the English in Pembrokeshire and in Wexfordshire, at Forth and Bargy; and of the High Dutch in the Sete Communi in Lombardy, are examples of the preservation of a separate language by a small community.

Mr. Fergusson's theory, however, reduces itself to this form—that Greece, before the time of the Inachids in the year 8200, was peopled by a race of Indo-European or Celto-Hellenic savages, the forefathers of the Hellens, who were civilised and made to live in towns, and taught the arts of peace by a few Ibero-Pelasgic immigrants, who had long practised those arts in Asia and Egypt; and who were, in consequence, so far in advance of their subjects as to remain the dominant tribe for centuries, though too few in number to introduce their language—on the contrary, they were forced to speak that of the subject races. Our writer allows that his Pelasgi, when living by themselves, did speak a barbarous language, wholly unlike the Greek, and continued to do so down to the time of Herodotus.

We think it much more consistent with historic likelihood to suppose that the Ibero-Pelasgians were the dominant race, and were slowly superseded, and as it were worn out, by the Celto-Hellens,—as took place in Italy, Spain, Gaul, and Siluria; a process similar to that now going on on the the borders of Wales, the Highlands, and in Ireland, by the advance of the English. Such a process is favoured in a double form—by the immigration of the predominant race among the inferior race, and by the emigration of the inferior race towards the metropolis of the predominant race. This took place in Etruria as regarded Rome: it does now in the Celtic lands as regards the English metropolitan towns; and would among the Greek Pelasgi and the Hellens.

Our writer does not think that the Inachid immigrants from Egypt into Greece were Egyptians—but Pelasgi, perhaps fugitive Hyksos. This gets over the difficulty of the incompatibility, with Egyptian habits, of such emigrations and maritime expeditions. He, however, believes that Cecrops was a native of Sais in the Delta, but leaves it unsettled whether he were a born Copt, or the offspring of the stranger tribes.

We agree fully in the influence which the Phenician traders must have had in Greece. This is shown even in the Homeric poems. He considers the Phenician traders introduced the alphabet. We do not: we think it was the Pelasgians.

Upon the theory he has laid down the writer says, with great truth, that there is no difficulty in understanding why the arts of early Greece and of Etruria should be so similar, as they really are; nor why the intercourse between Greece and Asia Minor should have been so frequent as it was in those days. Mr. Fergusson holds that the Argonauts and the heroes of Troy were Pelasgians. Upon this latter hypothesis we do not feel fully satisfied.

Applying his principles to architecture, Mr. Fergusson says he thinks he can trace most distinctly the existence of these two races "architecturally," both in Greece and Italy. He looks upon it as nearly certain, that all the polygonal masonry and walls were the work of the Indo-Germanic aborigines, whether Hellens or Dorians; Oscans, Sabellians, or Umbrians. On the other hand, the Pelasgians, Tyrrhenians, or Etruscans, always show masonry in flat courses, more or less perfect. This distinction seems to harmonise the classification of what are called Cyclopean works; but we see no reason therefrom to assert that the Indo-Germanic works as the ruder are therefore the older. In Britain, the Welsh and old English undoubtedly executed rude works with the Roman models before them. This appears to us more confirmed from what Mr. Fergusson himself says, that the Dorian races used this polygonal masonry long after the return of the Heraclidæ, and mixed with the more perfect forms which, from their position, must have been used synchronously, as in the Temple of Themis at Rhamnus, or in the Bridge at Xero-Campo, or in Italy in the walls of Cosa and Pompeii. In a wall in the Peloponnesus, the polygonal masonry is actually raised on the top of the horizontal masonry, which is to us strong proof of our position.

To the polygonal masonry, Mr. Fergusson proposes to restrict the term Cyclopean. Of the Pelasgic remains, Mr. Fergusson has spoken at some length; and the so-called Treasury of Atreus at Mycenæ, he very ingeniously distinguishes as a tomb.

In coming to the later works of the Hellens, our writer prepares his way by asserting that the Ionians were Pelasgised Hellens, and the Dorians ruder Indo-Germans. Hence he distinguishes between the rough Dorians of Sparta and the milder Ionians of Athens and Asia Minor; but we do not think his theory carries conviction. He allows, however, that in the four centuries of slumber, the Hellenic tribes nursed and prepared themselves for their subsequent career.

Mr. Fergusson's sections on Homer, and on the climate and race of Greece, are original and ingenious, and tempt us to make some observations on them; but we are forced to pass them by.

Of Dorian architecture the temples are the only remains we have, but fortunately in sufficient number to enable us to judge of their condition when perfect. Their forms are always very simple; and our writer asserts that this was because the buildings were the mere framework for the display of the several arts; and that any novelty or complexity of design might, by attracting attention, have interfered with the pre-eminence they wished to assign to the more important arts. We do not think this a very happy explanation.

The peristylar temple, it is here suggested, was borrowed by the Greeks from the Egyptians; and it is certainly in favour of this supposition, that such buildings were used on the banks of the Nile before even the walls of Tyrinthus were built, and nearly a thousand years before the erection of the oldest example of a colonnade found in Greece. The reasons for the adaptation the writer conceives to be two-fold: first, to get a beautiful external framing to their temples, and to give the greatest possible value to the dimensions of the building, for a peristylar temple arranged as the Greeks arranged theirs, would appear nearly twice as large as one of like dimensions with only plain unbroken walls. The next motive was to shelter from the weather the paintings with which their walls were covered, and to do this in such a way that the framing of the pillars should add to the effect of the paintings; and what is of no less importance, that the painting should at the same time relieve and give effect to the columnar ordonnance.

This seems to us to be perfectly in harmony with the character of the Doric order as carried out by the Greeks, though not as carried out by the moderns.

One of our paintings, it is observed, would be utterly destroyed by such an arrangement; so also would one of the great battle-pieces of the Egyptians, which required an uninterrupted length of wall. But the reader is referred to Pausanius's description of the paintings in the Lesche at Delphi, to understand how the grouping of various and incongruous objects would lose in effect by being seen at once; whereas, to a spectator from the outside, the columns performed the office of our picture-frames, and separated the groups, so as to allow of each being contemplated singly.

The Doric column, Mr. Fergusson likewise considers to be of Egyptian origin, and he goes into the question of the origin of the order from wood or stone; and at great length advocates the latter theory, and brings forward some very strong arguments in its support. We cannot, however, enter upon this interesting discussion here, but refer our readers to what has been lately said on the subject in one of Weale's Rudimentary works, by one of the greatest critics and most learned writers on architecture, Mr. William Henry Leeds.

Mr. Fergusson considers that the roofs of the Greeks are copies from wooden structures, and he points it out as singular that the Dorians should have rendered the ends of the rafters so important in their triglyphs, but omitted the purlins altogether, though they must have used them—a circumstance which he thinks is owing to the purlins only appearing on the slope of the œtoi, and not either at the sides or in the horizontal cornice at the ends. The Ionians, on the contrary, omit altogether to notice the rafters, but repeat the purlins all round in the form of dentils. These views are supported by references to the cave-temples and modern buildings of India,—and, like every part of the work, deserve the attention of the reader.

With the closest research, Mr. Fergusson has not been able to discover the smallest indication of a triangular-framed truss for a roof in ancient Egypt, India, or Asia, while the Greeks used it very early. He looks upon it as a feature in architecture most important and influential, to which only the introduction of the arch can be compared. This truss he attributes to the Dorians.

Of the Ionian temples, Mr. Fergusson says that there is more variety in the plan, and instances the temple of Minerva Polias at Athens. The Ionic order he attributes to an Asiatic origin—perhaps Persepolitan.

The Corinthian order he considers to be the most original of those used by the Greeks, and the one to the invention of which they have the most distinct claim; and thinks that it was invented at a time when, owing to the decline of pure art, they were no longer capable of executing the Doric order with its integral sculpture and painting, and when they were tired of the Ionic. Incidentally here our writer expresses his dislike of the Ionic volute. He asserts that they are as clumsy an invention for the capital of a column as ever was hit upon. The Corinthian capital, however, he admires as rich and tasteful; but considers that no Corinthian portico ever erected was equal to the whole effect of the portico of the Parthenon, as finished in the days of Pericles.

The section on the Hypæthron, and the mode in which Greek temples were lighted, is that part of the book which has perhaps excited the most attention among architects and critics. This has always been a knotty point, for the roofs were supported by wooden beams which have long since rotted and fallen in, and left no indication of their original arrangement. There is likewise only one passage in ancient authors which has a direct bearing, that in the first section of the first book of Vitruvius—manifestly corrupt. This passage our writer considers refers only to the Temple of Jupiter Olympius, at Athens, and to decastyle temples.

The common way of restoring the hypæthron is by removing the roof off the cell, and exposing it to the weather as an open court. Some commentators have denied the existence of the hypæthron altogether.

Our writer strongly disputes that the cella of a Greek temple was lighted by dim oil-lamps, for it seems impossible that an artistic people like the Greeks should have been contented with such gloom. Their whole art was cheerful and sunny: we cannot therefore suppose they would shut out the bright light of day from their beautiful temples, or from such works of art as the Minerva Parthenon or the Jupiter Olympius of Phidias.

Written authorities throw no light on the subject, for it was apparently a thing everybody knew and understood; as when a modern tourist having said that such a building is ornamented with a portico of six or eight Grecian Doric or Corinthian columns,—he passes on, and does not stop to define and describe what a Doric or Corinthian column is, as everybody is already acquainted with it.

Mr. Fergusson begins with the small and simple temple of Apollo Epicurius, at Phigalia. The first thing which is familiar to us is the existence of the sculptured frieze, now in the British Museum, and which ran round the cell inside at the height of the external frieze of the Doric order of the temple. If the cell were roofed in any way, the sculpture so placed could not have been properly lighted by artificial means such as the Greeks possessed. In Stuart's "Athens," and in M. Blouet's "Expedition Scientifique," the temple is restored by omitting the roof altogether,—which is here repudiated, as making merely an open court, a sham temple, a peristyle, and dead wall, surrounding nothing; what might be done by architects now-a-days, but which were never executed anywhere except by them.

Mr. Fergusson therefore directs attention to the plan of the temple. The distance from the external frieze to the internal one is very nearly the same as that of the two internal friezes from one another; so that if the temple had three roofs, they would be as nearly as possible of equal widths. A striking peculiarity is, that the internal pillars fall exactly between the external ones, and in a manner which could not be accidental, and the internal pillars could never be seen in conjunction with the external ones. This is therefore conceived to be with the design that the principal drainage of the roof should fall between the external columns, not against them so as to corrode them, as otherwise it would do.

A plan is therefore given showing a roof in three bearings, but in one pitch, having the hypæthron or attic under the centre, and lighted by openings left in the roof; the drainage of which would be carried off by a gutter laid on the top of the entablature of the inner columns. The openings could likewise be protected by curtains or shutters, to which there would be access from below.

This is in effect an elevated clerestory, than which artistically speaking, our author says, no mode of lighting has been discovered more pleasing. The use of internal lighting in Greek buildings has often been advocated by "Candidus" in our columns, and its application in the examples already quoted confirms the justice of his views.

Externally, this mode of lighting neither breaks the ridge of the roof nor its lower termination, nor the outline of the temple; but it does break the monotony of the great flat expanse of the sides of the roof.

The same is then applied by the writer to other temples, and with equal appearance of success; and in the great temple at Pæstum the stairs are demonstrated by which the attendants had access to the curtains or shutters by which the hypæthron was closed. This, as he says, is the only plausible use for such stairs as yet suggested.

For the great temple of Jupiter, at Agrigentum, the system of Mr. Cockerell for lighting the aisles is adopted, and the new system for lighting the nave. For the temple of Eleusis the new system is the happier, as it explains how the temple could be lighted and darkened at pleasure, and scenic machinery used in the galleries.

If we have seen strong views expressed on some points, on none more so than on polychromy, the essentiality of which in a Doric building is insisted on. Our modern architects admit that decoration improves the inside walls of a room, church, or public building: they may find out that what improves one side of a wall improves the other. The force of this we are bound to admit; there is no artistic reason against it, and an unfounded conventionality alone stands in the way.

The Greeks, it is observed, used their colour in a manner so ephemeral, that the water-colour has, in almost every case, washed off, or the plaster has peeled off. They did not countersink their patterns, as did the Egyptians; nor did they inlay them or use variegated materials, the good effect of which Mr. Fergusson has witnessed on the banks of the Ganges. He conceives the colours to have been used first in painting the mouldings with honeysuckles, scrolls, and all those ornaments which we find afterwards carved in the richer Ionic orders; then relieving the sculpture by a blue or neutral-ground tint background, and tinting it so as to correspond and be in tone with the rest; but the mass of colour and art must have been applied to the walls of the cell, which he looks upon as the great picture-frames of the temple. To the height of six or height feet, at least, he conceives them to have been covered by a rich dark dado; and above that, in one, two, or three rows, pictures of processions, scenes from the life of the god, and such myths or sagas as the Greeks were so fond of repeating. The Panathenaic frieze represents such a frieze as our writer conceives would have been painted in any temple less rich, but was in the Parthenon carved as a crowning ornament to the great picture below.

The invisible curve, as to the form of which Mr. Penrose and Mr. Jopling are in controversy, Mr. Fergusson altogether repudiates, and ends by saying, that "We have long copied what we do not understand. It seems carrying the system to its acme of absurdity to attempt also to copy what we cannot see." There is too much truth in this to be willingly acknowledged.

Another doctrine, but of older date, which is here controverted is as to the commonly assumed symmetrical regularity of Greek architecture. This, too, is repudiated, as a property which exists only in the imagination of the moderns. Their temples, it is true, are all perfectly so: and so are the Gothic churches and cathedrals designed; a line drawn through the centre divides the building into two equal and like halves, unless some local necessity prevented. In contradistinction to the law of symmetrical regularity, it is asserted that the true law of architecture throughout the world is picturesque effect. As an example of its adoption by the Greeks, an appeal is made to the little triple temple in the Acropolis. In this building not one part ranges, and even two different orders are introduced; so that it might be understood to be three things joined together, as the steeple or chapter-house is joined to a Gothic cathedral,—contributing to the general effect, but preserving a distinctness of character. In the Propylæa, at Athens, is another example. The centre part, as one apartment, was of course symmetrical; but the wings were studiously separated from the main design, and one wing made unlike the other. On one side was placed, in front, the little temple of Nike Apteros, at an incongruous angle; at the other a pedestal, the axis of which was different from that of every other part. On the sides of the main building were placed other smaller ones, and the writer infers that pains were purposely taken lest any one line of one should run into any line of any other; and the whole group was placed so as to be as unsymmetrical as possible with the Parthenon, or with any other building. The same effect is exemplified at Eleusis and at Rhammis.

Symmetrical regularity is asserted to be an invention of the Italians.

Having pointed out as a remarkable characteristic of Greek architecture, that it made little progress, and became immutable in its types, our writer contrasts with it the contemporary art of sculpture, and says, that instead of the stationary unprogressive character of the former art, we find the latter striding forward with a speed unequalled even by the progress of Gothic art in the thirteenth, or Italian painting in the fifteenth century. The special cause of this was, first, the form of their mythology,—representing gods, bearing the forms of men and women, without any other attribute than was possessed by human beings, and yet greater and more beautiful than mortals. It is inferred that architecture was by the Greeks in their best age looked upon as the subordinate art, and sculpture as the principal art,—which is the canon applied in judging of their temples and architecture. Mr. Fergusson asserts roundly that though architecture has high aims, they are neither so high nor so difficult of attainment as those of the sister art: the proof of this lies in the facts, that barbarians have surpassed Greeks in the one, but no nation ever equalled them in the other.

An ingenious theory is given to account for the length of time during which Greek art maintained its vitality,—the Laocoon, the Tauro Farnese, the Dying Gladiator, the Gladiator of Agesias, and others, being executed after the age of Alexander—some extending late into the Roman period. A work in marble requires great labour, time, and thought—far more sober mechanical contrivances and labour than a painting, and the vehicle in sculpture must always be a correct and literal imitation of the human or some animal form—not even of plants. Expression and ideas may be added to any extent: but the form is given, and must always remain the same. In painting, on the other hand, harmonious colouring, chiaro-oscuro, aerial perspective, fore-shortening, and many less attributes, may be magnified into importance, and lead the painter astray from the true path;—but the sculptor can wander neither to the right or the left; he must stand still, or go on.

From this explanation the writer exempts the conventional absurdities of winged men and beasts, chimeras, gorgons, satyrs, hydras, harpies, minotaurs, and centaurs.

Another point brought forward is as to the monochromy of Greek sculpture. This is attacked, as the monochromy of architecture. All antiquity is so loud in praise of the chryselephantine statues of Phidias, the Olympian Jupiter, the Pallas Athene, that while we cannot refuse to allow that they were the greatest works of the best age of the arts, we must modify our views as to the monochromatic form being the canonic form of sculpture. Still, the transition from monochromatic to polychromatic sculpture is so great, that we may well be said to jump at once from the so-called purely Greek art of sculpture, to the native one of waxwork.

The Greeks, Mr. Fergusson thinks, had both; but they must have found out that perfection did not lie in the cold monumental purity of the one, nor in the more correct imitation of the person or thing represented, which is the aim of the other. Now, Mr. Fergusson thinks the practice of the Greeks was diametrically opposed to ours: that they generally, if not always, coloured their statues, but rarely coloured their pictures—that is, they used one or two colours only on a ground, as on the vases.

Mr. Fergusson, therefore, urges most strongly the re-introduction of coloured sculpture, and as strongly deprecates the white inanity of sculptural works of the present day. The common objections to coloured sculpture, Mr. Fergusson shows to be without any relevancy; and we cannot but think it is well worthy of the attention of sculptors to attempt something in this way. Gibson broke the ground in his statue of the Queen; and although some conventionalists objected to his decoration of the robe, the least prejudiced were pleased; and the effect was such as at any rate to authorise him to continue and carry the application further.

The popular taste for Greek vases, coloured glass, painted porcelain, coloured clay models, and waxwork is in keeping with a love of the beautiful engendered by the progress of painting: and unless the sculptor keeps pace with the growth of public taste, he will be overcome by the better artistic feeling of Madame Tussaud and the modellers of Spanish matadores, Mexican Indians, Maltese water-carriers, and Hindoo coolies. There must be an imitative plastic art, as well as an imitative art of design.

(To be concluded in our next.)

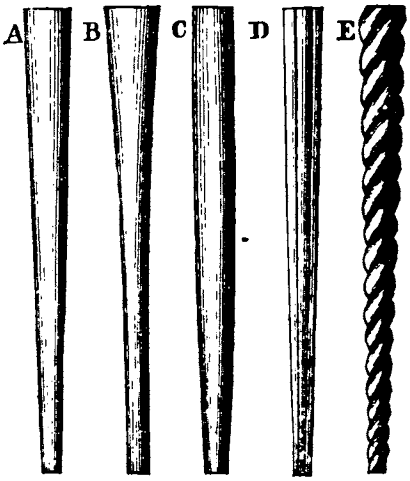
REGISTER OF NEW PATENTS.

TAPER TUBES.

Robert Walter Winfield, of Birmingham, manufacturer, and John Ward, of Birmingham, for "*improvements in the manufacture of tubes, and in the manufacture of certain articles made in part of tubes.*"—Granted September 14, 1848; Enrolled March 14, 1849. [Reported in the *Patent Journal.*]

This invention relates: First—to improvements in the making of taper tubes, which is effected by drawing them through dies or plates, as in the drawing of straight tubes.

Secondly—to an improved mode of manufacturing brass tubes, employed for conveying gas, which has for its object the better prevention of any escape of the gas.



In the manufacture of taper tubes, this invention is not confined to the making of that description whose sides are in straight lines, as at A, but may also be employed in the manufacture of such as are of a curved form, as represented at B, and C, and also in the tubes having flutes in a longitudinal direction, as at D; or spirally, as represented at E. In the manufacture of such taper tubes, the patentees employ a mandril or triblet of the intended form for the tube, on which a piece of sheet-metal is placed, which has been roughly turned up somewhat near the form, which is then to be drawn through the die or draw-plate, of a shape corresponding with the mandril or triblet; but this draw-plate, unlike the ordinary draw-plates, is made of a soft yielding material, which gradually expands as the tube is drawn through it, the opening thereby becoming gradually larger; whereas, in the ordinary draw-plates, the opening through which tubes are drawn is permanent, and finishes the tube of an exactly similar diameter to that which it commenced. Fig. 1 represents an end view of one of these improved draw-plates or collars; and fig. 2, a longitudinal section; this is constructed to draw a taper tube, fluted throughout its length, and is made of tin, which they find answers the purpose extremely well. It is made of a sufficient thickness to withstand the pressure necessary to the drawing the tube of the required form, which will in a great measure depend on the thickness of the metal to be drawn. The rough tube having been placed on the mandril, is drawn through this metal collar, which is placed in a holding-plate in the drawing-bench. This apparatus, being of the ordinary kind, it is not necessary to give any description thereof. The small end of the tube is held by the drawing nippers, and as it is drawn through the metal collar, it is gradually drawn into form as it passes through it, and when issuing from the other side, is compressed to, and assumes the shape of the mandril, and this being of a hard and rigid material, the collar is expanded according to such shape; thus delivering the tube tapered and fluted in as perfect a condition as if it were a parallel tube. It will be readily understood from this how the other forms shown are produced, with the exception of E, which involves another arrangement. This tube, it will be seen, differs from the foregoing, inasmuch as the flutes, instead of running in the direction of its length, are carried spirally round the tube. This form is produced either by causing the drawn collar to turn, or else suffering the mandril to turn as it passes through the collar. For this purpose, they prefer the latter mode, which is effected by placing the mandril or triblet, on a spindle, the head of which takes on the back end of the mandril, while the point projects through at the other end, and is laid hold of by the drawing-nippers, instead of the tag-end of the brass, as usual. In this manner, the mandril and tube is drawn through the collar, while at the same time it is carried round by the spiral flutes in the mandril, the soft metal collar effecting the same purpose as in the last case—delivering the tube completely formed on its mandril, which is then withdrawn, being readily effected by turning the tube slightly on the mandril. In this way may various other forms of taper tubes be produced, the small end, of course, being always drawn through the collar first, the collar in all cases adapting itself to the mandril, where there is no contraction of the mandril at any point to a size smaller than that which it has previously passed.

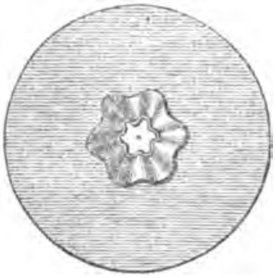


Fig. 1.

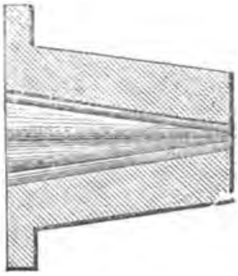


Fig. 2.

The second part of this invention has reference to the manufacture of brass tubes, for the passage of gas, which consists in simply drawing one tube within another, for the purpose of giving greater security to the joint, which, in the one, is diametrically opposite to that of the other; thus, if any leakage occurs in the inner one, it will be effectually sealed by the outer tube. The mode of drawing these double tubes is by simply drawing the inner tube of the proper size, then placing the external tube on it, which is large enough to slide on easily. The compound tube is now drawn through another plate, which contracts the outer one on the inner, and may virtually be said to be one tube. This may either be effected with or without the internal mandril or triblet usually employed, and well known in the drawing of brass and other tubes.

Having described the nature of their invention they would have it understood that they do not confine themselves to the precise detail, as such may be varied without departing from their invention; but what they claim is: First—the manufacture of taper tubes, by pressing a roughly-formed tube into contact with a mandril in its interior, the said pressure being exerted by a ring or mould, made of a material which will yield or expand as the tube is drawn through it, but exerts sufficient pressure to force the partially-formed tube into contact with the mandril, whether the said expanding ring or mould be of the form, and used in the manner described, or have a different form, or to be differently used, and whether the said taper tubes have any of the forms described and represented in the annexed engravings, or have any other form.

Secondly—the manufacture of gas fittings of double tubes, as herein described.

IRON BARS.

Richard Shaw, of Gold's-green, West Bromwich, Staffordshire, railway-bar finisher, for "*improvements in the manufacture of iron into tyre-bars, round bars, square bars, and flat bars; tee-iron, angle-iron, and trough-iron.*"—Granted August 21, 1848; Enrolled February 21, 1849. [Reported in the *Patent Journal.*]

This specification, which relates to the manufacture of iron, consists of various modes of forming and arranging the bars constituting the piles for rolling into—first, tyre-bars for tyres of railway-wheels; secondly, round bars, square bars, and flat bars; thirdly, tee-iron; and fourthly, angle-iron and trough-iron, in place of arranging the bars forming the pile, so that the edges of them shall appear when rolled or manufactured; thus preventing the joints of the bars impairing the strength of the article made, and liable to be much laminated from use. The patentee forms the piles of bars bent and arranged in such manner that only the sides of the bars shall be presented at the exterior of the article made, preventing thereby to a considerable extent the lamination taking place, and increasing the strength.

Fig. 1.

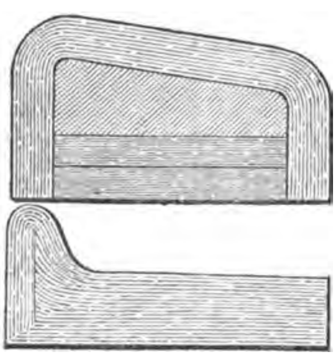
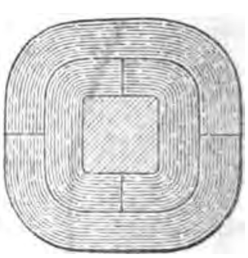


Fig. 2.



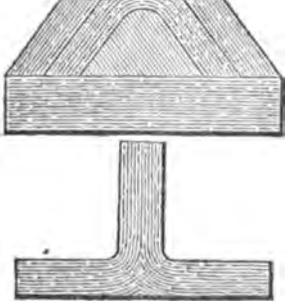


Fig. 3.

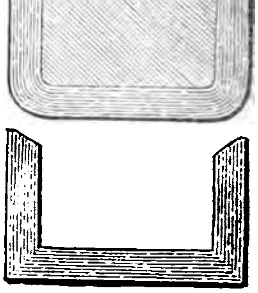


Fig. 4.

The annexed cuts show the modes of piling described by the patentee for forming the above-named articles: Fig. 1, being the section of a pile arranged for making tyre-bars, and a section of the tyre rolled from it. Fig. 2 is a section of a pile for making square, round, or flat bars. Fig. 3 is a section of a pile for making tee-iron, and a section of the tee-iron made from it. Fig. 4, sections of a pile for making trough or angle iron, and of the trough-iron made. The interior of the pile may be filled, in any convenient manner.

The patentee does not claim for forming the piles from which railway-bars are rolled, as it has been in practice; but he claims for forming the piles for making tyre-bars, square bars, round bars, and flat bars; tee-iron, angle-iron, and trough-iron, with bent bars, as described.

MANUFACTURE OF WHITE LEAD.

Thomas Richardson, of Newcastle-on-Tyne, chemist, for "*improvements in the condensation of metallic fumes, and in the manufacture of white lead.*"—Granted August 21, 1848; Enrolled February 21, 1849.

The improvements relate, first, to the manufacture of white lead, in the following manner. Tea lead is to be submitted in a melted state to a slow current of heated air, in an ordinary red-lead furnace, or in the iron pan employed for calcining hard lead, by which means the tin contained therein will be caused to separate from it and float upon the surface, together with a variable quantity of the oxide of lead, which is to be removed with an iron rake The completion of this part of the process is known by the lead becoming so soft that it may be scratched with the finger, when the remaining materials are to be taken away also. The lead is then to be reduced into crystals by the desilverizing process of Mr. Pattinson, or employed in a granular state. The prepared lead is to be moistened by the application of certain proportions of nitric or acetic acid of commerce, or nitrate or acetate of lead, diluted with water until of equivalent strength, and the moistened mass turned over from time to time, and, when sufficiently treated in this manner, about 20 or 30 cwt. of the same is to be placed in chambers, lined with lead, slate, or stone, the latter being preferred, fitted into a suitable frame, provided with doors, and having spaces between each of such chambers, into which spaces heated air is to be admitted (by means of a pipe furnished with a stop-cock), in order to keep the chambers at a proper temperature. Carbonic acid gas, is to be introduced into the chambers with the prepared lead, by means of pipes with stop-cocks; the heat is to be kept up, and steam admitted occasionally. At the expiration of from 10 to 14 days, the materials will be properly treated, when they are to be removed from the apparatus, ground between a pair of stones, and washed in a dolly-tub, which separates the metallic lead from the white lead, the former being returned with a fresh supply to the chamber.

Secondly, the improvement relates to the condensation of metallic fumes, which consist in introducing steam into the main pipe connecting the furnaces, by means of a small iron pipe situate at a distance of 2 feet or 3 feet beyond the furnace, and in building near the chimney a tower, not less than 20 feet high, divided internally by a partition wall, which reaches nearly to the top thereof; iron bars are placed across, upon which a layer of coke or pieces of broken brick is placed. The fumes ascend up the one compartment, but are intercepted in their passage down the other by the layer of coke or broken brick, upon which water flows in from the top. If the draught be not sufficient to draw through the coke, it is to be increased by means of steam jets.

VENEER CUTTING MACHINE.

Pierre Armand Le Comte de Fontainemoreau, of 4, South-street, Finsbury, Middlesex, for "*certain improvements in the machinery for cutting wood, and in laying and uniting veneers.*" (A communication.)—Granted May 25, 1847.

The improvements relate, firstly, to machinery for cutting wood into thin and continuous sheets of any desired width; secondly, to apparatus for pasting and doubling those said sheets, and their application to useful purposes, such as for hangings of apartments, &c. For the better comprehension of the invention, before entering into a detailed description of the manner of carrying it into effect, it will be well to premise by an *exposé* of the present state of the manufacture.

The mode of cutting wood in a cylindrical manner by means of a knife tangent to the circumference has been already devised, but up to the present time the mechanical means employed have proved insufficient to produce practical results, and manufacturers have not been able to operate but on small widths. It has never succeeded completely; and it may be added, that here endeavours have entirely failed, notwithstanding the numerous experiments which were essayed upon it—not because the system of cutting wood in that manner was unattainable, but because neither the mode of operating, nor the proper and rational mechanical dispositions which such an operation required, were found out. But it must be admitted that this operation is very delicate, and presents very great mechanical difficulties. It is therefore only after many experiments, attended with considerable trouble and perseverance, that satisfactory results have been obtained by the invention hereafter described.

From what proceeds, it will be easily understood that the first part of the invention is not the mere endeavour or idea of cutting wood tangentially to the cylinder in a spiral form, but consists really in the mechanical means or dispositions hereinafter described for obtaining such desirable results.

The machine which forms the subject of this patent, by cutting wood of large widths in a continuous manner, fulfils all the required conditions—namely, producing it with a great economy of time and manual labour. Thus a piece of wood—a log of mahogany for instance, whatever be its size, set in this apparatus, is cut in a continuous manner, without any interruption and with a velocity truly surprising; which is the more remarkable as it is obtained without sawing, but merely by cutting the substance on all its surface simultaneously and cylindrically, so as to form a spiral developed from the circumference to the centre.

We shall in the present number confine our extracts from the patent to the first part—viz. to machinery for cutting wood into veneers. The patentee proceeds as follows:—

My means, which as it will be easily seen are entirely new, comprise:—

Firstly,—The application of a sharp-edged and very thin blade, held fast between two knives or straight rulers ending in basil, which, while they keep tight the blade over all its length and near its cutting edge, prevent it on one side from going too deep into the wood, and on the other side force it to penetrate far enough into it, and to the required degree, according to the thickness designed for the sheets. That application, or rather addition of a thin blade working between two knives, is of the greatest importance for the success of the operation, and forms—I venture to say, a mechanical principle quite new, not only in the apparatus hereinafter described, but also in all other machines for wood-cutting, either from prisms, blocks, or logs.

Secondly,—The disposition of a strong leader set immediately above the knives, and resting constantly on the wood as fast as it is cut. That pressing leader, which is of a quite new application, is also of great importance in the operation, as it serves to keep the wood fast over all its length, and close to the part which is to be cut by the blade; so that, notwithstanding the knots, brambles, and defects which the knife meets with, it is always perfectly supported, and cannot be the cause of any defect or accident. If even the wood by its nature were very defective, uneven, and presented very little homogenousness in its different parts, it would nevertheless be well cut, and with all the precision and nicety that could be wished for.

Thirdly,—The mechanism adapted for working the blade, and at the same time the pressing leader in a continuous manner, is proportioned to the velocity given to the piece of wood to be cut; and it produces sheets of a surface constantly even, and of an equal thickness upon all their width, from the beginning to the end of the spiral. The quicker the block turns the more the progression of the blade and leader is rapid, and so reciprocally, whatever be the thickness previously regulated.

Fourthly,—The addition to the machine of a moveable drum, or cross-bar, provided with several arms, permitting to receive simultaneously a certain number of pieces of wood, and to cut them into thin and rectangular sheets, instead of continuous sheets, which in many cases enables me to make valuable applications of my invention to bramble woods and others.

Without the particular means which I have hereinbefore mentioned, and which constitute the whole of my invention, that is to say, all the principal or working parts of the machine, it is quite impossible to obtain the practical results which I produce, especially when it is required to operate on pieces of wood of large dimensions, as, for instance, upon logs of two or three yards, or even more in width, and upon any diameter and size whatever. It will be seen, as I before said, that it can be applied at will to cutting wood from a single piece into continuous and very large sheets, as to cut wood from several narrow pieces into rectangular sheets, proportioned to the size of the same pieces.

Description of the Engravings.

Fig. 1 shows a longitudinal elevation of the machine entirely set up, and ready to cut up a large piece of wood. Fig. 2 is a longitudinal section taken through the axis, according to the lines 1, 2, of the plan. Fig. 3 is a transverse section taken perpendicularly to the preceding, according to the line 3, 4. Fig. 4 is a general plan of the machine.

By examining the several views and details of the apparatus, it will be seen that the log or piece of wood, A, to be cut, is not set on mere conical points, as on a lathe, but on two square points of the iron axis BB^1, between which it is held sufficiently fast to avoid its having any play, but so that it may fall in steadily with the simultaneous rotary motion of these two axes. At its ends are adjusted the iron cross-bars C, which serve to maintain it on their points in a steady manner, and to keep it always perfectly in the centre from the beginning to the end of the operation. The forms of these cross-bars are similar to those shown in figs. 5 and 6; the largest of these are applied to the largest logs of wood, and the smallest replace the former when the logs are reduced to a small diameter. These cross-bars being at their centre pierced with square holes, having the exact form of the points, it is easily understood that when these points are inserted in the holes, the piece of wood is connected with the axis B, and B^1, in a continuous and solid manner, and must necessarily turn with them when they are put in motion.

As the logs of wood are not always of the same length, it is absolutely necessary to be able to cause the points, and consequently the axes, to advance and recede when requisite. For that purpose I have adapted to the end of one of these axes (that marked B) a screw D, fig. 4 and fig. 2, which can be turned by the hand, without giving to the axis the same rotary motion. That screw D, passing through a permanent nut E, is obliged to move when turning, and consequently causes the axis to advance or recede; and as that axis is held by two strong supporters FF^1, between which are placed the cog-wheel G, and the pulley H, set on the said axis, those two pieces G and H cannot move with it, as they are kept between two supports. Thus the screw D, and its axis B, only move and change their position.

The second axis B^1, is by itself a screw; it is wormed over all its length, and is provided, as the first axis B, with a cog-wheel G^1, having exactly the same diameter as the first-mentioned wheel G, and which also must rest in the same place, whatever may be the position given to the axis. For that purpose, this wheel G is kept on one side by the large supporter F$''$, by means of a nut *a*, which presses against it, and on the other side by a nut *a*, which rests on the nave of the wheel G^1. When that axis *B* is to be made to advance or recede, those nuts are loosened, and then, by means of the screw D, placed above, the moveable bearer I, is made to proceed. That bearer I, serves at its lower extremities as a supporter to the wormed axis B^1.

That second screw D^1, produces exactly the same effect as the former one D; its nut E being also permanent, is obliged to move according to its length, when it is made to turn lengthwise on the right or left side.

When the position of the two axes BB^1, has been so regulated, that their square points are inserted, and kept into the cross-bars which are adjusted to the extremities of the log of wood, as shown by figs. 2 and 4; the position of the blade-bearer carriage must be adjusted so that the more forward knife should advance, and rest on the external surface of the log.

Fig. 1.

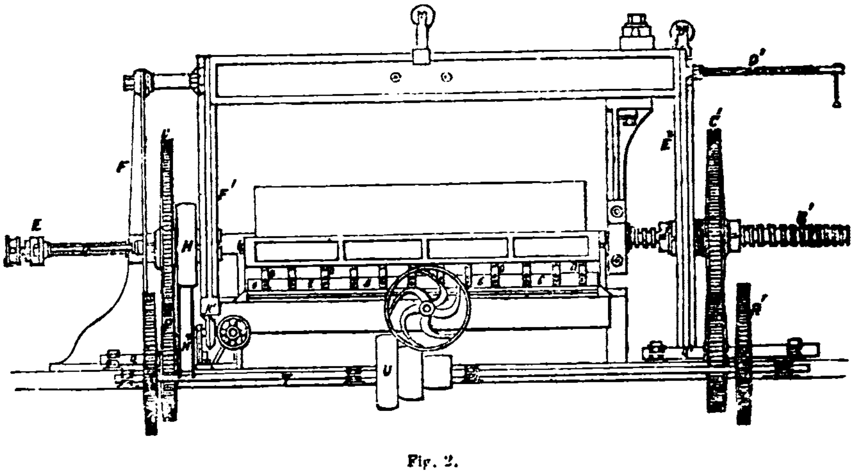


Fig. 2.

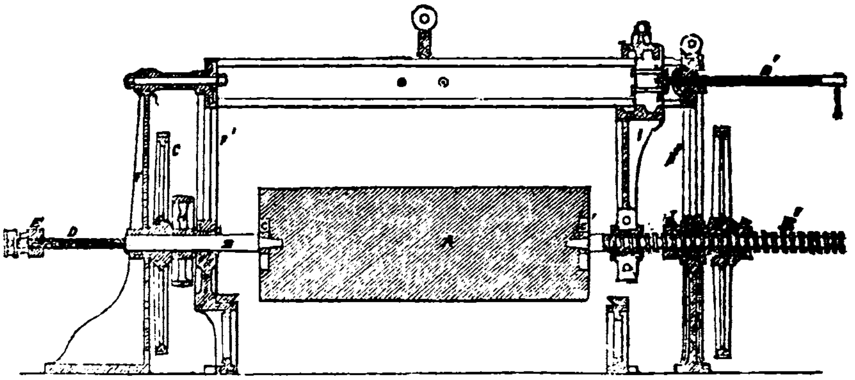


Fig. 4.

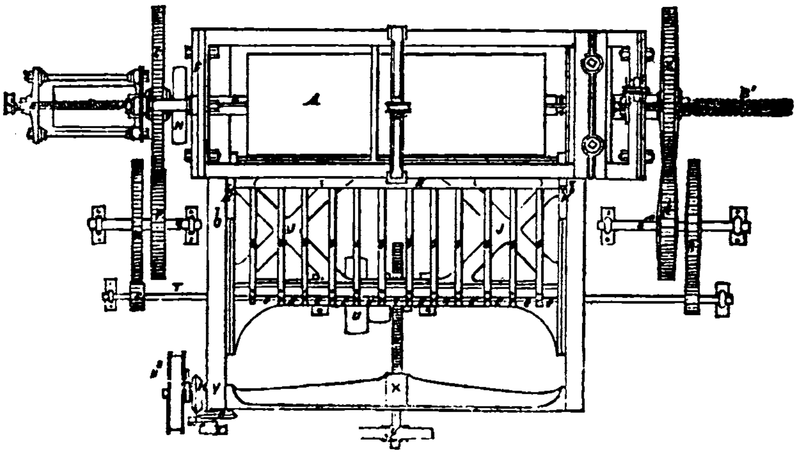


Fig. 3.

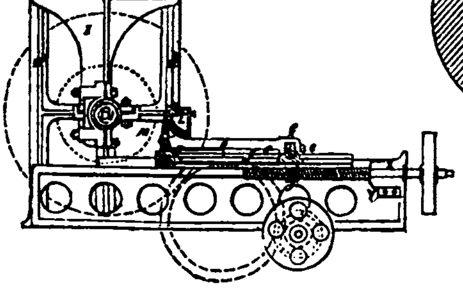
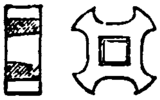


Fig. 5.



F g. 7.

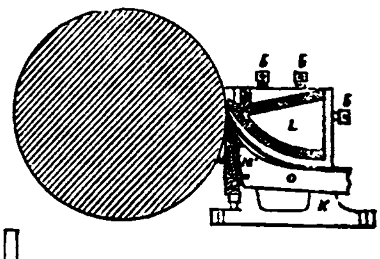
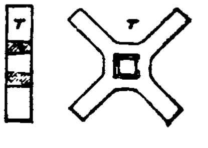


Fig. 6.



That blade-bearer carriage is composed of a cast-iron frame J, which, at its two opposite extremities, is provided with the two cast-iron chairs R, intended to receive on one side the cast-iron guide, or pressing leader L. That last guide rests constantly on all the length of the wood, immediately above the sharp edge of the blades, in order to prevent them from causing the wood to split, or from taking off a greater quantity of it than they ought really to do. The application of that leader L to the machine is, as has been herein-before described, of the utmost importance, as it permits to obtain results which could not possibly be attained without its use. It has been disposed in such manner that its position may be regulated as exactly as it can be required. For that purpose the cast-iron chairs K, which are to support the extremities of the above-mentioned leader, are crossed by bolt screws *b*, which allow it to be lowered, raised, or moved on the right or left side, to be inclined in one way or another, so as to comply with all the required necessities, according to the nature of the wood, the thickness of the sheets which are to be cut, &c. In order to make well understood the construction of that guide or leader, it is represented minutely in fig. 7, which is a transverse section. From this it is easy to understand that, by its nerves and its strong thickness, it presents a great resistance. As it must bear with a certain strength during the working on all the length of the log, it is expedient to make it solid and without chance of being flexible.

The two knives, MM^1, between which is kept tight the additional blade *l*, by which the wood is cut, are placed underneath the forward face of the guide L, and in a tangential direction to the external circumference of the log, as shown by fig. 7. Those knives are both fixed by a cast-iron ruler N, going over all their length, and are kept in an immovable position by means of the iron holdfasts O, on the extremities of which they are screwed. Their fastenings are placed at equal distance, and in a sufficient quantity, over the breadth of blade-bearer carriage. In order that the latter may give to the knives the exact position which is necessary relatively to the pieces to be cut, it has been necessary to adjust on one side upon the ends of the chairs K, some projecting screws *d*, upon the heads of which the ruler N rests at its extremities, so as to cause it to occupy a more or less elevated position; and on the other side some bolt-screws *e*, have been placed on the forks which end the iron holdfast O; the screw *e* holds the holdfasts O upon the blade-bearer carriage, and permits at the same time, to incline them more or less, or cause them to advance or recede relatively to the surface of the log. It results from that contrivance that, whatever may be the size of the block, the direction of the knives and of the blade can always be regulated so as to have the sharp edge of this last in the most convenient part; that is to say, in order that on one side it should not tend too much to penetrate into the wood, for which purpose the forward knife M, resting on the surface of the cylinder, guides and maintains that blade, and in order that the other side should not hold back. That is prevented by the blade held by the second knife M^1, which rises very near the sharp edges, and forces in the mean time the sheet, as soon as it is cut, to pass between it and the pressing leader.

It is therefore evident by that contrivance, that the cutting-blade is neither too eager nor too slow in working.

When the machine has been regulated for a required thickness, it is certain always to be obtained all through the operation.

That disposition is the more remarkable, and the more advantageous, as it permits to change the blade and the knives, to put them on or take them off with greater facility, without disconnecting the other logs which may be fastened to them, as it suffices to loosen the screws which fasten them to the iron holders.

When the blade and the knives which hold it fast, as well as the pressing leaders, are exactly regulated, the machine can then be put in motion. To that effect it is to be observed, the movements have been so disposed that the two axes BB^1, at the extremity of which the log is supported, may both at the same time be acted upon with the same velocity, in order to prevent any attempt to twisting, and to have the block moving regularly all along its length. Thus it has already been seen, that the two similar wheels GG^1, are set upon those axes to which they are fastened, each of them by a pin, adjusted in a groove contained in their length, in order to allow them to remain in the same place. When the axes are caused to advance or recede, those wheels catch with the pinions P and P^1. Figs. 1 and 4, which are set on the intermediate shafts Q and Q^1, which are themselves commanded by the eight wheels R, R^1, adjoining the preceding, and catching with the pinions *s.s.* These two last pinions, of small diameter, are set on the same shaft T, which is the moving shaft of the machine, and which, for that purpose, is provided with the pulley U, having several diameters, in order to receive, in case of need, different speeds, more or less rapid, according to the dimensions or size of the logs to be cut.

It will be easily understood, that the motion can be given to those pulleys by any moving power whatever, by means of which a convenient velocity may be obtained.

Whilst the rotative motion is so given by means of those transmissions of movement to the piece of wood set between the two points, the blade-bearer carriage is caused to advance very slowly, and of a quantity corresponding to the thickness of the sheets to be obtained.

That forward motion is effected by the machine itself, without any trouble, and in the following manner:—

Under the carriage is set a nut *f*, through which passes an horizontal screw V, inserted in a collar contrived in the centre of the cast-iron cross-bar X, bolted on the sides of the main frame Y, which serves as a basis to the carriage. On the head of that screw is set a pulley *g*, facing another smaller pulley g^1, set in a small intermediate axis represented in fig. 4, and provided with a small bevel wheel *h*. This last wheel receives its motion from a similar wheel h^1, fastened to a second axis similar to the first, but perpendicular to the precedent, and bearing a pulley H^1 which has been already represented as placed on the axis B. Thus the movement of the screw V, having a very small worm, is always proportional to the velocity of the rotative motion of the log of wood. The more quickly the block turns, the more rapidly also the blade-bearer carriage advances. But if the thickness of the sheets is to be changed it is necessary to modify the ratio of velocity, which is effected very easily, as it suffices to replace one of the pulleys *g* or *g'*, by another larger or smaller one. By this contrivance, sheets extremely thin, or of any required thickness, can be cut all over the length of the log of wood.

It is understood that, as the log turns in a continuous manner, and as the blade-bearer carriage is always advancing progressively at the same time, and of a similar quantity; the sharp edge is always made to rest tangentially on the external surface of the log. By such means it is perfectly easy to cut sheets of a perfectly equal thickness, the development of which can reach several hundred yards without interruption.

This mechanism, by which the knife-leader and the blade-bearer receive a motion in a continuous manner, and proportioned to the rotative movement of the block, is therefore equally very essential.

From the apparatus before described, not only very long slices or sheets can be cut from a log, but also from any piece of wood, whatever may be its shape, the dimensions of the sheets being, however, proportioned to the sizes of the pieces of wood. To obtain that effect, it is sufficient to set, in lieu of the two axes B and B^1, which support the blocks, a drum, which is composed of an iron shaft and of several cast-iron discs or cross-bars, on the plain parts of which are bolted two set-up flat bands, intended to receive some wooden frames. The pieces or blocks of wood to be cut, are fastened upon those frames in the same manner as they are set upon the ordinary frame of the sawing machines for veneering. It is easily understood that, by causing that drum to turn on itself, as it would be done in causing the block which it replaces to turn, each of those pieces of wood is successively presented to the action of the blade-end of the knives, and will be cut into thin sheets, which, as a matter of course, will be separated from each other.

That disposition is also a most important addition to the improved apparatus, and increases as much the value of that system which thus unites all the required advantages for practical and manufacturing working; and by the celerity with which the operations are carried into effect, by the great saving of wood which it effects, as well as on account of all the profit obtained from the machine and the excellent work it produces, that system affords very great advantages. Another very simple addition is equally applied to that machine, and has for effect to cut the wood, not only in sheets, but also immediately after into matches of different lengths and sizes. That addition consists merely in the application of a cylinder set on the leader itself and provided with circular blades. These blades rest on the wood and cut it transversely—that is to say, perpendicularly to its own axis, whilst some grooves contrived over all the surface of the cylinder impress on the wood, a kind of denting, more or less deep, while at the moment that the lower cutting blade arrives to perform its operation, causes the sheets of wood already cut in the direction of the axis to be separated in small breadths, and at the same time as the saws divide the wood lengthwise.

This additional cylinder is composed of an iron axis, in which is adjusted a set of blades or circular knives, supported at the required distance, according to the length of the matches, by means of steel rings or washers, which are fluted on all their circumference, that they may at the same time serve as rowels. This axis is supported at its two extremities on two moveable bearers, properly set upon the upper part of the leader; they are able to approach more or less, according to circumstances, the log of wood to be cut, either by means of screws purposely adapted or by any other suitable contrivance; consequently, if that cylinder, prepared as before described, be sufficiently advanced against the wood, so as to cause the circular blades to penetrate into it to a certain depth at the same time that the rowels or washers *y* bear firmly upon it, so as to impress deeply their projecting spokes, and the surface of the wood being afterwards cut in the manner before described, by means of the lower longitudinal blade, the matches may be entirely separated one from the other, or allowed to remain slightly adherent, which would facilitate their packing up and carriage.

COUPLING JOINTS FOR PIPES.

William Edward Newton, of Chancery-lane, Middlesex, civil engineer, for "*an invention of an improvement or improvements in making coupling-joints for pipes, nozzles, stop-cocks, still and cylinder heads, and other apparatus.*" (A communication.)—Granted March 22; Enrolled September 20, 1848.

This patent relates to an improved means of connecting pipes, and to fastening on the ends of steam or other cylinders or vessels, still-heads, connecting shafts, and various kinds of apparatus that require to be connected by bolts or screws passed through flanges.

Fig. 1.

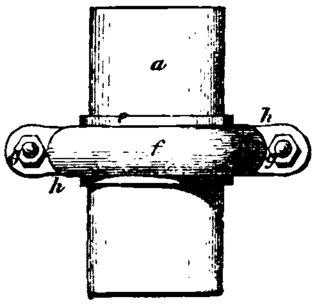
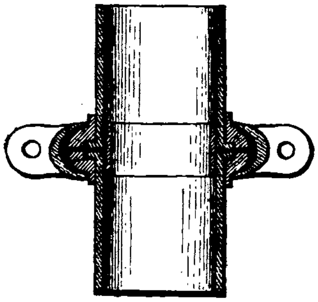


Fig. 3.



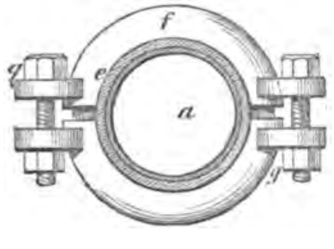


Fig. 2.

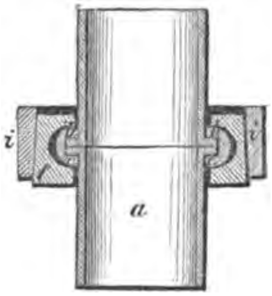


Fig. 4.

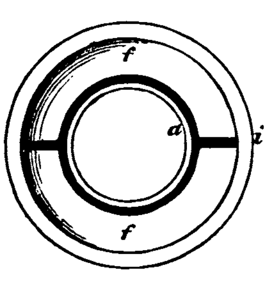


Fig. 5.

Fig. 1 is an external view; fig. 2, a plan; and fig. 3 a section of the improved clasp couplings, as applied to coupling of pipes. A similar joint may also be applied to the securing of a cap-plate on to a quadrangular vessel. Fig. 4 is a section of another modification of the invention as applied to the coupling of small pipes.

The invention consists in forcing together the two bodies to be coupled, by means of a grooved segmental, or other clamp, according to the form of the parts of the vessel or article to be coupled. The groove of the coupling embraces the flanges or their equivalents, which project from, or are connected with, the bodies to be coupled; so that when the said grooved segments are drawn together by screw-bolts, keys, conical wedge-rings, or any equivalent means, the groove therein shall act on the said flanges, or their equivalents, so as to force them together, and thus make a tight joint, with or without interposed packing.

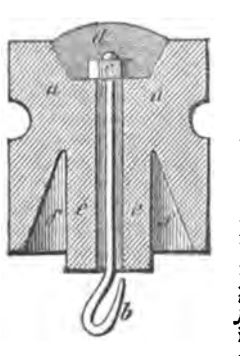
In figs. 1, 2, and 3, *a*, *a*, represent two sections of a pipe, each provided with a turned or upset flange *b*, with packing *c*; but, if desired, the packing can be dispensed with, by facing the flanges, or making what is termed a ground joint. At the junction of the pipes, an inner pipe *d*, is introduced within the pipe to serve as a guide, in joining the flanges together, but it may be dispensed with if desired. Over the two sections of the pipe, and extending over the flanges, are two rings, one for each section, the inner faces of which correspond or nearly so with the faces of the two flanges, and are curved or bevelled on their outer faces. These rings should be made to fit somewhat closely on to the sections of the pipe, or may be shrunk on if desired. When the two flanges and rings are put together, face to face, they are embraced by a segmental clamp *f*, *f*, made in two parts, the inner periphery of which is grooved to embrace the rings *e*, *e*, and to act on the outer curved or bevelled faces thereof; so that when the segments are drawn together by means of screw-bolts *g*, *g*, that pass through ears *h*, projecting from their ends, the sides of the grooves are made to act in a wedge-like manner on the outer curved or bevelled faces of the rings *e*, to force them and the flanges of the sections of the pipe together, and there hold them firmly. In this way it will be seen that the flanges are forced and held together around the entire circumference simply by the use of two bolts; thus effecting a better joint, which can be connected and disconnected in less time, and held with more strength, than by the means heretofore employed.

Instead of forcing together the segments of the clamp by means of screw-bolts, as above described, this can be done by means of a ring *i*, as represented at figs. 4, and 5, the inner periphery of which is made conical, so that it may be driven on to the segmental clamp, the outer periphery being also made of a corresponding conical form. In these figures the parts corresponding with those represented in the figures above described are indicated by similar letters. The rings *e*, *e*, that extend over the flanges may be dispensed with, and the grooved segmental or other clamp may be made to act directly on the flanges; but it is better to use the rings, as they can be more readily adapted to the groove of the segmental clamp, and at the same time give strength and support to the flanges, which, in general, are formed by turning over and upsetting the metal of the pipe. If desired, packing of any kind may be interposed between the flanges and the rings; but this in general will not be found necessary.

INSULATING WIRE OF ELECTRIC TELEGRAPHS.

John Lewis Ricardo, of Lowndes-square, Middlesex, Esq., M.P., for "*improvements in electric telegraphs, and in apparatus connected therewith.*"—Granted September 4, 1848; Enrolled March 4, 1849.

The improvement relates—first, to the insulation of the wires of electric telegraphs by combining two or more wires between two fillets of gutta percha or its compounds, whereby they are insulated from each other, and from surrounding materials; secondly, to an apparatus for suspending wires used in electric telegraphs, whereby such points of suspension are rendered inaccessible to wet or damp, and consequently less liable to any imperfection in the insulation. The annexed engraving exhibits a section of the apparatus, which consists of an earthenware support *a*, having the eye or hook *b* suspended to the centre by a nut *c*, in the recess at the top, which is afterwards filled up with cement *d*. The cylindrical projecting part *e*, has a groove or throat *f*, cut round it, by which any water coming in contact with the outer surface is intercepted, preventing its getting access to the point of suspension; and it is this throat or groove *f*, that constitutes the novel feature in this, the second part of his invention.



SMELTING AND REFINING LEAD ORES.

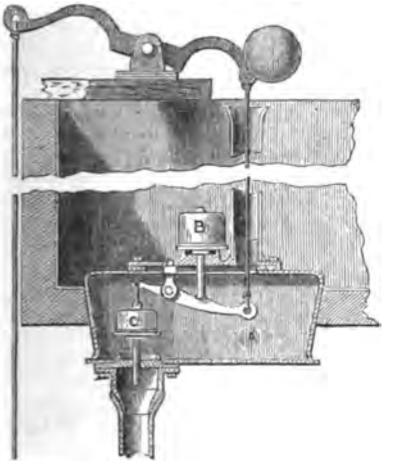
William Young, plumber, and Henry Burgess Young, engineer, of Barnstaple, Devonshire, for "*improvements in smelting and refining lead ores.*"—Granted August 28, 1848; Enrolled February 28, 1849.

These improvements relate to the condensation of the vapours which escape from the furnaces employed in the manufacture of lead from ore, for the purpose of obtaining the litharge and other oxides, which are carried off mixed with the products of combustion. For this purpose, the flue from the furnace is made to pass through a steam-boiler flue, so that the waste heat may be used in generating steam; the flue then opens into a fan, by which the vapours are projected down the surface of a large closed tank of water. A great portion of the metallic compound is then mixed with the water. The vapours next pass from the top of this tank into another flue, into which there is projected a strong jet of high-pressure steam from the boiler above-mentioned. The combined steam and vapours are then made to pass successively through a series of chambers, the opening from the one to the other being through finely-perforated plates of metal. The gravity of the particles of oxide is increased by the steam, and they collect upon the floors of the chambers. Connected with the large tank of water there is a smaller cistern placed outside, by which the height of the water inside the chamber is regulated, and, consequently, the distance of the surface of the water in the tank from the mouth of the descending flue can be readily ascertained, and the pressure be regulated accordingly.

The patentees claim—1st, the employment of a water lute, which may be regulated by raising or lowering the water in the cistern, whereby the draught will be regulated, and an economy of fuel effected.—2ndly, The causing the metallic particles which escape from the furnace along with the smoke, to pass through water, and then through finely-perforated plates into vaults filled with steam; and the condensation and collection of the metallic particles.—3rdly, Applying these processes in the smelting of lead, for collecting white and blue oxide of lead in a paste.—4thly, Causing the metallic particles, if any, which may remain with the smoke after the second process, to pass through the body of the furnace, and again to undergo that process; and a complete collection of the metallic particles.

DOUBLY TRAPPED WATERCLOSETS.

Combined Patent Self-Acting Pan-and-Valve Doubly-Trapped Waterclosets, suited to every description of Dwelling Houses, Public Buildings, Hotels, Railway Stations, Hospitals, Asylums, &c. Patented by Messrs. Joseph Bunnett and Co., of Lombard-Street, City, and Deptford, Kent, engineers.

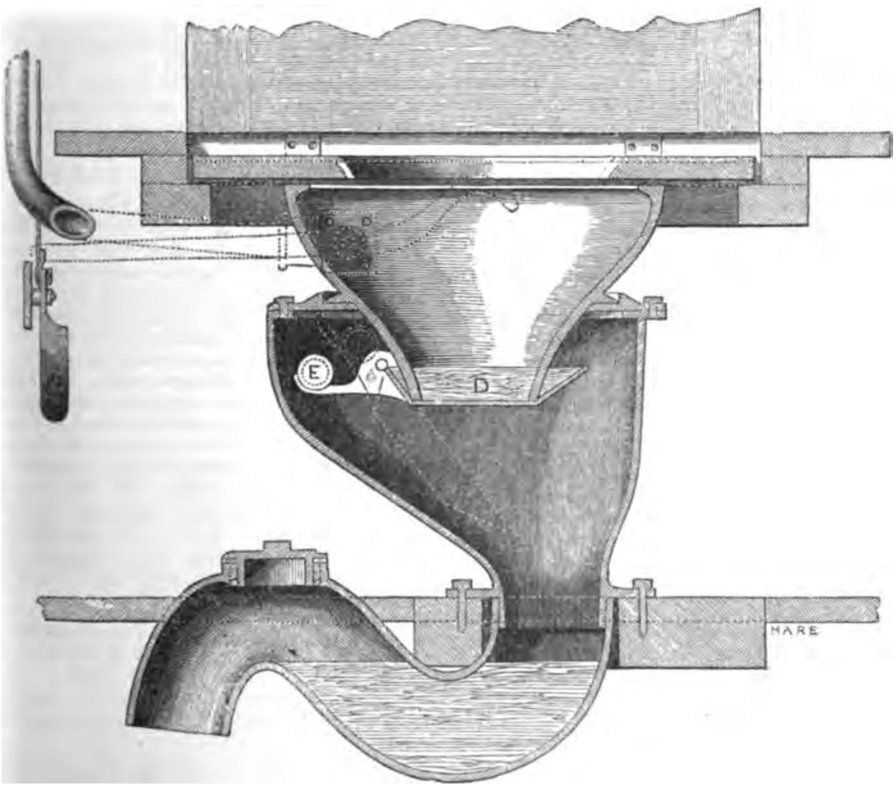


Some time since, we gave our readers the specification of a patent granted to Mr. Bunnett, for improvements in waterclosets, (see *Journal* Vol. X., p. 144);—we have much pleasure in again bringing this subject forward, on account of its great value in the progress of sanitary reform.

By adopting the principle of his Patent Effluvia Traps, Mr. Bunnett has succeeded in producing a Self-acting Watercloset, which requires no attention from the person using it. The supply and force of the water is always efficient and uniform, and cannot be wasted; no soil can be left in the basin after use, and an ample supply of water is always secured in the basin, to form a water lute between that and the syphon trap, thereby effectually preventing the least smell from rising. All other self-acting waterclosets being only trapped by the syphon or D traps, a portion of the fouled water is always left exposed in them, liable at all times to smell, particularly after standing for a day or two.

The improved trap is formed so as to allow a perfectly free passage for the soil, &c., with an opening at the top of it, the cover of which may be removed and replaced, should any necessity arise for the same, from anything being either accidentally or wilfully dropped down the closet.

This improved watercloset appears to us to be very simple and durable in its construction, and cannot get out of order. It is not necessary that the cistern should be placed directly over the closet, but may be placed at a convenient distance; and any number of closets can be supplied from the same cistern.



References to Engraving.

In the annexed engraving, A is the supply-box, which may be fixed either within the cistern, or in any other convenient situation. B and C are the inlet and outlet valves. When the closet is not in use, the valve B is closed. By the pressure on the seat the valve B is opened, and the valve C is closed, and the supply-box is thereby charged; as soon as the pressure is removed from the seat, the valve B is again closed, and the valve C is opened, and the whole of the water confined in the supply-box is discharged into the basin. D is a moveable pan or trap, suspended on a centre and balanced by E, a rolling weight, which, on the rush of water into the basin, instantly rolls towards the centre and allows the pan to fall to its fullest extent, as indicated by the dotted lines.

There are several modifications of this improved watercloset which for want of space, we are unable to lay before our readers, but specimens of each may be seen in action at the office of the patentees, Lombard-street, City.

REVIEWS.

Companion to the Improved Log-Book for Steam-Vessels. By Peter Borrie, Engineer, &c. London, 1849.

Mr. Borrie's object in publishing this work is to induce owners of steam-vessels to adopt a uniform method of keeping a correct account of the hourly performance of the engines of their vessels, and of the expenditure of fuel, tallow, &c. The log proposed by him appears to be well adapted for the purpose he has in view, but we think its utility might be extended if every sea-going steam-vessel were furnished with an "Indicator" and "Counter;" and that it be the duty of the principal engineer to attach daily an indicator-card to the log; and the reading of the counter be given hourly, instead of the number of strokes per minute, in the log. If the counter be kept under lock-and-key, it could not be tampered with, and the commander of the vessel might at any time check the engineer's log. The columns in Mr. Borrie's log of the dimensions of the propeller or paddle-wheels may be omitted, as those dimensions are of course constant, and known to the owners as well as any other part of the engines or vessel. The book contains likewise instructions to engineers on the duties they have to attend to in inspecting and managing the several parts of a steam-engine, the boilers, and propellers, all of which will be found to be extremely useful.

Digest of Evidence taken before a Committee of the House of Commons appointed to inquire into the Agricultural Customs of England and Wales in respect of Tenant Right. By William Shaw and Henry Corbett. London: Joseph Rogerson, 1849.

Engineering in connection with Farming is daily becoming a most important branch of the profession: not only does the drainage of the land form an essential department of the engineer's duty, but also the adaptation of machinery to the wants of the farmer; the formation of roads, the construction of suitable buildings, and many other departments of the farm. It is therefore necessary that the engineer should be well acquainted with what is tenant-right, in order that he may advise both the landlord and tenant how far they will be justified in going to the expense of improvements and alterations of farming property.

The tenant farmer is greatly indebted to Mr. Shaw for the very able manner in which he has at all times most perseveringly advocated his rights, and we hope by continued exertions the important question will be finally adjusted during the present session of parliament.

Mr. Shaw and his coadjutor have favoured us in the digest of evidence before us with a very good insight into the mode of farming in different parts of England,—and which is of the more value, as it is the evidence of many of the leading farmers, land-owners, and valuers of England and Scotland.

Reference Book to the Incorporated Railway Companies of the United Kingdom. By Henry Glynn. London: Weale, 1849.

Our indefatigable correspondent, Mr. Henry Glynn, has here produced a work of great labour, showing in a brief form all the particulars of each railway—whether of interest to engineers or shareholders. It contains some information not to be found elsewhere.

Plan of the Parish of Clapham in the County of Surrey, 1849. By Messrs. A. & R. Bland, Surveyors.

This survey appears to have been very accurately made, and laid down with great care. A few more publications like this will show to government that the civil surveyors are quite equal to undertake the survey of the metropolis, without calling in the aid of the military, as was lately done by the Commissioners of Sewers,—a proceeding which, we contend, was most unconstitutional.

The Patent Gutta-Percha Company's Pattern-Book of Ornaments.

Here we have another material brought to the aid of the architect, and which, from the specimens before us, appears to be admirably adapted for ornamental work of ceilings, cornices, picture-frames, and other purposes to which plaster and papier-maché have hitherto been applied. The gutta-percha ornaments appear to be got up sharper than those of paper. The designs set forth in the pattern-book before us are well selected, and possess considerable freedom in the outline; and we hope the company will not be induced to follow the too prevailing taste of the day, in adopting French ornaments.

Remarks on the Improvement of Tidal Rivers, illustrated by Reference to works executed on the Tay, Ribble, Forth, Lune, and other rivers. By David Stevenson, C.E. Second Edition. London: Weale, 1849.

Mr. Stevenson has in this book entered upon a subject of great professional interest, and we mean therefore to call the attention of our readers to it in a future number.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

Feb. 19.—Sydney Smirke, Esq., V.P., in the Chair.

A paper was read by Mr. C. Barry, jun., descriptive of "*a mode of Constructing Malleable Iron Fire-Proof Flooring,*" recently patented by Mr. Beardmore.

Mr. Barry described the experiments made by Mr. Beardmore, the result of which was the form of construction patented by him. This consists of a mere beam of sheet-iron of a reversed T form having top and bottom flanges; the latter being connected with plates of the same material, on which is laid concrete or other incompressible material, which keeps the beams in their vertical position, and thereby brings into action their full power to resist compression. The advantages of the materials employed are their perfect fire-proof character, their non-liability to disintegration on exposure to fierce flame, and the fact of their cohesion not being destroyed by sudden cooling; while the mode of construction is less expensive than the usual combination of brick arches and cast-iron girders, and occupies much less space between the ceiling and the floor line.

Some remarks were made by Mr. T. H. Wyatt "*on the Church of St. Andrew, at Greensted, Essex,*" lately restored by himself and Mr. Brandon.

The interest attached to this little church arises from the material employed in its construction, from its undoubted antiquity, and from the strong evidence that exists of its having been originally built for the reception of the corpse of St. Edmund on its return from London to Bury St. Edmunds in the year 1013. The inclosing walls of the nave are formed of rough half oak trees, averaging about 12 inches by 6 inches, and about 6 feet high, including the sills and plates: from all appearances this is the original structure. The east end timbers were doubtless removed to make way for the red brick chancel erected about the beginning of Henry the Eighth's reign; and thus there remains no evidence as to whether the original form of the church was a parallelogram—or if an apse was at the eastern termination, as was so prevalent in the early churches. At the western end is a tower, also of timber, erected at the beginning of the seventeenth century, and in which is a bell bearing the following inscription: "William Sand made mee, 1618." Mr. Wyatt described fully the construction of the roof and other parts; and in conclusion stated, in regard to the restoration, that those portions which from their completely decayed state had necessarily been removed had been replaced timber for timber.

March 5.—T. Bellamy, Esq., V.P., in the Chair.

A paper was read "*On the probable Form and Design of the Temple of Solomon at Jerusalem.*" By E. I'Anson, Jun.

Mr. I'Anson alluded to the numerous and unsatisfactory conclusions of the various authors who have written on this subject or attempted to make designs for the restoration of the building in question; and also to the circumstance of its still occupying the attention of the curious,—as no less than eighteen works on the subject have been recently advertised in a German catalogue. He describes its restoration as partaking more of a Tyro-Egyptian style of architecture than of that of Greece,—as has been suggested by the late Mr. Wilkins, in his Preface to "The Antiquities of Magna Græcia."

In the discussion which ensued it was suggested that the discoveries at Nineveh might eventually throw much light on the subject, and assist in explaining the description of the temple given in Kings and Chronicles. In support of an opinion expressed that the architecture of the Egyptians was known in Syria, it was mentioned that the monument cut in the rock of the Narh El Kelb, on the coast beyond Tyre, was of the best style of Egyptian art and of a period anterior to the time of Solomon; and that hitherto there had not been discovered in Syria any monument of Greek art of that period to support the theory of the Grecian Doric temple having formed the model for that at Jerusalem.

INSTITUTION OF CIVIL ENGINEERS.

Feb. 13.—J. Field, Esq., President, in the Chair.

The paper read was "*On the Coal Field of South Wales*," by Mr. Joshua Richardson, M. Inst. C.E.

Mr. Richardson commenced by enforcing the necessity for an unbounded supply of fuel for the export trade, the manufactures, and the domestic uses of Great Britain, and enumerating various sources from whence that supply was at present, and might be in future obtained; giving, at the same time, the various and discordant opinions of eminent authorities as to the presumed duration of that supply from the several mineral districts of which the extent was now ascertained. This was variously stated by different authorities at between 200 years and 1700 years; but Mr. Richardson ventured to assert that, in spite of the increasing demand for home consumption, and an augmenting export trade—amounting, at present, to upwards of six millions of tons annually—when the coal field of South Wales should be brought into full work, the duration of the supply was beyond calculation. The area of this coal field alone he estimated, from actual survey, to be 1,055 square miles, embracing all qualities, from extremely bituminous coal to pure anthracite. The various veins, and their several thickness, were fully described, with examples of their quality, and analyses of them chemically, with their practical evaporating powers—showing that there existed 64 seams or veins of coal, having an aggregate thickness of 190 feet. These veins were described to be so situated as to be easily worked by adits or levels, and by pits of slight depth; and thus the cost at the mouth of the levels varied from 2*s.* 2*d.* to 3*s.* 6*d.* per ton—giving a mean of about 2*s.* 10*d.* per ton. The means of transport to the ports of Cardiff, Newport, and Swansea, although at present inefficient, were daily improving, and enabled the coal to be shipped at about the same rates as the coal in the Tyne and the Wear. The actual annual consumption was shown to be—

In the iron-works of South Wales	1,500,000	tons
The copper-works	300,000	„
The tin-plate and other works	200,000	„
In agricultural and domestic uses	1,000,000	„
Exports	1,500,000	„
Total	4,500,000	tons

The useful and evaporative qualities of the various veins were carefully investigated, and it was shown, in a table of relative evaporative values, that

1 lb. of Welsh coal will evaporate	9 lb.	of water
1 lb. of Newcastle and Yorkshire coal	7½	„
1 lb. of Lancashire coal	7	„
1 lb. of Scotch coal	6	„

And it followed, that if

	s.	d.	
Welsh coal was worth	20	0	per ton
Newcastle and Yorkshire was worth	16	8	„
Lancashire....................................	15	6½	„
Scotch..	13	4	„

The coals of Staffordshire and Derbyshire were not taken into consideration, because they were used chiefly for the consumption by home manufacturers.—From these, and other statements, and from extracts from Sir Henry de la Beche and Dr. Lyon Playfair's able Report on Steam Coal for the Navy (see *Journal*, Vol. XI., 1848, p. 273), it was shown, that the Welsh coal excelled all others for steam purposes, and for almost all uses to which it was applied; and that, when all other sources of supply had diminished, or had failed, the prosperity of the manufactures and the commerce of Great Britain might be maintained for ages by the coal field of South Wales.

A very animated discussion ensued, in which several eminent engineers and chemists reasoned upon the statements in the paper, and the contested questions of the evaporative powers of different fuels.

Feb. 20.—The paper read was "*On the Explosion of Fire-damp which occurred in the Eaglesbush or Eskyn Colliery, Neath, South Wales, on the 29th of March*, 1848," by Mr. Joshua Richardson, M. Inst. C.E.

This paper first detailed the frequency of these occurrences in some parts of South Wales, and more particularly in this colliery, where the tender and friable nature of the coal peculiarly induced in the working, or excavation, the formation of fire-damp and explosive gas. This had been shown experimentally by Sir Humphrey Davy, when, on breaking up large coal under water, he collected a quantity of fire-damp at the surface.

It then gave a description of the colliery workings; the state of the mine before the explosion occurred; the condition in which it was found at the time of the inspection, a fortnight after the accident; the probable causes of the catastrophe, and the best known means of preventing a recurrence of such events. The seam of coal was described as being about 4 feet in thickness, of a highly bituminous and friable nature, and worked by an inclined adit or entrance, with a main gallery, whence the stalls were worked on either side—horses being employed to draw out the coal in trams, which were conveyed direct to the vessels in which it was shipped for exportation, to the extent of 30,000 tons annually. The ventilation was effected by a down-cast and an up-cast shaft, between which an air-course was arranged, so as to extend throughout the active workings, with a chimney at the exit, through which the air should have been expedited by a furnace, which, however, had been rarely lighted; and the air-course, which was 1 mile and 5 furlongs in length, was in places of unequal and inadequate areas, so that, in certain states of the external atmosphere, the air in the mine became very sluggish, and even at times oscillated to and fro, instead of regularly travelling onwards in an uninterrupted current. This was so much the case, that the colliers employed fans to drive the gas from them into the proper channels. Great negligence appeared to have existed, both in the general system of working, and in the use of the Davy lamps, which were frequently used without the wire-gauze guards. The usual state of the mine could not be judged of by an inspection *after* the accident, as all the falls and incumbrances had been removed, the destroyed doors and stoppings had been well replaced, and general precautions had been adopted, which evidently had not previously existed; but there still remained evidences of want of precautionary measures. Candles and open lamps had been constantly used, although the general fiery character of the mine was notorious; and, after the explosion, two Davy lamps were found, without their wire-gauze guards.

The temperature in various parts of the mine was so near that of the external atmosphere, that it was evident spontaneous ventilation could not have proceeded regularly; and it was shown, that the slightest change of the density of the air, even from the sun breaking out, would have sufficed to render stagnant the whole system of ventilation; especially as the furnace, which should have accelerated the current by exhaustion, had been allowed to fall into a ruinous condition, and had seldom been used, and the velocity of the current had rarely exceeded 5 feet per second, which was totally inadequate to supply the requisite quantity of air for such an extent of workings. The cause of the accident was, therefore, very apparent, and might be attributed to a want of a general good system of ventilation, permitting accumulations of gas and fire-damp, and the careless use of open lights, or unserviceable Davy lamps; and the consequence of this was the sudden death of 20 men, and several horses, with great injury to the mine. The means of prevention were, evidently, a complete revision of the system of ventilation—the enlarging of the air-course to uniform and adequate dimensions—the proper division of the air into several columns—the construction of proper doors and stoppings in convenient positions—strict regulations for the use of Davy lamps, or other means of lighting, and better general superintendence, by educated men, who would enforce precautionary measures. Due credit was given to the proprietors for their anxiety to afford every means of inspection, and for adopting all suggestions calculated to prevent the recurrence of such an event; and it was stated that they had since erected one of Mr. Price Struvé's ventilating apparatus, of the working of which an account was promised in a future communication. In the discussion which ensued, the various systems of working and of ventilation, in all parts of England, were noticed; and it was shown that, in general, every means was adopted to prevent accidents; but that, up to the present time, the mines in the west were not as well managed as those in the north, or the midland district. Every day, however, introduced better measures and better men, of education, for carrying into effect the most approved systems, and that, as the mines became more extensively worked, so these accidents would, and did, become less frequent.

Feb. 27, & *March* 6.—The paper read was "*On Fire-Proof Buildings*," by Mr. James Braidwood, Assoc. Inst. C.E.

After alluding to the paper by Mr. Fairbairn, on the construction of buildings of this description, (see *Journal*, Vol. X., 1847, p. 156), the author proceeded to analyse the evidence as to the capability exhibited by cast and wrought iron beams for sustaining weights, where they were exposed to any extreme changes of temperature. He then demonstrated, by a collection of specimens of metal from buildings that had been destroyed by fire, that occasionally the temperature in the conflagration of large buildings rose almost to the melting point of cast-iron, and that, even in a small fire, beams and columns of cast iron would be so affected by the heat and jets of water upon them, that they would probably be destroyed, and sometimes cause a fearful loss of life; as in many of the so-called fire-proof warehouses of the city, a number of persons employed on the premises slept in the upper floors, and, if the lower beams gave way, the whole would be dragged down suddenly; whereas timber beams resisted fire some time, and allowed time for the inmates to escape. The firemen, also, were liable to more danger from the same circumstance as the only chance of extinguishing fires was to send them into the buildings with the branches and water-hose; but where there was such evident danger, the men were forbidden to enter, and limited their efforts to restraining the spreading of the fire.

Another point which the author considered had not been sufficiently insisted on, was the derangement of the brickwork by the expansion of the iron beams at high temperatures, and its sudden contraction on the application of cold water; and, also, from the mortar becoming completely pulverised by the excessive heat—instances of which have been known to occur.

The following were the principles on which Mr. Fairbairn proposed to construct fire-proof buildings:—

1. The whole of the buildings to be composed of incombustible materials, such as iron, stone, or brick.
2. That every opening or crevice communicating with the external atmosphere be kept closed.
3. An isolated stone or iron staircase to be attached to every story, and to be furnished with a line of water-pipes communicating with the mains in the street.
4. The different warehouses to be divided by strong partition walls, and no more openings to be made than are absolutely necessary.

5. That the iron columns, beams, and brick arches be of a strength sufficient not only to support a continuous dead pressure, but also to resist the force of impact to which they are subject.

Lastly. That in order to prevent the columns from being melted, a current of cold-air be introduced into the hollow of the columns from an arched tunnel under the floors.

Mr. Braidwood argued that there could be no doubt, if the second principle could be enforced, a fire would go out of itself; but it was very doubtful if the object was not defeated by carelessness in leaving a door or window open just at the time when a fire occurred. The fifth principle showed that Mr. Fairbairn had not laid sufficient stress on the loss of strength to the iron consequent on an increase of temperature; and the last principle, it was thought, would not be likely to answer the purpose, as a specimen of 1¼ inch cast-iron pipe, on being heated in the centre, with both ends open, and a current of air passing through it, gave way, on one end being held in a vice and the other pulled with slight force by the hand, after an exposure of only four minutes in the fire.

For these reasons and others, the author submitted that large buildings, containing considerable quantities of combustible goods, and constructed on the usual system, were not practically fire-proof; and that the only construction which would render such buildings safe, would be groined brick arches, supported by pillars of the same material laid in cement. The author was also of opinion, that the loss by fire would be much reduced if warehouses were built of a more moderate size, and completely separated from each other by strong party-walls, instead of being constructed in immense ranges, into which, when fire once penetrated, it set at defiance all efforts to extinguish it.

In the discussion which ensued, the accuracy of Mr. Braidwood's general statements was fully accorded; and it was generally acknowledged, that the principles upon which many buildings, particularly dwellings, were constructed, were very erroneous. It was argued, that even with the ordinary materials, if attention was paid to filling in the partitions and ceilings, as practised in France, and mentioned in Professor Hosking's book on the construction of buildings, using slate or stone for the stairs, as from its present cheapness might be done, taking care to support the steps properly, a fire would spread very slowly, and would allow ample time for the escape of the inhabitants. Beardmore's, Fox and Barrett's, and Nasmyth's new systems of flooring, were all alluded to; as was Mr. P. Fairbairn's fire-proof dwelling-house at Leeds. Chubb's, Marr's, and other fire-proof safes were advantageously mentioned, and were shown to have effectually preserved the deeds within them in the most intense conflagrations.

March 13.—The paper read was *"A description of the Camden Station of the London and North-Western Railway."* By Mr. R. B. Dockray, M. Inst. C.E.

In the first design of the railway, in 1833, this station was intended for the sole terminus of the line, and, after much discussion, thirty acres of ground were purchased, although that quantity was considered preposterously large. A very short time demonstrated the necessity for the establishment of the Euston Station solely for passengers; and fourteen acres were there secured, and ultimately covered with buildings. The whole station at Camden was then devoted to goods and cattle; and, although in the original design great care was taken to anticipate the wants of the traffic, yet such has been the rapid development of the railway system, that in the space of ten years it has proved necessary to sweep away almost every vestige of the original constructions, and entirely to remodel the station. These changes have been partly produced by the increase in the goods' traffic, which was first undertaken by the great carriers, who built large warehouses on the company's land. The whole system has, however, been reformed, and the company do all that business, and are responsible to the public for the due performance.

As the increase of the traffic progressed, the trains in the sidings frequently became of such length as to cause danger to the passenger trains; it, therefore, became necessary to alter the whole disposition; which has been so done, as now to give a length of double line of 2,500 feet, for the goods' wagons only, entirely clear of the main line.

Another reason for the alterations was the demand by the public for a more rapid rate of travelling: this demanded heavier and larger engines, and necessitated wider buildings and larger turn-tables; in fact, everything required to be remodelled;—and the results of all these changes were shown in detail in the paper and the illustrating drawings.

The circular engine-house, 160 feet diameter, to contain twenty-four engines and tender, with a central turn-table, 41 feet in diameter, and an iron roof, was excellently described; as were also the other engine-houses, stores, warehouses, sheds, &c., with their appurtenances; and among the external works, the new wrought-iron bridge, at Chalk-farm, on Mr. R. Stephenson's box-girder principle, and the wooden lattice-bridge over the Regent's canal.

The supply of water for the locomotive engines was then treated of at some length, and exhibited some curious anomalies. The only water that could originally be used was taken from wells at Tring and at Watford; an attempt was, however, made to obtain a supply at Camden Station, first from the Regent's canal, and then by sinking a well down 145 feet into the chalk, or to a total depth of 300 feet below Trinity high-water mark. The water from the sand stratum was excluded, and although only that from the chalk was pumped up, which ought to have possessed the same qualities as the water at Tring and Watford, derived also from the chalk, yet it was found to cause the locomotive to "prime," or flush water through the cylinders, with the steam, to such an extent as to seriously impede the progress of the trains. This was shown, by analysis, to arise from the excess of carbonate of soda contained in this well water, which there was an entire absence of in the waters of the wells at Tring and at Watford.

The well, therefore, became useless for the engines, but the water was so excellent for household and other purposes, that it has been employed for the general uses of the Station, and for the hotels and houses belonging to the company.

Some idea of the extent of the Station was given by the statement, that the length of single line of railway, exclusive of the main lines, exceeded twelve miles. There were 112 sets of points, 196 turn-plates, and 110 cranes, varying in power from 1½ tons to 20 tons. The area of goods' sheds was upwards of 135,000 superficial feet, and that of the platforms was 30,000 feet.

The annual consumption of gas exceeded 6,000,000 cubic feet.

The discussion that ensued turned chiefly on the causes of the excess of alkalinity in the water at that spot, and it was suggested that it might be owing to the rapid filtration of surface water through a crevice in the chalk upon which that well had been sunk; and as a cure for the "priming," it was suggested to try a minute quantity of sulphuric acid to neutralise the alkali. There appeared, however, to be a question whether the water from the green sand was really completely excluded.

ROYAL SCOTTISH SOCIETY OF ARTS.

Feb. 26.—John Cay, Esq., F.R.S.E., President, in the Chair.

The following communications were made:—

"On a Method of Making Flint Glass for Optical purposes." By Mr. William Cooper, glass manufacturer, Aberdeen.

Mr. Cooper, in his communication, states as a known fact, that "crown glass," a manufacture peculiar to this country, answers very well for optical purposes; but hitherto there has been great difficulty in obtaining suitable flint glass of a uniform density, and free from striæ, wreathes, &c.; and this may be attributed to the excise restrictions formerly altogether preventing, by heavy penalties, the necessary trials being made to produce a suitable glass, and hence we were driven to France and Switzerland for a supply, where no obstacles exist in the way of making it. The mixture given by Mr. Cooper was stated to produce a glass suitable for optical purposes; and the excise restrictions being removed, and being possessed of materials and every other facility for making it equally good, it is expected that the manufacture of optical glass will be perfected in this country.

The following recipes are given by Mr. Cooper for making good optical flint glass:—

Sand, well washed, dried, and sifted ..	60 lb.
Oxide of lead	60
Purified carbonate of potash	15
Saltpetre	3·5
Cullet	15 to 20

The specific gravity of this glass is 3·568, and of ordinary density. A heavier glass is obtained by altering the proportions thus:—

Sand	60 lb.
Oxide of lead	63
Purified carbonate of potash	14
Saltpetre	3·25
Cullet	20

The specific gravity of this glass is 3·628. In both cases the cullet must be of the same kind of glass.

Before disposing of this communication, the Secretary was instructed to write to Mr. Cooper to send specimens of optical glass made after these recipes, or to communicate the names of opticians who had used the same and found it good.

"Statements regarding the American Saw-Gin, for separating the seed from the Cotton Fibres; and as to the practicability of applying Steam-Power to the Roller-Gin: and Description and Drawings of a Steam-Power Roller-Gin." By Robert Burn, Esq., Edinburgh.

After describing Whitney's Saw-Gin, and assigning the alteration of climate as the cause of the failure to introduce it into the East and West Indies, Mr. Burn, in explanation of the above-mentioned model, pointed out that the application of steam-power to this, the only kind of gin adapted for the cotton of those countries, was mainly wanting to reduce the price of their produce to that of America, and, by an increased supply, to place the cotton trade in safer foundation, and more secure against the growing competition of the United States.

In support of this hypothesis, Mr. Burn adduced the past history of the cotton trade, and the transfer of it from the East Indies to Britain by mechanical science and skill, in the application of steam-power to the spinning-wheel and power-loom, which at first was slow, but sure in its progress. In the United States, this mechanical skill is now carried to as high a pitch, and by the invention of the Saw-Gin they are in advance of us, as no similar machine has yet been adapted to the cotton of any of the British colonies.

"*Description and Drawing of a New Hydraulic Locomotive and Railway.*" By Mr. Daniel Erskine, plumber and gas-fitter, Clerk Street, Edinburgh.

This locomotive is constructed on a principle altogether different from any other hitherto invented. It resembles the present locomotive only as to the frame-work, while the top resembles a stage coach. The propelling power is water, turning an overshot-wheel, fitted in an air-tight case in the centre of the carriage; the water is supplied by a syphon, fixed to the locomotive, and dipping into the trough of water after-mentioned. Mr. Erskine showed experimentally that the syphon will do its work, although moving through the water at the rate of 60 miles an hour, and even at greater speed. The syphon is supplied with water from a trough of cast-iron supported over the railway, and having a longitudinal division from end to end open at the top, capable of being heated to prevent the water from freezing in winter. It is to be supplied with locks to answer the gradients of the railway. The locomotive opens and shuts the locks in travelling along the line, and the surplus water is conducted into a narrow trough between the two lines of rails, and is allowed to run waste, or used for purposes of irrigation.

BELL ROCK LIGHTHOUSE.

Sir—In answer to your obliging communication as to the time for receiving papers, I beg leave to say that my reply to Sir John Rennie's statement on the subject of the Bell Rock Lighthouse, will occupy a considerable space; and, as I wish to illustrate the subject by some diagrams or drawings, I cannot be in time for the next number of your excellent *Journal*. I have been from home, and did not see Sir John Rennie's statement till my return. May I request the favour of your inserting this note in next number?

I remain, Sir,
Your most obedient servant,

Edinburgh, March 14, 1849. Alan Stevenson.

DEEP DRAINING.

[The subject of draining connected with agricultural purposes has now become an important branch of the duties of the civil engineer, which induces us to give at length the following valuable paper from the *Journal of the Royal Agricultural Society of England.*]

On the Failure of Deep Draining on certain strong Clay Subsoils, with a few Remarks on the Injurious Effect of sinking the Water too far below the Roots of Plants in very Porous, Alluvial, and Peaty Soils. By William Bullock Webster.

As I find the system of very deep draining (4 and 5 feet) on strong clay-subsoils is looked upon by many of our members as a practice altogether new, and one likely to lead to very advantageous results, I think it of importance to call their attention to facts which have come under my own notice or which I have collected from others, and which will be found strongly in opposition to such views. Before I do so, however, as I find that the part I have taken in discussions on this question has led to erroneous impressions respecting my opinions on the subject of draining generally, and as I not unfrequently see myself classed among the "shallow drainers," I wish to set myself right with the agricultural public, and to have it distinctly understood that I am not a partizan of either faction—am not a deep, a shallow, or a medium drainer; but consider each of the several practices exclusively advocated by various zealous experimentalists proper to be applied in individual cases. It would greatly simplify medical art, could we find one mode of cure adapted to evey constitution and every disease; but though we hear such vaunted, I have no faith in anything professing so much. For deep draining I am strongly an advocate on soils injured by under-water; and on spongy, and some porous soils; but am opposed to the practice of going to a greater depth than 3 feet upon the *very* strong clay-subsoils, where the injury is *not* from under-water, but from rain. To guide me in forming that judgment I have had extensive opportunities of observation, which have led me to the strong conviction that this practice is not advisable—first, because (after a time) the water will not find its way to the drains at all; secondly, because if it does so its percolation is usually so slow as not to free the ground from moisture with sufficient readiness to insure the full benefit for agricultural purposes; and thirdly, because even when the percolation is more rapid an effective drainage cannot be accomplished with the drains placed at intervals so wide as to compensate for the extra expense of sinking them to the increased depth. In cases which have come under my notice where the experiments have been tried, I have seen that the land between deep drains at wide intervals was not in so perfect a state for cultivation as that between drains of more moderate depth placed at less distances. The cost of cutting an additional foot deep is very considerable; in many cases it would double the outlay upon digging. I must observe here that, even among those soils which we class together as strong clays, the conditions arising from local positions and their chemical components are so various, that they cannot all be placed in one category as to the facility or resistance they offer to the percolation of water. Again, in the case of fine rich grass-land on the alluvial, and therefore more pervious soils, I condemn the practice of sinking drains to depths of 4 and 5 feet, as rendering the ground too dry for the roots of grasses—and exposing them to suffer severely in seasons of continued drought. The same objection is applicable, and perhaps in a still stronger degree, to moss or peat lands, excepting where they are thickly covered or mixed with some heavier material, such as clay or marl, that has a tendency to retain the moisture. The system of draining deeply in all these instances has not the novelty claimed for it by its modern advocates, but has been tried years since in many parts of England and abandoned because it was found signally to fail.

Since Elkington, indeed, first drew attention to the full importance of draining, a vast number of experiments have been tried upon all the geological formations of this island; and could we but have before us a fair statement of the entire results, we should be furnished, I believe, with sufficient data for our future guidance.

Almost every system that has in turn been introduced has been attended in some cases with success, and thus has found advocates, and had a fictitious importance for a time attached to it: each one has, on the other hand, in some cases failed; nor is it reasonable to expect like results where conditions are totally different.

The prevailing custom until lately was, no doubt, to put in drains much too shallow. I am perfectly aware of the importance of permitting the water to filtrate through a sufficient depth of soil, to leave its valuable properties behind; I know that, under the old system, shallow draining in some cases did harm by carrying away too rapidly the soluble parts of the manure. But whilst it is well to avoid the errors of our predecessors it is advisable to exercise caution lest we fall into mistakes of an opposite kind. A system of drainage can only be tested by its results in quantity and quality of produce, and its permanent efficiency only by the observation of these results through a series of years; for in some cases deep draining has appeared to answer, in the first and second years after laying down the tiles, but has subsequently proved wholly inefficient. The drains upon examination have been discovered to be unimpeded, but the water has ceased to find its way down to them.

We have scarcely had time yet since the re-introduction of deep draining upon those soils to which my objections apply, to be able to determine the permanent value even of experiments which are apparently attended with success. Conclusions are drawn much too hastily; and in this, as in other matters, persons of sanguine minds generalise upon very inconclusive data. If water is found to run from pipes laid 4 or 5 feet deep the triumph of deep draining is considered complete; the true test, however, is not in the water thrown off, but in the condition in *which the soil is left for agricultural purposes.* The real object in draining should be to put the land in such a condition that all the rain which falls should do good, or at least do no harm; and this first requisite held primarily in view the problem next in importance is to effect this with the nicest adjustment of present and future economy.

Error in new systems is quickly propagated. The person who has reduced theory to practice with real or imaginary success, is proud of his sagacity and ready to proclaim it: he, on the contrary, who has failed, is by no means anxious to call the attention of the world to his mistakes. In our medical journals may be seen weekly accounts of remarkable cures just completed: the members of the therapeutic art do not bring forward with equal eagerness their cases of remarkable homicide. Perhaps, therefore, while so many successful experiments in deep drainage are being pressed upon the public with enthusiasm, I shall not be doing ill service in turning to the other side of the account, and showing that "profit and loss" in the drainage-ledger should have entries as well in the debtor as creditor side. I have for some time devoted much attention to the subject, with a mind open to conviction and an anxious desire to arrive at truth. I have visited and conducted draining operations on almost every geological formation of this country; I have also been in communication with many of the first agriculturists, who have been draining for years soils of every description, both deep and shallow. On my own farm (of about 200 acres) I have tried various experiments. In one field I took equal quantities of land to test the deep against the shallow plan; the soil, a strong brick earth. On part I sunk the drains 4 to 5 feet deep, and placed them at intervals of 40 feet; upon the other portion the drains were 21 feet apart, and only 2 feet deep. This depth of 2 feet is less than I should have adopted for the regular drainage of the field, but I wished to try extremes against each other. On the deep drains I returned the clay, as the advocates for the deep system state that all water enters from below. These operations were effected last year and during the past winter. The water has been constantly standing between the deep drains, as it is at this time, 29th April; whilst the shallow-drained portion has been in a comparatively dry and healthy state. To this experiment, indeed, I can attach no great importance, as it has been made only lately, and the results may in some measure be different in another year; yet upon other portions of my land I have drains not exceeding 30 inches, which have acted perfectly for years. In another field I put some deep drains, and returned the clay on the tiles, and found in the spring, when I wanted to roll the wheat with Crosskill's clod-crusher, that on that portion of the field the land was not nearly so dry, and the soil stuck to the roller. I may mention here that a railway cutting through my farm 18 feet deep, drains no more land on each side of it than a drain 3 feet deep.

A neighbour of mine, the Rev. E. Tunson, of Woodlands, had several deep drains put on his farm many years ago. These drains continued open, but ceased to act, and the land above them became so wet that it had to be re-drained. The same may be seen on the estate of H. Holloway, Esq., at Marchwood; and also the Park at Norris Castle, Isle of Wight, where, though thousands have been expended in deep drains for springs, the soil being retentive, surface-draining is more wanted. *This* would not have been the case had the soil been of a porous nature: it arose from the fact that the water could not percolate through the clay-bed to the required depth. I found numerous other deep drains quite unobstructed, yet the land about them so wet that we did not know it had been drained; for instance, at Thornhill, near Southampton. And I remember Lord Portman telling me of a similar instance on an estate of his near Blandford.

I wish to point to cases of the failure of deep drains, under those circumstances in which I have expressed myself opposed to their use, in many parts of England, and on various geological formations; and I may as well, therefore, arrange them in something of geographical order. From Hampshire, then, we will turn eastward and pass into Kent. We have heard much on the deep-draining on the weald-clay;—like most other clays it varies greatly in its nature; in some places it is of a very tenacious character on the surface, but as you dig into it, instead of becoming stronger it becomes milder. In this case your drain may have a freer flow of water at 4 feet than at 2 or 3; because the water having, by however slow a process, percolated through the superincumbent mass, does not meet with a more retentive bed of clay at 2 or 3 feet, as on other soils; but in other parts of the weald the arrangement will be found which is common with the clays of the London Basin—the oolite and lias. The section of the ground will then present soils in the following order:—

Surface.

The ploughed soil.

A soil partaking of the character of the superincumbent cultivated earth and of the strong clay beneath, and which will admit of percolation.

A bed of tenacious clay, not full of water, but almost impervious, being the cause of the wetness of the land, rain-water not going into it.

In this case the water will be found just above the tenacious clay, and it is a great error in draining to go deeper into this than to bury your tile or pipe with safety, unless this mass of retentive clay is within a foot or two of the surface; then place your drain 30 inches or 3 feet, filling that portion in the retentive clay with some porous material, such as a grass sod or soil, for the purpose of at any future time deepening your soil by subsoil ploughing, trenching, &c. In proof that deep draining will not in all cases answer upon the weald clay, I quote the following letter:—

Staplehurst, January 30, 1847.

Dear Sir,—In reply to your favour of the 25th inst., I beg to say that the land in my occupation is for the most part very stiff, wet, and flat, consequently subjected frequently to serious injury from wet seasons, to obviate which I have been draining about 200 acres on the farm upon which I reside, besides small quantities of other farms, perhaps altogether rather more than 300 acres, nearly the whole of which has been done on the clay soils of the Weald of Kent. I commenced by going 2½ feet deep, and found it answer my expectations fully. Subsequent to this an opinion began to be entertained that deeper drains would be much more beneficial for our clays; many advocated it and adopted it, some of which is said to have been successful, although I must confess I have never myself been an eye-witness to a single case in which *deep draining* has been successful upon *wet stiff clays.* Although my employment as a land agent and valuer gives me the greates tpossible opportunity for observation, the general prevalence of the opinion induced me to go a little deeper than before, and in one field of between 6 and 7 acres, at the earnest request of my deep-draining friends, I put in the drains near 4 feet deep and 33 feet apart four years ago (this was in 1843): in consequence of the stiffness of the soil, being nearly all strong clay, it proved an entire failure; and I have this winter drained it again about 30 inches deep, and am fully persuaded that depth in land like mine is much the best, being wet from the rain that falls upon it, and not subject to springs. I have no doubt the water would after a time pass down to the deeper drain; but it would do great injury before doing so. I should recommend deep drains upon porous soils and land subject to springs, but on those soils on which there are no springs, which are wet from rain that falls on them only, and are not porous, it is next to madness, in my opinion, to drain them deep—say 4 or 5 feet, as some contend for. Yours, &c., William Barnes.

W. B. Webster, Esq., &c., &c.

Turning northward, we will pause at Norfolk to record the opinion, upon the subject of draining deep upon strong clay, of one of the best farmers in that county, Charles Etheredge, Esq., of Sturston, Harleston. He writes thus:—

You know all round my heavy land here I have ditches from 3½ to 5 feet deep, and such ditches are general throughout the same land in Norfolk and Suffolk, on farms well cultivated, and they are generally kept clean with a free access for the water. Still we find it necessary when our drains are parallel to these ditches, to make them not exceeding 22½ feet apart from them. I do not mean to say that if drains 3½ to 4 feet deep were put 40 feet apart on these soils, the centre between the two would not be improved by them. I think it would, but certainly in a much less degree than if they were 22 feet apart and 30 inches deep; and there would be another great objection on clay interspersed with flint and chalk boulders in the digging. I find that after 2½ feet of soil has been removed, the next 14 to 16 inches have cost 6*d*. to 8*d*. per rod of 5½ yards. It is not at all uncommon to see a clay-pit stand with water, within 2 feet of the surface, within from 3 to 6 yards of a 4 feet ditch: where I have been draining 4 feet deep, the subsoil is interspersed with sand pockets, and a much greater width between the drains may be allowed; but there can be no rule. Finally, my great object in draining is not only to do it effectually, but rapidly. You must in no instance be satisfied to have your soil saturated with water till your sluggish drains draw it off; it must go off as quickly as it falls, or your drainage will be neither effectual nor permanent. Yours, &c., C. Etheredge.

W. B. Webster, Esq., &c., &c.

Mr. Nesbitt (the well-known agricultural chemist), in the discussion which took place at the London Farmer Club on the 9th of March, in the present year, in stating his opinion that upon some soils deep-drainage was most effective, whilst upon others a shallower drainage ought to be adopted, referred to Mr. Thompson in this county (I think he said), as having tried deep draining on his farm, and having been compelled, after a fair trial, to abandon it, not finding it successful on that soil. To quote instances of the success of an opposite system is no proof that deep draining might not likewise produce advantages; yet where experience has proved the value of the one, it is hardly wise to engage in large operations on an experimental plan that can hardly produce fairer results, and may be attended with disappointment and waste of expenditure. It has been by draining at depths of 30 and 36 inches, and at distances of 18 to 24 feet, that the farms of Mr. Harvey, Mr. Gidney, and many others on the clay lands round Harleston, in the south-eastern part of this county, have been brought into their present admirable condition. In Lincolnshire I have gone over thousands of acres of the fens; and I found the fact testified to by most of the best farmers, that if the water in the ditches or dikes is taken off to a level below 3 feet, the grass-land in dry summers is decidedly injured. The following letter from a farmer of this county will show that deep draining is not so novel a practice as some of its modern advocates assert:—

Swanton, near Folkingham, February 17, 1847.

Sir—I will answer your postscript first. My opinion is decidedly against deep draining on strong clay land. The parish where I reside is composed of part field and part fen; a great portion of the field land is strong clay. Several years ago when we first commenced draining with tiles, they were put in deep, 3 feet 6 inches, and the lands being wide with high ridges were thrown down so as to make the surface level; after a short time the land became so solid, that surface water could not get down to the drains, and it remained on the land in a stagnant state, to the manifest injury of the growing crop, and the land had to be top-gripped in the same manner as if it had not been underdrained, or nearly so. We have now altered our plan, and now rarely drain deeper than 18 to 24 inches; the tiles we invariably cover with a small portion of stubble, and then with the soil dug out, but never ram the earth on the drains. There is an inclination to drain deep in *porous soils*, where the fall will allow it. Yours, &c., W. MOORE.

W. B. Webster, Esq., &c., &c.

In Yorkshire the greater portion of the soil being the new red sandstone is naturally rather porous, and of a character fitted for deep drainage; and on the coal measures near Rotherham there is in places found much underwater, which, as it generally comes from a higher level, and constantly forcing its way to the surface, requires to be removed, or seriously damages the crops. Very different, however, are the coal formations of Durham and Northumberland. I remember going for eight miles underground (in a coal-pit), in the neighbourhood of Newcastle-on-Tyne, where the soil above was of a strong nature, such as to require draining at about 30 inches deep, yet where but little of the surface water percolated to the mine; yet the percolation of water is often a source of the greatest annoyance in mines of great depth, where the superposed strata consist of mild clays and porous rocks. The following is a letter of the well-known Mr. Stephenson, of Throckley, near Newcastle-on-Tyne:—

Throckley House, March 1, 1847.

DEAR SIR—I received your letter. Not having sufficient experience, I cannot answer it respecting 40 feet apart. I should doubt the result being satisfactory. In 1845, I drained a field of 30 acres, 10 yards apart and 3 feet deep, strong clay, which has given me every satisfaction. I had a splendid crop of wheat upon it last year, and the whole field appears perfectly dry and fit for every purpose.

I have drained 60 acres since October, 20 feet apart, 30 inches deep, and *am perfectly* satisfied it is the best distance and also depth for strong clays. The effects are astonishing. Yours, &c., W. STEPHENSON.

W. B. Webster, Esq., &c., &c.

From such opportunities as I have had of examining the soils of Scotland, I have found reason to believe in that part of the island the clays are generally of a less retentive nature than what are common in the south; and evidence of this is seen in the fact that the tread of the horses in ploughing double is not, as on many of our English clays, injurious to the land. This milder prevailing character of the aluminous soils of North Britain may result from so large a portion of the land lying upon the primitive rocks, the materials supplied from the disintegration of which are not of a very cohesive kind, in comparison to some others. It is stated, nevertheless, in the Encyclopædia of Agriculture, "that" (in Scotland) "it was formerly the practice to go 4 feet deep, but that it is now found that a shallower depth and closer drains do much more good.

What said the late S. D. Sterling, of Glenbervie, near Falkirk? who, after trying all kinds of draining for years most extensively, writes to me in 1846, and says—"I do not believe on such land" (the strong clays) "that any increased depth will compensate for a greater distance between the drains."

Extracts from a Meeting of the Highland Society.

Mr. Dixon, of Saughton Mains, at a discussion held at the Museum of the Highland Agricultural Society, Edinburgh, on Wednesday the 15th of March, 1848, quite agrees with me on the impossibility of fixing on any depth or distance for drains, and although he knew the importance of deep draining on some soils, yet he mentions its failure on others, and says—"After going 3 feet the soil changed to gravel and sand, much water was found, and deep draining answered perfectly at wide intervals; yet in the same county an experiment of the same kind was tried with the opposite result, the *subsoil being a very retentive clay;* here one-half a field was drained at the depth of 4 feet, and 36 feet apart, and the other half at the depth of 2½ feet, and 18 feet apart, and the result was most decidedly in favour of the shallow drains, with an interval of 18 feet between them; the other portion of the field appears only to be half drained." Where instances are quoted of deep drains in clay at wide intervals being successful, we must remember they are only of recent date. I have never been able to find a single instance of a field drained 4 feet deep and 40 feet apart, that had been done for ten years, successful on the strong clay subsoils.

What says Mr. Scott, of Craiglock?—"We are told that on all soils, whether muirland, till, stiff clay or dry clay, sand, gravel, or moss, a minimum depth of 4 feet is stipulated for, and a minimum distance of 36 feet apart." Upon hard impervious clays I have not been able to thoroughly dry the land with drains at 36 or even 30 feet apart. I have seen the attempt made with drains 4 feet deep, 36, 32, and 30 feet apart; but in *all* these cases the result was unsatisfactory. In all these instances a great quantity of water was carried off by the drains, and the land was much benefitted; but still the soil was not brought into that state in which the greatest fertility could be called into operation.

What says Mr. Tinnie, of Swanston?—"Where the subsoil is uniformly retentive I make my drains 18 feet apart and 3 feet deep, and were I to drain the same ground over again I should follow the same course."

Smith of Deanston also instances two failures, one on the property of Sir Ralph Anstruther in Fifeshire, and another on an estate at Coltness, made three years ago, in Lanarkshire: and also says—"I have never seen an instance of thorough draining by deep and distant drains, whilst all over the country you may see land perfectly dried with drains 30 inches deep and 18 to 20 feet apart." Also an experiment had been made by Mr. Hope, of Teulin Barnes, in East Lothian, which went to show that better crops had been raised over the shallower than deep drains. At the same time Lord William Douglas stated that the turnips on the shallow drained land at Balcaskie weighed about one-third heavier than on the other.

I am quite aware that at this meeting instances were brought forward of deep drains being successful, but I am now showing the failure of such drains on retentive clay-subsoils, and not going into the question why they have succeeded on certain spots. This I shall be happy to do at some future time.

Returning southward by a western route we will let the moss lands of Lancashire detain us for awhile. What I stated as the opinion drawn from observation among the best farmers of the Lincolnshire fens, is as true of those who cultivate the peaty soils of this county. Thus respecting Rawcliff, the property of Mr. Wilson Ffrance, near Garstang, where upon 1,000 acres of what a few years ago was a bog is now a most thriving tenantry, Mr. Ffrance told me as one of the most familiarly known facts, that deep draining upon that soil is extremely injurious—the land, as moss land, is actually ruined by it. If the soil, indeed, be altered in its texture by the application of clay or marl, it will then bear deeper drainage; but even in that case drains beyond 3 feet are not found advantageous. Testimony to this effect is borne by William Aiton in his valuable treatise on the Cultivation of Moss. "Whenever a moss," he says, "is either by nature or art rendered drier than such furrows or shallow drains would make it, instead of being benefitted, it is thereby greatly injured. Proof of this may be seen at every plough moss." And again, "At Paisley, where a number of deep furrows had been cut, they were found to be hurtful—they were filled up." And in another place: "All the moss improvers I have met with have owned to me that they had injured their mosses by making them *too dry;* but none ever could say to me that they found any want of drains where no water stood or stagnated on the surface."

The late William Roscoe, of Liverpool, stated in a letter written to Mr. Aiton, in 1807, that, having undertaken the improvement of a large portion of that moss, he began by cutting drains 5 feet deep, but afterwards changed his plan to drains about 1 foot only, which he said answered as effectually as the larger drains. His letter concluded thus: "My workmen even insist upon it that the shallow drains carry off more water; but this may appear so from the water being confined. In sudden rains they carry off a great quantity, so that the moss is sooner freed from surplus water than any other land, and is now passable in any direction, although it was lately not only difficult, but dangerous to go upon it." Mr. Aiton, as the result of his extensive experience, finishes his remarks by saying, "All future draining (on moss land) beyond a moderate depth ought to be guarded against as the sin of witchcraft." But to leave the moss land and return to the strong clays, a proof of the obstinacy with which they will retain wet near the surface, without such condition at a greater depth in the earth as to prevent the escape of the water, could it percolate through the clay, may be seen on the estate of Sir O. Mordaunt, near Warwick. There draining is required, although the subsoil, at a depth of little more than 4 feet, is a dry sandstone.

Soil, 15 inches.

Clay, 3 feet.

Dry sandstone.

This is also the case in many other parts of England—the clay resting on dry chalk, sand, and stone. Now if water will freely percolate through 4 feet of stiff clay to reach a line of pipes 30 and 40 feet apart, how is it that it will not reach an absorbent material that spreads eager for more, like a thirsty sponge, beneath the whole of its lower surface? Simply because the clay is not overcharged with water, and does not transmit it.

In Worcestershire deep draining has been tried upon the strong clays of the blue lias with ill success many years ago, as Mr. Bayles, of Prospect House, near Evesham, in that county, has had to re-drain land on account of the inefficiency of deep drains. The following is his leter:—

Prospect House, near Evesham, Worcestershire, January 13, 1847.

Dear Sir—I have drained one field over again, owing to its being too deep. The drains are from 3 to 4 feet; the land being strong stiff clay rendered them useless for surface water; the new drains I have put in about 2 feet, and filled them with broken stones or burnt clay. As to my sandy or porous soil, I prefer draining deep. Yours, &c.,

W. B. Webster, Esq., &c., &c. G. Bayles.

I have seen similar instances of failure in other estates in the same county, in the vale of Evesham.

I shall add a letter from Mr. Randall, likewise of that neighbourhood (although it refers to no case of the failure of deep drains), as it is founded upon experience.

Chadbury, near Evesham, February 16, 1847.

Dear Sir—I can give you my opinion of draining clays for surface water in a very few words: it is that I would not put in pipes at a greater depth than 3 feet, nor less than 2½ feet. This is the result of some experience. I fully consider 2½ feet sufficient. Yours, &c.

W. B. Webster, Esq., &c., &c. C. Randall.

Now if the advantage of deep over shallow draining is so decided in *all* cases, how is it that those who have tried 3 feet do not altogether abandon 24 and 30 inch drains? The advocates for deep draining upon those strong clays upon which such a system has not been in use, say that it only requires that we should try the experiment in order to be convinced of its superiority: where does the proof of superiority commence? If 4 feet is obviously superior to 3 feet, might we not expect that 3 feet would be in an increasing ratio superior to 2 feet? We find experienced drainers continuing upon strong clays to vary their depth, being guided therein by other local considerations; but if 5 feet draining is to explode 3 feet draining, the latter ought, long ere this, to have put an end to draining at still less depths.

I am able to quote a statement from a gentleman in the neighbouring county of Herefordshire, whose experience has led him to abandon the practice of laying deep drains in stiff clays in favour of those of more moderate depth. The practical basis on which his opinion is founded gives it importance.

Tarington, near Ledbury, Herefordshire, January 28, 1847.

With reference to your request as to my opinion of the deep draining on our *stiff* soils, I beg to say, that I have had much practical experience in draining such lands, *formerly* at 5 feet deep, very rarely less than 4; but latterly 2½ and 3 feet. *I am fully convinced* that in dense clay lands 30 to 36 inches is fully as deep as it is profitable to drain, and that a drain at a greater depth will not answer the purpose intended. Where springs exist the case is of course different. I have drained with the best possible effect land at 30 inches deep, where I had previously drained at 5 feet with only a partial effect. Yours, &c., C. A. Mason.

W. B. Webster, Esq., &c., &c.

I think the facts I have brought forward are sufficient to show that deep draining will not prove successful alike upon all soils and under all conditions. Arguments and opinions unsupported by specific facts are of little comparative value; yet when it is shown that what is called the new system of drainage is not new, but has been tried long ago, great importance must be allowed to attach to its abandonment as evidence of its inefficacy. Elkington testifies to the fact of deep drains having been tried as a means of removing surface-water from strong clay soils in or before his time. No one could be more an advocate for going deep for springs; but, with reference to trying the same plan for draining clay, he says (see his work, by Johnson, p. 137), "In soils that are so tenacious as to retain water on the surface, this method of draining (deep) has been tried, and found entirely to fail." Indeed, throughout, this work, and all others published up to 1843, condemn going deep in strong clay-subsoils.

I have myself inspected many of the works executed by Elkington, and taken up drains put in by him eighty years ago (he began in 1764); and my observations, whether upon the state of the lands drained by him where no subsequent system had been tried, or on the condition of the drains, went quite to confirm his view.

I will only further quote from old Mr. Tebbet, who made the Duke of Portland's water-meadows (no one will question his sagacity and experience); and is the result of his experience to show that the deeper the drains the more efficient their action? —No!

Mansfield, Nottingham, January 28, 1847.

Dear Sir—The underdraining I have directed upon strong clay land I have done in various ways; but the *best* way I have adopted is to put the drains 14 feet apart and 2 feet deep. Some clays will draw 18 to 24 feet apart, and 2 to 3 feet deep; I have seen a great deal of good done by cutting deep drains for springs 8 and 10 feet deep, and there is much land here that cannot be made dry unless the springs are removed.

Yours, &c. T. Tebbet.

I will not ocupy more space in quoting the opinions of persons who, having had sufficient opportunities of witnessing the effects of various depths of drainage, have formed unfavourable conclusions respecting the use of deep drains on strong clay land at wide intervals; though those of old Pearson, the spring-drainer in Essex (see his evidence before the House of Lords); of Smith of Deanston, who first forced upon the public the importance of thorough draining, and did show what could be done in strong land at moderate depths and distances; and of others are before me—these are accessible to the public in other forms. What I have said may, perhaps, be sufficient to excite attention, and set people on their guard against plunging into the expense of a system of drainage which has failed in many instances, and might therefore cause disappointment in many more.

William Bullock Webster.

Hounsdown, near Southampton, April 29, 1848.
and 48, *Charing Cross, London.*

VOLTAIC IGNITION.

At the Royal Institution, Feb. 16, Mr. Grove delivered a lecture "*On Voltaic Ignition.*"—Mr. Grove introduced his subject by asserting that the only philosophical idea of heat was that which regards it as a repulsive power—that, with the single exception of water and other bodies which assumed a crystalline form when about to freeze (a condition which Mr. Grove ascribed to a polar state which these substances then took), all matter expanded by heat. Mr. Grove here referred to the experiments of Fresnel and Saigy on discs in vacuo, and the still more recent researches of Prof. Baden Powell on Newton's rings, as showing the repulsive effect of heat, measured by tints of light. This expansion of matter, so caused, can be communicated to neighbouring bodies. In the case of heat produced by intense chemical action, the effect was ascribed to the physical force of a species of molecular friction on the particles acted on. This chemical force is capable of transfer by the voltaic battery, and the calorific force moves with it. It was proved by an experiment on a compound wire of silver and platinum, that in proportion to the increase of conducting power, ignition was diminished. Mr. Grove here referred to recent researches of his own to prove that this calorific action was affected by external causes. The same current was sent through two coils of fine platinum wire, one of which was surrounded by an atmosphere of air, the other by an atmosphere of hydrogen, when it was found that the wire in air became white-hot, while that in hydrogen was not heated. This phenomenon Mr. Grove ascribed either to the mobility of the particles of the hydrogen, or to the vibrations moving away from the vibrating surface, or to the state of the surface itself, hydrogen being, as to radiating power, to air what the colour black is to white. That this cooling effect does not depend on rarefaction, is proved by the intense heat and light produced by the current in vacuo. Mr. Grove then proceeded to show how the chemical force in the battery acted on massea of matter interposed in the circuit. He exhibited, first, the attraction of gold-leaf terminals, and then explained how liquid masses similarly attracted each other, and noticed a remarkable experiment lately performed by him with M. Gassiot's large battery of 500 cells (Grove's battery): of the two platinum poles, the positive was placed under water, the negative held over it, when a cone of flame issued from the surface of the water towards the negative pole, on the extremity of which a small globule was formed, which fell off as soon as the current was suspended. These facts may serve to explain more clearly the phenomena of the voltaic arc. Mr. Grove then exhibited paper on which the strong disruptive effect of the electric battery had dispersed metallic wires, and he showed that these explosions had always occurred in a line transverse to that of the current. He inferred that when ignition commenced in the wire its molecules assumed a transverse polar direction. He stated that when platinum is ignited by the current under circumstances which admit of the effects being accurately noticed, it contracts, swells, and breaks, and that a lead wire, similarly acted on, becomes divided by a series of transverse facets. In conclusion, Mr. Grove adverted to recent endeavours to obtain voltaic light for practical purposes. After noticing that no greater power of producing light had been obtained since the invention of his nitric acid battery, nine years ago, Mr. Grove stated that recent calculations led him to believe that for some purposes, such as the illumination of lighthouses, especially where an intermittent light was wanted, and of the interior of large buildings, it might possibly be adopted at no very remote period. He mentioned that the light of 1,440 candles might be obtained at about 4*s.* per hour; but this concentrated light was not applicable for streets. The whole subject, however, was beset by many mechanical difficulties.

FIRE ANNIHILATOR.

At the Royal Institution, Feb. 23, the Rev. J. Barlow delivered a lecture "*On Mr. Phillips's Fire Annihilator.*" The annual destruction of property to the amount of more than two millions sterling, and the fearful loss of human life, necessitate additional resources against fire. The destructive agent of conflagration is flame. It is flame which occasions violent draught, produces the most intense heat, and most rapidly generates those suffocating vapours which render the burning apartment inaccessible. Mr. Barlow remarked that the origin and continuance of flame depended on two conditions—firstly, that the combustible material should be raised to, and kept at, a temperature high enough to afford a constant supply of inflammable gas; and, secondly, that it should be constantly fed with pure air. The usual remedy against fire is water. But water is able to interfere with the first of these conditions only. Unless the burning substance be so saturated with water that it cannot give out combustible gas, within a very few minutes after it has been set on fire, the heat of the flame first extends, and then ignites other inflammable gases and vapours from various parts of the room; the flames are thus dispersed about the apartments; and by the time that the engine arrives, the contents of the house are frequently consumed. Mr. Phillips proposes to subdue flame by effectually disturbing the second condition of its continuance—access of pure air. The object of the Fire Annihilator is to diffuse through the atmosphere (already vitiated by the combustion) of an apartment on fire, a quantity of carbonic gas and steam, and thus render the continuance of flame impossible. These gases and vapours are generated in a portable apparatus, which, when intended for the protection of private dwellings, weighs from twenty to thirty pounds; and the construction is such that the aeriform fluids can be evolved in less than three seconds on touching a spring. When saw-mills or docks and large magazines are to be protected, Mr. Phillips recommends that larger machines should be stationed at convenient situations. The effects of Mr. Phillips's apparatus were exhibited in the lecture-room. A large volume of flame was made to issue from models of a house, a room, and a ship and these flames were extinguished as soon as the Fire Annihilator was brought to bear upon them. Mr. Barlow remarked in conclusion that while the common fire-engine was necessarily tardy, required great power to work it, was liable to be rendered ineffectual by accidental circumstances, and occasioned inevitable damage to furniture, &c., the fire annihilator was always at hand, always ready for use, easily set in action, and that its coming into action when required might be as surely relied on as the discharge of a percussion gun when the trigger was pulled; that it occasioned no injury to furniture, and, above all, that though it acted by producing fierce combustion, those who used it need apprehend no injury from it.

NOTES OF THE MONTH.

Sale of the 'Great Britain' Steamer.—This ill-fated steamer has within the last few days changed owners. It is rumoured that she has been purchased by a company who intend to carry passengers between some point on the western side of South America and San Francisco. The sum she realised is said to be 25,000*l.*—What a sacrifice!

Paris.—For many years a survey of the underground works of Paris has been in progress, and which is now nearly completed. It is to form an atlas of five sheets—corresponding to a superficies of 500 by 300 mètres, and will exhibit quarter by quarter all the labyrinthine sinuosities of the ancient quarries and catacombs under the city of Paris, with the corresponding edifices, squares, and streets above ground. The labours of the engineers in the execution of this work, have been, says the *Journal des Débats*, of the most tedious and delicate nature. This may be imagined when it is understood that every subterranean point has its corresponding exterior point,—and that a double calculation is necessary for the precise marshalling of objects without, over the tortuous lines (empty or encumbered) within. The map has been co-ordinated on the supposition of two axes; one figuring a medirian passing by the Well of the Observatory—the other a line perpendicular to the first.

Water Test.—If there be any organic matter in water, it may be easily detected by a drop of the solution of nitrate of silver, which will cause a precipitate of a brown colour.

New Saw-Filing and Setting Machine.—Messrs. Norton and Cottle, of Holme's Hole, America, have recently patented in the United States a machine for filing and setting saws, enabling the operator to whet and set the teeth of saws in such a manner, that every tooth will be equal in size and length, the proportion being graduated by an index, and so adjusted as to suit the teeth of saws of every description. Saws that have been used and become useless in consequence of bad filing, can be re-cut, and made as valuable as new. The set is attached to the machine in such a manner, that when the filing is completed no alteration is required in the adjustment of the saw to complete the setting. The inventors have found by experience that the hardest saws can be set without breaking or injuring the teeth. Saws considered in a measure useless having passed through this machine, are said to work perfectly easy, and perform much faster than those filed in the usual manner; and the teeth being all of an equal length, will not require filing so frequently.

South Devon Railway.—The permanent way from the Laira station to Plymouth has been completed, and arranged to open for public traffic on the 2nd of April.

Ventilation of Coal Mines.—Mr. Goldsworthy Gurney's plan of ventilating mines by a jet of high-pressure steam, as proposed by him as far back as 1825, has now been put into practice by Mr. Forster, in one of the collieries at Newcastle, and it is stated with great success.

The Zinc Deposit of Galvanic Batteries.—It is suggested that the sulphate of zinc might be turned to a valuable account by the following process:—To a solution of sulphate of zinc add an equivalent of muriate of soda, also in solution; an exchange will take place, the muriatic acid combining with the zinc, and the sulphuric with the soda. By evaporation, the sulphate of soda may be crystallised, the muriate of zinc remaining in solution. From this solution the zinc may be precipitated in the form of oxide, by adding an equivalent of lime, in the state of cream. The soda, if not saleable as a sulphate, might be converted, by the usual process, into carbonate, and the oxide of zinc might be reduced into a metal almost chemically pure.

The Electric Light.—Mr. Henry M. Payne, of Worcester, Massachusetts, informs the *Scientific American* that he has discovered a means of generating light, by mechanical action, from water and lime. Mr. Payne says—"I have continued the experiment at intervals, and I am now enabled to announce a successful result. I have produced a light equal in intensity to that of 4,000 gas-burners of the largest bat's-wing pattern, with an apparatus occupying 4 square feet of room, at a cost of 1 mill. per hour, the current of electricity being evolved by the action of the machinery wound up with a common lock key, and the only materials consumed are water and lime. I am now engaged in making an apparatus for public exhibition, which will be completed this winter, and all its parts submitted to public inspection, except the interior of the generator. This apparatus I will exhibit one year, at the end of which I will make public the mechanism of the generator."

Artificial Light.—At the last meeting of the Ashmolean Society, Dr. Daubeny exhibited an apparatus to show an easy method of producing a light, capable of superseding oil, or even gas, simply by passing a stream of atmospheric air through inflammable liquids of a volatile nature, such as ether, or the liquor condensed in the preparation of oil gas.

Iron Ladders.—A correspondent in the *Mining Journal* suggests that all ladders used in mines, and also for military scaling, should be made of *wrought-iron* in the following manner:—The rounds or steps to be formed of ⅝ inch rod-iron, the width between the two sides 9 inches, their distance apart 6 inches, and the extreme length 10 feet. The sides to be made of flat bar-iron, 2¼ inches wide, and ½ an inch thick. The rounds fastened in with nuts and screws, so that the ladder can be taken to pieces easily, for conveyance of transport, and also for repairs. If a round be damaged, or worn out, it can soon be removed and a new one substituted. The method of fixing the rounds in is as follows:—*Square holes* are to be punched in the two flat sides, 6 inches apart; the holes in one side corresponding with those in the other. Then a rod of ⅝-inch iron is to be cut up into 11-inch lengths, and each end of these short rods forged into proper shape, which is this:—that ½ inch from the extremity the rod is made square to fit the square hole in the side-bar; this square part is ½ inch deep, the thickness of the side-bar, and the rod to be made round, ½ inch from the ends, and screwed to take a nut ½ inch thick. If the rods were not thus squared, they would soon wear loose and turn round when fixed in. A shoulder is thus formed on either end of the stepping-rods, which enables the side-bars to be screwed up tight against the steps, and so makes the ladder firm and strong. Iron ladders may be constructed of various lengths and strengths, to suit circumstances. Short lengths may easily be bolted together; and in this way a continuous ladder for the deepest mines can be made; or short ladders can be placed one after the other on landings or stages, as usual. The wrought-iron will, of course, rust; but will not wear out for a very long time.

Improvements in Condensers.—Mr. Siemens, C.E., of Birmingham, has invented a surface condenser for steam-engines, to supersede the injection condenser. It is constructed on the principle, that if two vessels of a good conducting metal be made of similar shape, but of different thicknesses of metal, one being—say $\frac{1}{16}$ of an inch, and the other 1 inch—water will boil with equal rapidity in each, proving that the transmission of heat through them is more rapid than the absorption by the water; and in its construction about 20 square feet of cooling surface is provided per horse power. It consists of a cast-iron box of sufficient dimensions, an air-pump, a hot well, a cold water chamber beneath, and a cistern above, the box. Within this box are placed a sufficient number of copper plates, $\frac{1}{16}$ of an inch thick, and long enough to fill the entire depth, and so arranged as to leave a space alternately between one end of each plate and the sides of the box, thus forming a zigzag channel for a current of cold water. Between each of the plates two pieces of flattened copper wire are placed to keep them sufficiently apart, and the whole is compressed by set screws on the outside, until the wires are indented into the plates, making the channel water-tight. The waste steam of the engine enters the box, and is condensed by the projecting edges of the copper plates; the heat is absorbed by the cold water; the condensed water collects at the bottom of the box, and is continually discharged by the pump into the hot well, and is then returned. Mr. Siemens has not patented his invention, but liberally publishes a description for the use of the public.

New Musket Ball.—Woolwich, March 19, and 22.—Some experiments were made at the butt in the Royal Arsenal, to test the merits of a musket-ball submitted to the select committee by Mr. Minesinger, an American by birth, but of Dutch origin. The ball is cast with a four-grooved tail attached to it, in length about three-fourths the diameter of the spherical portion, the tail resembling the first screw-propellers introduced with four leaves, but with a slight obliquity instead of the archimedian-screw form. Mr. Minesinger fired his balls, 23 to the pound weight, from a long-barrelled gun, the length being 5 ft. 7 in., and Colonel Dundas, C.B., from a common musket, the barrel of which was 3 ft. 8 in. long—both guns having percussion locks. The firing commenced at 100 yards, but after a few rounds by each the distance was extended to 200 yards, when excellent practice was made, the target being struck every time with two or three exceptions. The appendage to the ball gives it similar advantages to the balls projected from rifles, and considerably increases the range; and should it on further trial be approved, every common musket by its adoption would possess the projective power and excellent direction at present only obtained with any degree of certainty by grooved rifles. It is intended to have a number of 32-pounder solid shot and shells cast on the same principle for trial in the marshes. Some further experiments were made with a range extended to 300 yards. Previous to concluding the firing at 200 yards' range, Colonel Dundas made a number of excellent shots, striking the target every time, with balls of the sugar-loaf pattern, submitted by Mr. Lancaster, jun. These balls were fired from a beautiful rifle, of French pattern; and by a very simple appliance are made to fit quite tight in the rifle without wadding. A small groove is cut round the sugar-loaf-shaped ball near the base, and two or three worsted threads tied round and raised beyond the diameter of the base, to the extent required. The long-barrelled gun used by Mr. Minesinger contains a space for a chamber at the breach end of the barrel, and he loads his chambers before he commences firing, and fires five rounds before he again charges the five chambers he carries in his pocket. The gun, consequently, requires no ramrod; a small piece of wood and a stone from the ground being sufficient for driving home the powder and balls in the chamber—which is only three inches in length. Each chamber has a projecting nipple on which the percussion nipple is placed, and is held securely to the stock by a sliding hinge, and is capable of firing 20 rounds per minute.

The Fastnett Rock Lighthouse.—The Fastnett Rock lies nearly six miles W. by S. of Cape Clear, which is the nearest land. It rises 94 feet above the level of high-water—is steep and precipitous—bare and rugged—terminating in sharp points and ledges of the hard sandstone of which it is composed. Being situated at the point where homeward-bound vessels generally make the Irish coast, and being (as it were) its most southern outpost, it has been recommended by Captain Wolfe, R.N., and the officers carrying on the Hydrographic Survey, that the light should be removed from Cape Clear to the rock in question, and in accordance with this suggestion the erection of the new lighthouse commenced in May last. It will be remembered that in November, 1847, the New York line-of-packet-ship, Stephen Whitney, was lost, with 97 of her passengers and crew, within three miles of the Cape Light, and it is supposed, from her track leading so near the Fastnett, that the ship would have been saved had there been a light thereon; the Cape light being obscured by the fog on that night, from its great elevation of 459 feet. The summit of the rock barely affords space sufficient for the necessary sheds or shelter for the workmen; the iron tower for the light, the foundation of which has been completed and its base filled up with solid mason-work, and secured with all possible care, is 19 feet in circumference, and it is intended to raise it to 75 feet to the summit of the lantern, fourteen of which have been already completed. The sheds were very strongly constructed, and secured to the solid rock by massive chains, and seventeen persons took shelter therein during most of the summer; a large steam-vessel acted as a tender, and conveyed stores and provisions thereto, but such is the exposed situation of the rock that for several days no communication could be kept up but by a leather bag hauled through the surf. Several of the workmen, from the dangerous nature of the employment, gave up their situations and returned to Dublin, it being the opinion of the inhabitants at the Cape and Crookhaven that nothing could remain thereon in a heavy winter's gale. The foreman and a few others remained at their post until the gale of the 26th of December, when they were compelled to quit their sheds and seek shelter in the iron tower, which most fortunately had been roofed over for the winter, as a last place of refuge. The effect of the sea in that gale baffles all description; all the sheds were filled with water, and one of them has been washed down—derricks and cranes, with other materials, swept off the rock, and a large anvil of 3 cwt. and upwards taken from off its summit as if it were a feather; and notwithstanding all that has been written about the height of a wave, the men affirm that the sea ran several feet higher than the roof of the tower before it broke, and that the waves that passed the rock out of breaking distance were far more than ten feet above their level, which was nearly 100 feet above high-water mark. Water casks secured in the crevices of the rock, bolted and lashed down, were swept away, and as the sea broke it would leave the men in total darkness for several seconds, with a difficulty of respiration—and as the spray descended on their roof with immense weight and crash, the light and air both came in together. Two days after the gale they were taken from their perilous situation at considerable risk by means of life-preservers, and pulled through the surf by lines from a boat outside the breakers. The foreman, a very intelligent man, is now at Crookhaven preparing the stores for the spring or fine weather. He has no apprehension as to the stability of the tower, which is of cast-iron, in large pieces, and screwed together—beautifully cast, and of amazing strength.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM FEBRUARY 22, TO MARCH 20, 1849.

Six Months allowed for Enrolment, unless otherwise expressed.

Clemence Augustus Kurts, of Wandsworth, Surrey, gentleman, for certain improvements in looms for weaving.—Sealed Feb. 28.

Obed Blake, of the Thames Plate Glass Company, Blackwall, Middlesex, manager, for certain improvements in the process or processes of manufacturing and finishing plates, sheets, or panes of glass.—Feb. 28.

Joseph Barker, of Esher-street, Kennington, artist, for an improved method of constructing umbrellas and parasols.—Feb. 28.

John Hick, of Bolton-le moors, Lancaster, engineer, and William Hodgson Gratrix, of Salford, Lancaster, engineer, for certain improvements in steam-engines, which improvements are more particularly applicable to marine engines, and also improvements in machinery or apparatus for propelling vessels.—Feb. 28.

Benjamin Biram, of Wentworth, York, gentleman, for improvements in miners' lamps.—Feb. 28.

Robert Pollard, of Topsham, Devon, rope-maker, for an improvement in rope-making machinery.—Feb. 28.

Henry Crossley, of the firm of Henry Crossley, Son, and Galsworthy, of Emerson-street, Surrey, engineers and coppersmiths, for certain improved modes or methods of, and apparatus for, heating and lighting, for drying substances, and for employing air in a warm and cold state for manufacturing purposes.—Feb. 28.

Perceval Moses Parsons, of Lewisham, Kent, civil engineer, for certain improvements in railways, railway engines, and carriages, and certain of their appurtenances.—Feb. 28.

Amedee Francois Remond, of Birmingham, for improvements in machinery for folding envelopes, and in the manufacture of envelopes.—Feb. 28.

William Brindley, of Twickenham, papier-mache manufacturer, for improvements in the manufacture of waterproof paper.—Feb. 28.

Charles Jacob, of Nine-elms, Surrey, engineer, for improvements in the manufacture of earthenware tubes or pipes.—Feb. 28.

Dion de Boucicault, of the Quadrant, Regent-street, gentleman, for certain improvements in the mode or modes to be used for transmitting and distributing liquids and fluids for agricultural purposes, and for apparatus connected therewith.—Feb. 28.

Thomas Rowlandson, of Liverpool, chemist, for improvements in the treatment of certain mineral waters, to obtain products therefrom, and in obtaining certain metals from certain compounds containing those metals, and in obtaining other products, by the use of certain compounds containing metals.—Feb. 28.

Charles Andre Felix Rochaz, of New-court, St. Swithin's-lane, in the city of London, merchant, for improvements in the manufacture of oxide of zinc, and in the making of paints and cements where oxide of zinc is used.—Feb. 28.

Pierre Isidor David, of Paris, in the republic of France, for improvements in bleaching cotton.—Feb. 28.

Job Cutler, of Sparkbrook, near Birmingham, civil engineer, for certain improvements in the manufacture of metal pipes or tubes.—Feb. 28.

George Fergusson Wilson, of Belmont, Vauxhall, gentleman, for improvements in separating the more liquid parts from the more solid parts of fatty and oily matters, and in separating fatty and oily matters from foreign matters.—Feb. 28.

Edward Westhead, of Manchester, manufacturer, for certain improvements in the manufacture of waddings.—March 3.

Henry Constantine Jennings, of Abbey-street, Bermondsey, practical chemist, for improvements in the manufacture of vehicles for mixing pigments, and also in the manufacture of white-lead.—March 5.

Nathan Defries, of Grafton-street, Fitzroy-square, civil engineer, and George Brooks Pettit, of Brook-street, New-road, Middlesex, gas-fitter, for improvements in applying gas to heat apparatus containing fluids, and in heating and ventilating buildings; also improvements in gas-fittings, and in apparatus for controlling the passage of gas.—March 5.

Samuel Banks, of West Leigh, Lancaster, miller, for certain improvements in mills for grinding wheat and other grain.—March 5.

William Henry Green, of Basinghall street, in the city of London, gentleman, for improvements in the preparation of fuel.—March 5.

James Baird, of Gartsherrie, Old Monkland, Lanark, Scotland, iron-master, and Alexander Whitelaw, of the same place, manager, for improvements in the method or process of manufacturing iron.—March 7.

Andrew Shanks, of Robert-street, Adelphi, Middlesex, engineer, for an improved mode of giving form to certain metals when in a fluid or molten state.—March 14.

John Smith, of Hare Craig, Dundee, factor to Lord Douglas, of Douglas, for improvements in the manufacture of flour, applicable to the making of bread, biscuits, and pastry.—March 14.

Robert Ross Rowan Moore, of the Temple, barrister-at-law, for improvements in the manufacture of letters and figures to be applied to shop-fronts and other surfaces.—March 14.

George Fergusson Wilson, of Belmont, Vauxhall, gentleman, for improvements in the manufacture of candles and night-lights.—March 14.

James Williamson Brooke, of Camden Town, gentleman, for improvements in lamps.—March 14.

Thomas Clarke, of Hackney, Middlesex, engineer, and Thomas Morley, of Bristol, civil engineer, for certain improvements in obtaining and applying motive power; also improvements in railroads and other roads, and in supporting pressure, resisting strain, and protecting against fire.—March 14.

Robert Plummer, of Newcastle-upon-Tyne, manufacturer, for certain improvements in machinery, instruments, and processes employed in the preparation and manufacture of flax and other fibrous substances.—March 14.

William Payne, of New Bond-street, Middlesex, watch and pedometer maker, for certain improvements in clocks and watches.—March 14.

Alexander Swann, of Kircaldy, Fife, manufacturer, for improvements in heating apparatus and in applying hot and warm air to manufacturing and other purposes, where the same are required.—March 14.

William Gratrix, of Salford, Lancaster, bleacher and dyer, for certain improvements in the method or process of drying and finishing woven and other fabrics, and in the machinery or apparatus for performing the same, part of which improvement is applicable to stretching woven fabrics.—March 14.

Ignacio de Barros, of Lisbon, Portugal, but now of Paris, gentleman, for improvements in machinery for making lasts for boots and shoes, butts or stocks for fire-arms, and other irregular forms.—March 14.

Allen Bragg, of Queen's-row, Pentonville, bath-keeper, for improvements in propelling by atmospheric pressure.—March 14.

Francis Hay Thompson, doctor of medicine, of Hope-street, Glasgow, for an improvement or improvements in smelting copper or other ores.—March 14.

Pierre Augustin Chaufforier, of Regent's quadrant, merchant, for certain improvements in the manufacture of watches.—March 14.

Pierre Armand Lecomte de Fontainemoreau, of South-street, Finsbury, London, for certain improvements in coating or covering metallic and non metallic bodies. (A communication.)—March 14.

Alfred Vincent Newton, of Chancery-lane, mechanical draughtsman, for improvements in the manufacture of piled fabrics. (A communication.)—March 19.

Joseph Béranger, of the firm of Béranger and Company, of Lyons, France, civil engineer, for improvements in weighing machines.—March 19.

Thomas Henry Russell, of Wednesbury, patent tube manufacturer, and John Stephen Woolrich, of Birmingham, chemist, for improvements in coating iron and certain other metals and alloys of metals.—March 19.

Samuel Hall, of King's-Arms-yard, Coleman-street, city of London, civil engineer, for certain improvements in apparatus for effecting the combustion of fuel and consuming smoke, and for preventing explosions of steam-boilers and other accidents to which they are liable.—March 19.

George Knox, of Moorgate-street, city of London, secretary to the Shrewsbury and Birmingham Railway Company, for improvements in railway carriages.—March 19.

Alexander M'Dougall, of Longsight, Lancaster, chemist, for improvements in recovering useful products from the water used in washing, and in treating wood, woollen, and cotton fabrics, and other substances.—March 20.

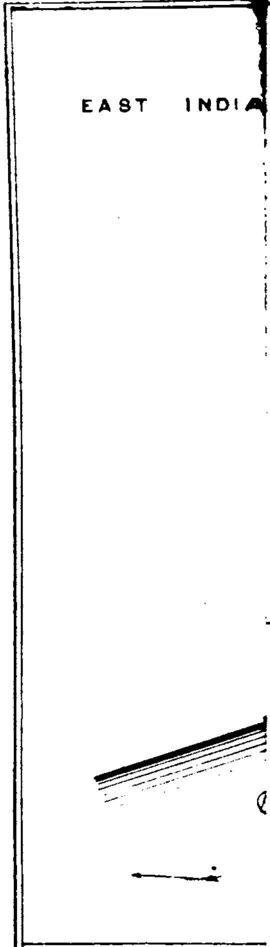
William Harrison Pickering, of Liverpool, merchant, for improvements in evaporating brine and certain other fluids.—March 20.

Charles William Siemens, of Birmingham, engineer, for certain improvements in engines to be worked by steam and other fluids, and in evaporating liquids.—March 19.

William Parkinson, of Cottage-lane, City-road, in the county of Middlesex, gas meter manufacturer, successor to the late Samuel Crossley, for improvements in gas and water meters, and in instruments for regulating the flow of fluids.—March 20.

ERRATUM.—In the article "George Stephenson," in our present number, p. 104, line 21, for "the cotton which was of home growth," read "the cotton, which was not of home growth."

PLATE VII.



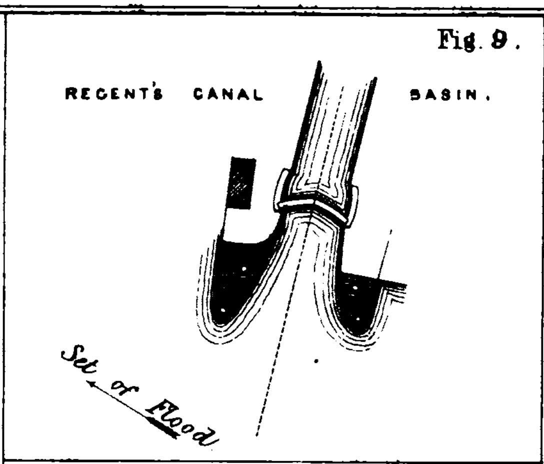


Fig. 9.

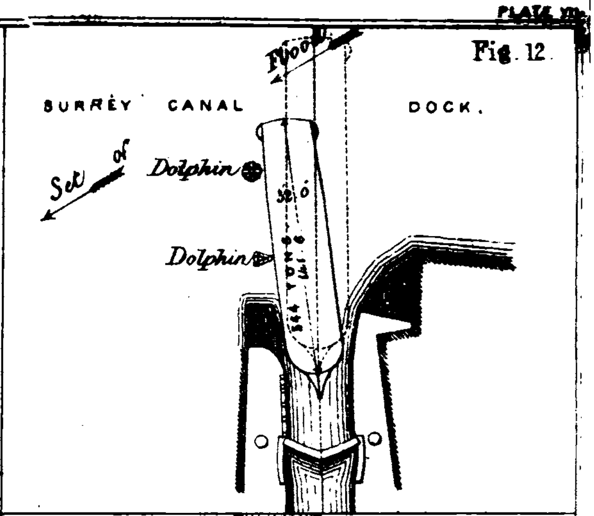


Fig. 12.

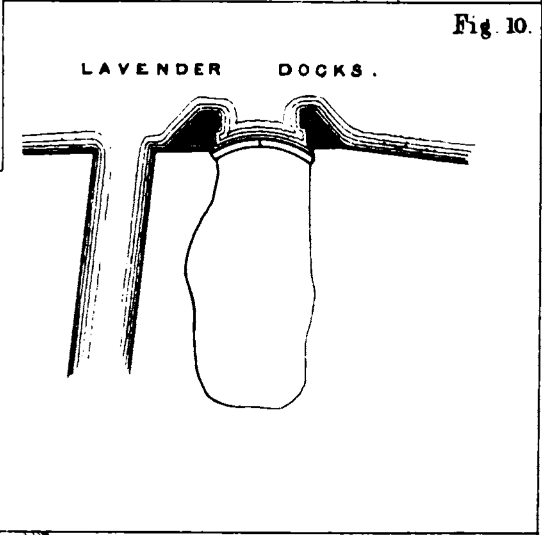


Fig. 10.

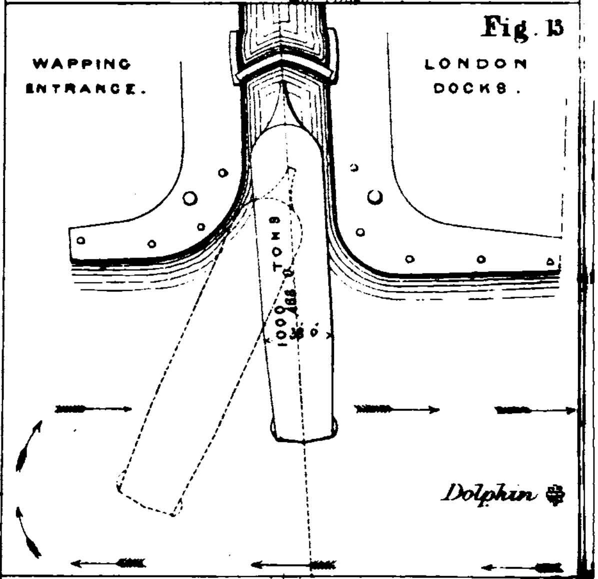
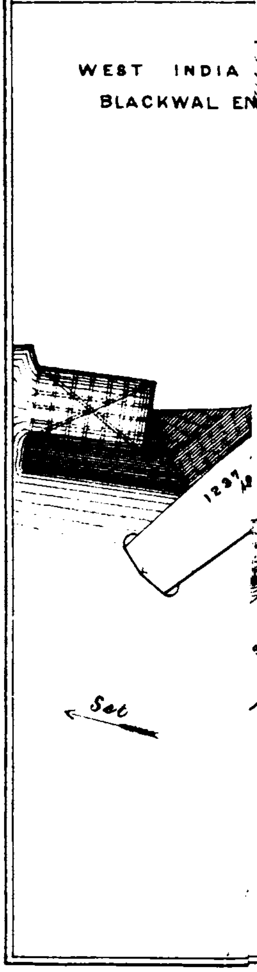


Fig. 13



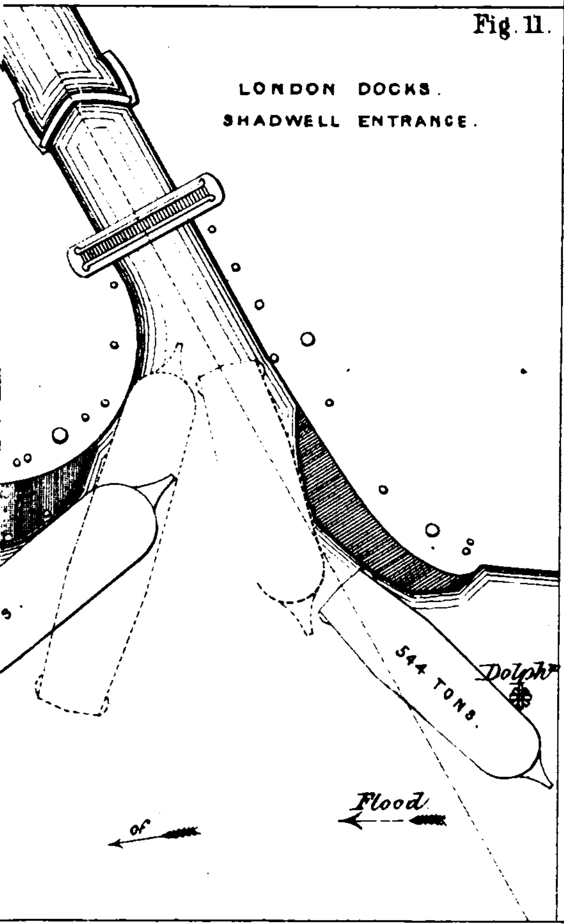


Fig. 11.

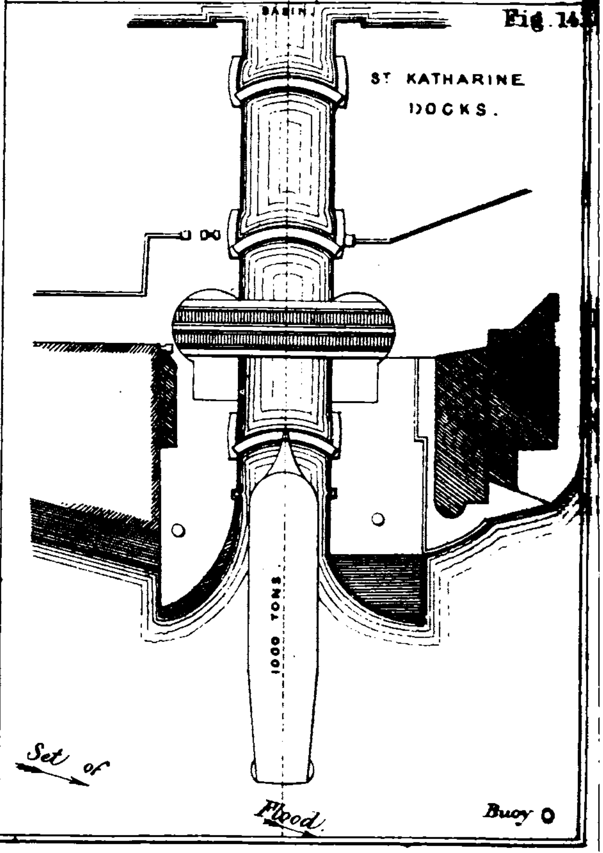


Fig. 14.

DOCK ENTRANCES.

(With an Engraving, Plate VII.)

Remarks on the Formation of Entrances to Wet and Dry Docks, situated upon a Tideway; illustrated by the principal examples in the Port of London. By John Baldry Redman, M. Inst. C.E.—(Read at the Institution of Civil Engineers.)

The importance of this subject is so great, that lengthened prefatory remarks would be superfluous; the instances which may be observed on the Thames, show that there has been considerable variation in the opinions and practice of engineers, or that the subject has not been considered important; though, at the same time, some allowance must be made for the peculiar circumstances of the Port of London, and the value of ground upon its banks: the question therefore is—What should be the proper direction and shape of a dock entrance in reference to the run of tide?

The practice in the Port of London is to dock a ship upon the flood, just before high water, and to undock her at about the same period of tide; high water is also selected, for obvious reasons, as the time for launching new vessels from the building slips. The angle these docks and entrances make with the line, or direction of the run of tide, is a very important element for consideration; much greater working facilities being afforded at some than at others, where, from their particular direction, expensive additional timber outworks have been rendered necessary, to afford those facilities which the entrances, when finished, did not afford.

It is only necessary to refer to the particular position of some of the principal entrances, to exemplify this.

Fig. 1.—The entrance at Blackwall of the East India Docks is considered by shipwrights and pilots of the port to be well situated; it points upwards, at an acute angle with the line of flood, and is at the same time covered, to some extent, by a projecting pier on the lower side; the effect is, that on a vessel entering, her stern being driven upwards by the action of the tide upon her starboard quarter, she is drawn by warps without much difficulty into the lock; this, however, is to an extent only, as, with the wind on shore, a vessel is sometimes driven athwart the entrance, and nipped between the lower pier and the projection of the Brunswick Wharf, against which her larboard quarter is driven by the flood and wind. This position is shown by the form of a vessel within the entrance. In this state of affairs it becomes necessary to wait for slack tide at high water, which sometimes, with a large and heavily-laden ship, is a dangerous experiment; or else, to heave her stern down against the tide from the starboard quarter. This operation, with an entrance so placed, is by no means so laborious as if it had been placed at right angles to the stream. To the natural position of this entrance, however, much of its superiority is attributed, there being plenty of room in the river in front of it, nor does the tide set strongly across it; but with easterly gales, large ships would formerly hang until the slack of tide, whereas now, with the assistance of steam-tugs, vessels may be docked as soon as there is sufficient depth of water.

This entrance was formed for the purpose of docking a limited number of large vessels on any one tide. It has been stated, that it was with this view that the outer lock-gate was projected so far outwards towards the river; the circumstances and conditions of the lock are consequently similar to those of a graving dock, and it is supposed that it was so formed with the view of waiting for the slack of tide. This would preclude docking more than one or two vessels upon the same tide, which, however, would have sufficed for the original requirements of the India trade.

The majority of the docks and slips at the respective establishments of the Messrs. Wigram, and Messrs. Green, at Blackwall, point more acutely to the flood tide. These docks are considered by ship-builders to be well placed,—they are, however, much exposed, as the flood-tide sets right into them; this, however, is not of such importance as for the entrance of a wet dock, because a ship-builder, having only one, or at most two, vessels to take into one dock, can afford to wait for the slack tide.

Fig. 2, shows the entrance at the Blackwall end of the West India Docks and of the City Canal, now the West India South Dock. This was influenced no doubt by the position, and the object of the latter, which was to effect a thorough communication for the navigation, and to cut off the reaches round the Isle of Dogs; but which failing as a canal, has long been used as a lie-by for ships and timber. The entrance is nearly in an opposite direction to that of the example first quoted, and forms rather an obtuse angle, or at least a right angle with the flood.

It is stated by gentlemen who have been many years connected with the port, that when the West India Docks were first completed, the danger to loaded ships was so great, that it became necessary to lengthen the upper pier, by additional timber external works. The entrance, in its present state, bears a very good character.

This entrance was formed with a view to docking the largest possible number of vessels upon one tide (having reference to the arrival at that period of the West India ships in fleets). The basin was formed as a tide receptacle for these vessels as they came up the river, the water being drawn down to about half-tide level in the basin, for that purpose; the great width of entrance was no doubt not found practicable, it being necessary (as is now done), to bring the vessels up with head to tide, and allow them to drop up from the buoys off the entrance, across which the flood tide runs up with strength; it was also found necessary to carry out a timber jetty to low-water mark, off the South, or Upper Pier, to prevent vessels from tailing round with the flood on to the shore. The great width thus eventually obtained between the wings is advantageous, as it allows a vessel to kant across, and to enter without the assistance of a quarter-rope, or a steamboat; another advantage is, that in undocking, sufficient space is allowed for the outward-bound vessel to pass out, the inward-bound vessel being at the same time within the entrance.

Mr. Pitcher's graving docks, to the westward of the canal entrance, are in nearly the same direction.

Fig. 3.—The Blackwall entrance of the South Dock answers well as regards direction, although, like the last, it is nearly at right angles to the stream, as from its being more in a bight, there is a slack of tide across it; it, however, requires a dolphin upon the upper side at low water, to counteract the tendency which vessels have, when docked upon the flood, to tail upon Mr. Pitcher's ways.

Figs. 4 *and* 5.—The Western, or upper entrances of the West India Docks and City Canal, or South Dock, at Limehouse, are favourably situated, as they point acutely up the stream, and considerable facilities are afforded to vessels entering by the West India Dock entrance, on account of its direction; the admission and exit of light vessels can thus be well and expeditiously conducted.

The West India Dock entrance is considered well adapted to the purposes of trade, as there is deep water on the north side, and there is an easy run of tide across it towards high water.

At Woolwich Dockyard there is great variety in the direction of the building slips and of the graving docks: some are nearly square to the stream, in other instances they point slightly up, and in others downwards—forming an acute angle with the line of flood in some instances, and an obtuse angle in others.

At Deptford Dockyard there is equal variety: at the lower part of the yard they are nearly at right angles to the stream; the entrance to the lower basin points slightly up the stream; that to the Transport Dock is nearly square; a dock above it is in the same direction; but the dock above, in what is called "Dudman's Dockyard," points up acutely to the flood; a building slip above this is in the same direction, and a dock entrance still higher up points upwards at a less acute angle. The conditions of the several properties appear to have had as much influence upon the direction of these slips and docks as any other considerations.

Figs. 6 *and* 7.—The entrance lock to the East Country Dock points slightly upwards, as also that to the Commercial Docks; both are considered good working entrances. The Graving Docks on either side of the Commercial Docks entrance point in a similar manner, showing that the disposition of one property has influenced the other, as regards direction.

From the particular local set of tide, the angle of direction upwards is very much reduced.

At each of these two entrance locks, two dolphins are placed in a line with their upper sides; they are *pro tanto* elongations of the upper wings.

On the opposite side of the river at Mill-Wall, Blackett's Graving Dock is nearly square with the stream, pointing slightly downwards.

The Graving Dock above this (Mitchell's), below Messrs. Seaward's factory, points up very acutely with the line of flood.

The docks of Messrs. Fletcher, situate between the Limehouse entrances of the West India Docks, are nearly at right angles with the river in their immediate neighbourhood; but as regards the general contour of the Reach, point slightly up the stream. Very nearly the same remark will apply to the docks of Messrs. Young, at Limehouse; the character these docks bear on the river is very similar, except that as Fletcher's docks lie in a bight, they are less exposed.

Limekiln or Limehouse Dock points up the stream; the small dock at Duke Shore belonging to Messrs. Young, though standing relatively very similar in position to their other docks, is stated by them to be perhaps the most awkward dock in the river, owing to the flood tide from Limehouse Reach setting right into it; and they consider that had its entrance been much wider, or its direction much more acute with the line of flood, much of this inconvenience would have been avoided.

Fig. 8.—Messrs. Dowson's Graving Dock at Limehouse is nearly square to the stream; but from the particular set of tide in this portion of the reach, the flood making over from Cuckold's Point, this dock points at a very obtuse angle towards the flood, as shown upon the diagram; great difficulty is consequently experienced in docking a heavy ship, a considerable purchase being necessary to keep her in position until near high water, by heaving down her stern against the tide. The evil at this dock, and the one at Duke Shore, is increased by the strength with which the flood tide sets directly into them.

There is a considerable length of outer tidal basin, or entrance to this dock, between the gates and the river; but as the quays, or wing walls which form the sides are parallel to one another, and in a line with the sides of the dock, it is obvious that no advantage is gained in reference to the particular direction which a vessel assumes whilst entering. This length of entrance appears likewise to have been principally induced from the particular local position of the dock, a public street crossing it, and the site of the swing bridge consequently determining the commencement of the dock. This latter remark likewise applies to the next example, which is shown in the same illustration, being close adjoining, and nearly parallel, to Messrs. Dowson's Dock, but pointing slightly down the stream, and consequently forming a more obtuse angle with the flood than even the last example, and is, therefore, as regards direction, even more awkwardly situated; but the widening out of the wing walls forming the entrance, slightly increases the facilities for vessels, both departing and entering, but the tonnage of such vessels is inconsiderable.

Fig. 9.—The Regent's Canal entrance lock, which leads into a large basin, or wet dock, admitting vessels of considerable burthen, principally colliers and coasters, is nearly square to the stream; but from the tide setting across, upon the flood, from the opposite side, induced by the local formation of the river, though not in so great a degree as in the last examples, this entrance forms in the line of its direction an obtuse angle with the set of the flood. It has a very bad character, on account of its direction and the small distance between the wings at the entrance, which had no room for expansion, from the gates being, as in graving docks, close to the river bank. The difficulty of docking a ship upon the flood must have been very great before the addition of the timber-works, which, in effect, remove the entrance gates further from the run of tide, creating slack water in front of them, and, by giving a greater width between the jaws of the entrance, allow somewhat for the necessary obliquity in entering, and afford more space for a vessel's bow to be turned down whilst departing.

Fig. 10.—Lavender Graving Dock, Rotherhithe, bears an excellent character for its convenience for docking; it is nearly at right angles, pointing slightly up the stream. But its character, as must be evident from former examples, is not dependent upon its direction, as from the particular set of tide away from it, in consequence of the tide setting from the point below on the same side to the opposite shore, it is left in an eddy, and consequently in slack water. It becomes for these reasons nearly similar in its conditions to a dry dock from a harbour, wet dock, or other still water; it therefore cannot be taken as an example in point, except so far as showing that there are particular localities and bights upon a tidal river where the direction of the entrance becomes of less importance. Even there, however, from the gates being placed so near to the river, the platform is carried beyond the wharf-line, and the necessity for the extension of piers to form a chamber has been involved. The object in this case, and with ship-builders generally, has been, no doubt, in placing their gates so close to the river, to get as great a depth of water as possible with the least amount of excavation, and to shorten the dock as much as possible, with reference to the expense of construction and the cost of land. In many situations on the Thames the existence of a road, or street parallel to and not far distant from the stream, has been the cause of an encroachment upon the river.

Fig. 11.—The Shadwell entrance of the London Docks points so much down the river as to form a very obtuse angle with the stream. The inconveniences that would otherwise result to vessels entering are, from various causes, obviated at this entrance, which, in fact, bears a very good character. One of these causes is, that the set of the flood tide is across the river, towards the opposite shore from the bight below the entrance, which is left in comparatively slack water, and is thus more at right angles with the flood on account of this particular set. The great width between the wings and the additional timber external works also afford great facilities, both when docking and undocking vessels. In this latter case the capabilities arise, like those at the Blackwall entrances of the West India Docks, from the judicious construction of the external works, which, however, have in both instances been, to a great extent, of subsequent formation, to obviate evils attendant upon the original form. It will at once be seen, by referring to the plan of this entrance as it now exists, that the conveniences for docking must have been much less before the external works were added. The timber pier added to the western or upper wing and the dolphin, form, with the northern portion of the wing wall, a line of direction pointing up the stream, which is the desirable direction for docking a ship upon the flood as she swings round, her larboard quarter coming in contact with the dolphin, and her starboard bow with the timber pier; she is thus prevented from tailing upon the shore on the upper side, as she would otherwise have done without these external works. The timber pier and dolphin on the lower side, perform the same office towards a vessel leaving the dock just after high-water, or being docked when there is no run of tide, and the south-west wind blowing her on to the shore below the entrance.

Much of the external wing wall on the lower, or eastern side, might have been dispensed with, had the direction of its entrance been more at right angles to the stream; it is, however, to be observed, that this direction would not have suited so well as the one adopted in the general plan of the docks. This entrance possesses an advantage pointed out in the instance of the Blackwall West India Dock entrance, from the great width allowing two vessels to pass.

Mr. Henry R. Palmer, the engineer employed to construct this entrance, published in 1828, a paper entitled "Report on the Proposed Eastern Entrance to the London Docks." In that paper Mr. Palmer says:—

> The taking of a ship into a harbour is required to be performed by the persons on board, and therefore the line of direction of the entrance is made as simple as her security from the wind and its consequences upon the water will allow. If the same force can with safety be employed to conduct a vessel to still water which has taken her to the mouth of it, the entrance will be performed with most ease.
>
> On the sea coast, the wind, and its consequences upon the water, constitute the principal forces to be contended with; the current of the water being comparatively of little or no value. On a river, the current of the water becomes an essential force, and that in proportion as the width of the river is diminished.
>
> It is obvious, that in both cases, it is preferable to make these forces subservient to our purpose, when it is practicable; and in the formation of an entrance to a harbour, or a dock, its position, direction, and form, should be such as to expose a vessel to as little action as possible not available to this object.
>
> The communication between a river and a wet dock, being through the medium of a lock whose limits but little exceed the dimensions of the ship that passes through, it is important that the water about the entrance to that lock should be, if possible, quiescent. If it have a running or turbulent motion, considerable labour is indispensably necessary to conduct a vessel within its narrow channel with safety; we therefore find that many of the public docks are provided with an external area, or basin, which is in fact a harbour, whose entrance is sufficiently wide to admit vessels during most weathers, while at the same time it has the effect of producing still water where that is required.

The adoption of this principle upon the Mersey and upon the Humber, on account of the heavy sea, is referred to; also the entrance to the Hull Docks, from the river Hull being formed in a recess or fore-bay.

The entrance to the Bristol Docks is referred to by Mr. Palmer, as a precedent for the case then under his consideration, where the entrance locks point down the stream and form an obtuse angle with the line of flood, and where, as Mr. Palmer says,

> Vessels go up with the flood tide only, and sail most generally at once into the entrance. When the wind is high and corresponds with the tide, a rope is sent on shore opposite the entrance, and being connected with the stern, the ship is easily presented to the lock, and is conducted into still water without risk.

It may be observed, that the extreme narrowness of the Avon necessarily induced such an arrangement.

The particular position of the entrances to the Runcorn Docks is next reviewed; those through the locks, Mr. Palmer describes as "parallel with the current," in reference to which he subsequently says:—

> Inasmuch as the vessels are not required to deviate from the direction of the current (*i.e.* to lie across it), not only is their introduction not made difficult by the motion of the water, but actually accomplished by it without risk.

Of the docks in the port of London, Mr. Palmer says:—

> When we contemplate the immensity of the traffic on the Thames, and the extent of accommodation afforded to the shipping, as compared with other ports, it is surprising that the entrances to the numerous docks should be less convenient than those on rivers whose navigation is more difficult. The entrances are all narrower, so that when the head of a ship arrives within its confined space, the stern is opposed to the action of the current.

Mr. Palmer then describes the entrances to the principal public docks, and the labour entailed at the graving docks on account of their position; in reference to this he says:—

> Now as the force of the water upon the ship is the same between the same parallels, the strength required to resist it will be the same, whether the head points up or down the stream. But it is argued, that if the entrance coincide with the direction of the stream (*i.e.* points down), the vessel may be forced against one of the side walls; and if no exertion be made to prevent such an effect, it undoubtedly would sometimes occur. But the vessel must be controlled by ropes at the stern, connected with a mooring, with less force in this position than when laid across the stream, and proportionally so in all the intermediate angles.
>
> Now if the entrance point up the stream, the vessel must be allowed to pass first above the entrance, and then be drawn towards it with a force greater than that required to resist her motion, as in the former case, because the motion of the stream is added to that of the vessel. Although the difference in the quantities of force and labour may not be great, the direction of the entrance, if narrow, should be guided by localities, such as the position in the river, the position of moorings, &c.

After stating that the above reasoning applied to narrow entrances, with the gates close to the river, inapplicable for the London docks, and referring to the want of width at most of the entrances, and the too close proximity of their gates to the stream, Mr. Palmer describes his plan for the Shadwell entrance, in accordance with the principles above laid down, and which was subsequently carried out under that engineer.

That entrance, however, by additional outworks, resolves itself into a very different form.

Fig. 12.—The entrance to the Grand Surrey Docks and Canal, Rotherhithe, points slightly down the stream; but from the local set of the tide from the opposite shore, its line of direction forms a very obtuse angle with the set of the flood. The effect produced by this is evinced in an external timber jetty and dolphin, off the upper side, by which a vessel is brought up upon the flood, in the right position in a line with the entrance, which is obviously insufficient as to width and length, when the set of the tide is considered, without these external works. The direction of this entrance has probably been influenced by local circumstances connected with neighbouring properties.

Fig. 13.—The Wapping, or central entrance of the London Docks is situated at right angles to the stream. Its direction in such a position must no doubt have been influenced by local circumstances. Its direction for the two purposes of docking and undocking is tolerably eligible; but there is a deficiency of length towards the river, and splaying out of the wing walls; dolphins have consequently been rendered necessary, but they are placed at such a distance out as to act similarly to the moorings at other entrances. There is a local eddy of the tide off this entrance, which makes its direction of less consequence. It is principally used for small vessels and barges.

The upper entrance of the London Docks, called the Hermitage entrance, is nearly square to the stream, or inclining slightly downwards. This entrance is not used; the principal trade is thus carried on at the lower eastern entrance at Shadwell, where large sums of money have been expended in the repairs and improvement of the immediate outlet or entrance.

St. Saviour's Dock entrance, on the opposite side of the river, points very much down the stream; but it is supposed by persons connected with the port, that its original formation was out of some natural inlet in the shore, outside the marsh wall, and, being only a tide dock, the direction of the entrance was not considered so much an object as in the neighbouring works. It would, however, be supposed, that the direction of the entrance to such a dock was a consideration of importance; but a comparison of this example with that of Limekiln Dock on the opposite side, and which has before been quoted as pointing acutely up the stream, shows how various have been the modes of treating these tidal constructions.

Fig. 14.—The St. Katharine's Dock entrance points slightly down the stream. There is at that spot a great depth of water, and ships are frequently docked after the tide has fallen, according to the judgment of the dock-master, whether it can be done safely. Under these circumstances the direction up, or down, is not of the same importance as in other examples. But an evil is entailed at these docks, by the small amount of width between the wing walls at the entrance; the particular locality must, however, have necessarily involved this, and the wings were probably projected and splayed out as much as the nature of the site would allow. The object here also was to dock ships quickly, and also upon a falling tide. For this the lock has three pairs of gates, the outer pair being placed as close to the river as possible. The fact of a public street here running parallel to the river, and the entailment of a swing bridge over the lock also prevented any great splaying out of the wing walls.

In reference to the general question it may be observed, that the foregoing examples resolve themselves into three classes—viz.. dry or graving docks, wet or floating docks, and building slips.

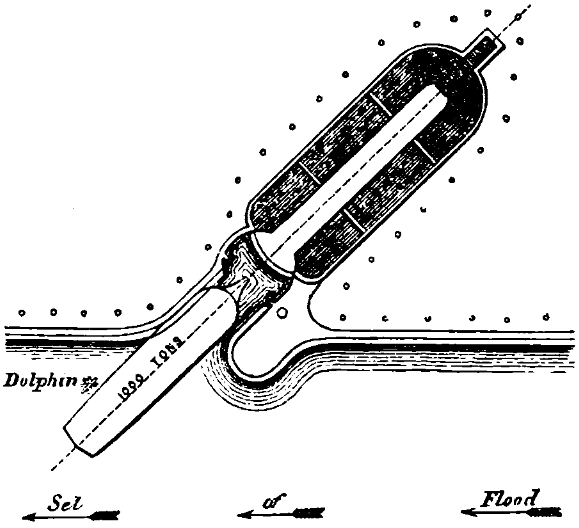


Fig. 15.—Proposed Graving Dock.

Fig. 15.—With examples of the first class, viz., the dry or graving docks, the great desideratum appears to be, to get them placed at such an angle to the course of the tide, that ships may be docked upon the flood with the greatest facility. There exists but one opinion among persons acquainted with the practice of docking ships upon the Thames as to what this direction should be—viz., an acute angle to the flood, or in other words, pointing upwards; some recommending (if the site will allow it) a direction nearly up and down the stream, others an angle of about 45°, with a dolphin half the length of the ship, above the entrance, to keep her from tailing on the ground if the wind should be on shore. It is obvious, that the greater the degree of obliquity, the more the river frontage will be required for each entrance. Ships are usually docked head first, and turned out stern first, from dry docks. If the line of direction of the dock points downwards, and forms an obtuse angle with the direction of the flood coming up, or is even square to it, considerable labour and difficulty are involved in heaving down the stern of the vessel against the tide, so that she may be in a line with the dock. This very force of the tide is taken advantage of, and assists in placing the ship in a proper position, when the dock points up the stream. This direction is equally advantageous in undocking vessels from dry docks, as the almost invariable practice is to turn them out stern foremost; thus the vessel's quarter first meets the tide, is carried upwards, and her bow is brought against the tide in the most convenient position for mooring her.

Fig. 16.—With wet or floating docks the case is altered as regards undocking, and this has been met by the greater width at the entrance, formed by the spreading wings on either side. The circumstances attendant upon a ship entering are precisely the same as when approaching a graving dock; but in undocking a loaded vessel from a wet dock, she is brought out head first. If the entrance pointed up the stream, the vessel's bow would require to be kanted up immediately she met the tide; this would cause considerable inconvenience to an outward-bound vessel, which should swing with her bow downwards. Ships are frequently taken out with their sails set on a fair wind, and in such a case, a fault in direction would be still more severely felt.

A direction nearly square to the stream is recommended by some authorities as the best for wet docks; others recommend an acute angle of about 60° with the flood, as shown in fig. 16. The amount of this angle, however, becomes of less importance if a great width is obtained at the entrance, by rounding out or splaying the wings. The upper wing, or pier-head, should be formed to a flat curve, or even a straight line, so as to present a favourable angle to the tide for a ship entering. The lower pier-head, or wings, should be rounded, or splayed off very much, to admit of a vessel, whilst going out, turning with her head upon tide; it should also project about 30 or 40 feet further out than the upper pier, in order to cover the entrance and render it more accessible.

The great variations that exist in the examples on the Thames, are attributed by persons interested in shipping, to the importance of the subject never having been sufficiently considered, and also to want of capital and available space on the banks of the river. The positions of dry docks have, no doubt, in many cases been regulated, irrespective of any other considerations, simply by the particular arrangement of the ground in which they have been constructed, the direction of the first dock regulating that of its successors, which were built parallel to it.

The great desideratum with docks of each description appears to be to obtain as great a width as possible at the immediate entrance, and the larger this is, of less importance does the angle become. The width is considered by many shipwrights as the most important element of consideration; with a great width, a small amount of heaving on one purchase or the other will correct a great amount of error in direction. A ship, when being docked at such an entrance, first touches the upper pier, and her stern must then be drawn down, to bring her in a line with the entrance; the greater the width therefore the better angle for leverage, or purchase, will be obtained. It is also a great desideratum to afford plenty of room to pilots, whether they happen to be taking vessels into or out of wet docks.

As regards building slips; their direction appears, like many instances of graving docks, to have been influenced, on the banks of the Thames, and perhaps also on other rivers, by internal local circumstances connected with the tenure and division of properties; the construction of one slip has also governed the direction of those in the immediate vicinity, which are generally parallel to the first. This direction, it will at once be seen, cannot be so important as in the instance of graving docks; still, however, as vessels are launched stern foremost, and usually about the same period that admittance into graving docks takes place, the same reasons that influence the direction of one would affect also that of the other: that is, a vessel being launched, and her stern carried up, her head would be brought up against tide, which is the most convenient position for mooring her—consequently, a position slightly inclining up the stream, appears desirable; practically, a direction square to the stream, answers the purpose, and is the best, having reference to the value of a river frontage.

The directions herein referred to as apparently the most desirable, are—an angle of about 45° pointing up the stream, for Graving Docks; an angle of about 60°, in a similar direction, for Wet Docks; and a right angle for Building Slips.

No one knows better the importance of the subject than the shipwrights and pilots, and with how much less risk vessels may be docked at some establishments than at others. The operation of docking a valuable ship, with perhaps but very few inches to spare, is at all times a nervous process, and they who are in the constant habit of conducting such operations can give the best practical opinions on the subject.

The opinions of Mr. Dowson, Mr. Knight, Capt. Bond, Capt. Evans, Mr. Kinipple, Mr. Green, Mr. Haslip, and Mr. Wigram are given in letters to Mr. Redman, from whence the following extracts are made:—

Mr. Dowson says:—"I have read with some attention your remarks on the several wet and dry dock entrances on the river Thames, and also examined the sketch you sent me (fig. 16).

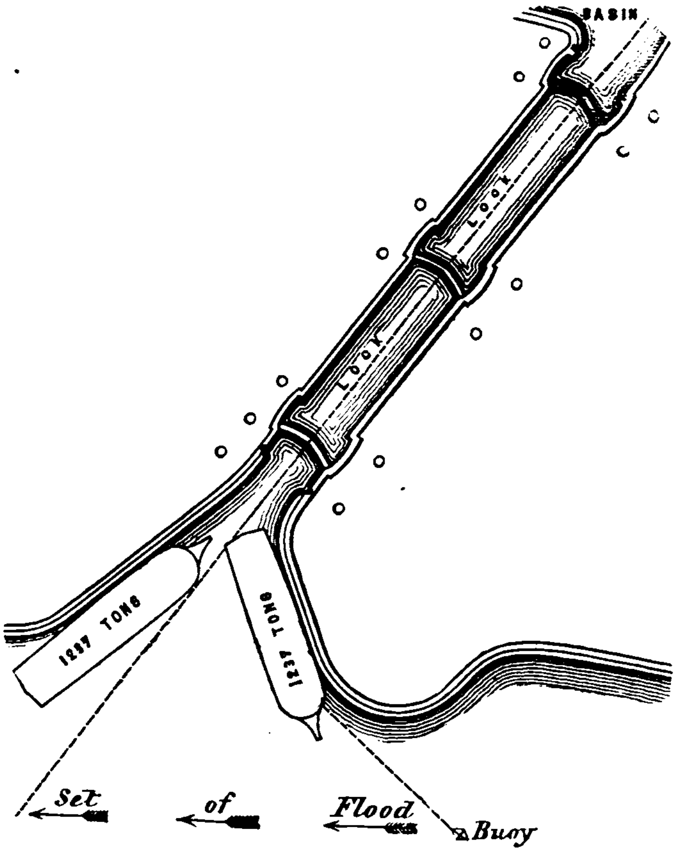
I feel a strong conviction that a great error has been committed in the construction of most of them. My opinion is, that the entrance should stand in a line, nearly up and down the stream; so that when a ship comes alongside the jetty, for the purpose of docking, the bow would easily enter, and much time and labour be saved in heaving the stern down against the flood tide.

The entrance into my dock and Duke shore are both very bad, and the evil is increased by the flood tide running particularly strong.

I admit that, in wet docks, where the entrances, or jaws outside the dock gates, are generally so wide, the evil is not so severely felt; but I remember when the West India Docks, Blackwall end, were first made, the danger for loaded ships was so great, that it was found necessary to extend the upper pier in the manner I prefer.

I attribute the bad entrances to want of judgment, want of capital, and perhaps of space on the shore of the Thames."

Fig. 16.—Proposed Wet Dock.



Scale to Figs. 15 and 16, 1 Inch to 100 Feet.

Mr. Knight says:—"With reference to the general question, I think it may be presumed, that the entrances to the public dock establishments have been constructed in a manner deemed most eligible (having reference to the set of the tide), for the purpose of docking loaded ships, and that the construction of the graving docks has been more particularly determined by internal considerations, as regards the ground on which the docks have been formed, although the entrances to the public docks may, in some cases, have also been influenced by similar considerations. As regards graving docks, it is to be observed, that they are comparatively but seldom used, and that the slack of tide is generally taken advantage of to dock the vessels.

The entrance to the East India Docks, pointing upwards to the stream of tide, is probably the best direction which could be given to it, as the stream of tide runs rather strongly across it, and until the introduction of steam-tugs, large vessels would occasionally hang until the tide slacked; now by means of a quarter rope, the stern can be hove down the stream, when the head is pointed to the lock, and the vessel brought into the line of direction of the lock without the vessel being brought to a right angle with the stream.

The following are the observations I have received from Captain Bond of the East India Docks, and Captain Evans, of the West India Docks.

Captain Bond says:—'I think the East India Dock entrance has an advantage over the other docks, in having plenty of room in the river, and the tide never running hard, except when it blows with an easterly gale; and now we have the use of the tug to keep the ship's stern down, we can dock immediately we have water; before we had tugs, if the wind blew hard, the large ships would hang until the tide slacked.'

Captain Evans says:—'I am decidedly of opinion that the Blackwall entrance into the West India Dock is by far the best constructed in the port of London, its bell mouth giving sufficient room to kant the largest vessel that ever was docked in the port, and that without the assistance of either a quarter-rope or that of a steamboat; although it must be admitted that the length of the lock is in some measure an impediment to the quick dispatch of business. Had the basin been carried about 70 feet further out, and the bridge kept within the lock-gates, I should then consider it a perfect model for an entrance; and I am of opinion, that all dock entrances should rather incline upwards with the set of the tide, which would make them easier of access upon the flood, as all vessels of any magnitude should be brought with their head upon tide, to enter with safety where there is a strong current; but where an entrance is formed in an eddy or counter tide, which is to be found in various parts of the Thames, I would recommend that the lock should be placed at right angles with the flood, in the stream; and when there is a strong tide immediately across the entrance, it should incline upwards, with the lower pier-head carried about 25 feet or 30 feet further into the stream, than the upper one, as that would cause a partial eddy, and thereby make the entrance easier of access, as well as facilitate the docking.'

The great width of the Blackwall entrance of the West India Docks is advantageous as regards the undocking, as it admits of the inward vessel being within the entrance, and leaves sufficient room for the outward ship to pass out. In this respect the Shadwell entrance of the London Dock may possess the like advantage."

Mr. Kinipple says:—"I have long paid attention to the different entrances into the various wet and dry docks on the banks of the river Thames, and consider that an angle of 45°, pointing up the stream to the set of the tide, is in every way the most eligible; for instance, Limehouse Bridge Dock, which I now superintend, from being nearly at right angles to the stream, and from the set of the tide being so strong, particularly at the height of the springs, when it is usual to dock large ships of heavy draft of water, it is very difficult to square the vessels and to place them in position, without a large warp from their quarter, to heave on, with a great number of men, assisted, within the last few years, by steam-power. This process causes so much delay, that the vessel frequently cannot be hauled a-head until nearly high-water, and then sometimes with only from three to six inches water to spare. This, it will at once be seen, involves great risk—indeed so much so, that I could name several ships that have grounded in some dock entrances, and have overhung the sill of the gates from 20 feet to 50 feet, owing entirely to the above causes. These difficulties would be entirely obviated if the docks were excavated to the above-named angle, because the pilot could keep the ship off in deep water, opposite the dock, until fifteen or twenty minutes before high-water; and when ordered to bring her to (having every rope already prepared), he would be enabled to make more certain of getting her safely in and secured than at present, when so much labour and care are required.

With regard to wet docks, I consider nearly the same angle to be equally advantageous for bringing to and docking a large number of homeward-bound ships, in one tide; but with this difference—for undocking, the lower pier-head would require to be carried out nearly at right angles, projecting about 40 feet or 50 feet, and rounded off; which would so widen the entrance, that ships when being undocked, when they always come out head first, may, provided they want to go down the river, that is to say, being outward-bound, make a warp fast to the said pier-head, and with another taken off to a buoy, laid out for the purpose at some convenient distance, be enabled to swing with the tide, and at once proceed on their destination."

Mr. Green says:—"I have no hesitation in stating that the entrances of dry and wet docks should point up, and not down the stream."

Mr. Haslip says:—"My opinion is, that dry docks pointing up the stream on the river Thames, at an angle of 45°, may answer every purpose.

With respect to wet docks, I consider that they ought to be at right angles, with a sufficient entrance.

Respecting building slips, the angle or run is always governed by the river wherein a new ship is about to be built and launched."

Mr. Wigram says:—"I fear you will not arrive at any definite rule on the subject; but it appears to me, that all dock entrances should point upwards; the degree will depend on whether the tide runs strong, or not, at the point or part where the dock is to be constructed. You are of course aware, that the set of the tide alters greatly in velocity at different parts of the river; but, in my opinion, the stronger the set or run of the tide may be across the dock entrance, so much more should it point up, for the convenience of using the dock."

Mr. Redman begged to acknowledge, and to offer his thanks for the assistance afforded him by the proprietors of docks and the officers of dock companies on the river, and he requested it might be understood, that when he had designated a dock entrance as "bad," or "indifferent," it was not meant invidiously, but that from circumstances, or locality, it was not so favourably situated as others which he had especially denominated as "good."

He then referred to the drawing of the Blackwall entrance of the West India Docks (fig. 2), and stated, that there vessels could not be brought in so readily as had been originally intended; but they were brought up head upon tide, and were warped in; also to the Shadwell, or lower entrance of the London Docks, (fig. 11), which although pointing down the river, and forming an obtuse angle with the line of direction of the flood, was yet, by the additional works at the entrance, resolved into a very advantageous form; for the upper wing, with the timber jetty and dolphin, formed a rather acute angle with the particular set of the flood, and was therefore advantageous for docking vessels; the lower works formed at the same time a good direction for vessels departing, and being brought up head upon tide. Viewing the particular outline of the London Docks, it was obvious that a direction pointing up the stream would have entailed so bad an angle of communication with the docks, and so awkward a turn for the vessels, as to render such a position next to impossible.

Fig. 14 was a plan of the St. Katharine Dock's entrance, where the direction, as had been before explained, was rendered of less importance by the great depth of water, which allowed vessels to be docked after high water. At such a site as this, a wide entrance was almost unattainable, from the great value of the land.

Figs. 15 and 16 were drawings of what appeared from evidence to be good forms for entrances: the former for a graving dock, at an angle of 45°, with a projecting pier on the lower side; and the latter for wet docks, at an angle of 60°,—the upper wing turning at an angle of 45° upwards, and the lower at a similar angle downwards, together with a projecting pier. Such an entrance would afford equal facilities for docking and also for undocking; a double lock was also shown.

There was another question, which however had not been touched upon in the paper—viz., the best angle for a wall along which a vessel would pass to enter a lock: for instance, upon a canal, what angle would give the least amount of resistance to a boat entering a lock? This, however, was not of importance in reference to the present inquiry; still it was an interesting question, well deserving the attention of the Institution. To illustrate the notice as to docking vessels, he might remark, that at Messrs. Young's establishment at Limehouse, where a large government steam frigate was now being fitted, it was found necessary, in docking that vessel, to connect a warp from her starboard quarter to a capstan at the West India Dock in order to keep her in position, on account of her great length.

Remarks made at the Meeting after the Reading of the foregoing Paper.

Mr. Walker praised the talent and industry displayed by Mr. Redman, in collecting the examples shown by the drawings; the majority were matters of fact, and the compiled drawings (figs. 15 and 16) were theoretical examples, deduced from reasoning upon the facts now laid before the meeting. It must be borne in mind, that from the value of land in the vicinity of London, and more particularly of river frontage upon the Thames, the direction of the entrances must have been, to a great extent, regulated by local circumstances. For instance, the Shadwell entrance to the London Docks could not have been differently placed, because, from the position of the docks, any other than a direct entrance would have created greater inconvenience than any facility of entering could have compensated for. At the same time, from a local eddy, there was slack water in front of the entrance.

The entrances to private docks were even more governed by locality, and the influence that might be exercised upon the neighbouring property; because in the case of an oblique entrance, the vessels in entering or leaving the dock, would traverse and occupy the frontage on either side of it. There was no doubt of the theoretical correctness of making the entrance to point obliquely up the stream, if it was situated in the run of the tide, and the locality permitted it; but where there was not any run of tide, or an eddy existed, or where a deep fore-bay could be formed, the entrance might be quite as advantageously placed at right angles with the stream. It must, however, be considered, that in entering, when a vessel came up with the tide, it made fast, and then swung. In the case of the right-angle entrance, the tide striking upon the broadside would have a tendency to drive it upwards; whereas the tide striking a vessel obliquely, would have less power upon it, and less force would be required to draw it across the tide into the dock. When the mouth was widened, and was shaped as in fig. 16, the current would assist a vessel, and with a judicious arrangement of buoys, vessels would be docked very rapidly; and in such cases, if the locality permitted, the angle pointing upwards was advantageous; but where still water existed, from a bend in the river, or the tide was sluggish, a rectangular entrance would be found as useful, and in general would accommodate itself better to the property upon which the dock was situated.

Mr. Rennie thought the author had taken very judicious views of the subject; it was, however, evident that engineers must be governed by local considerations, and the velocity of the tide. The late Mr. Rennie had designed several entrances pointing up the stream, and with the widened mouth like fig. 16; but in practice, it had been found necessary to adapt them to the locality, and with reference to the adjoining properties. Mr. Rennie had arrived, by calculation, at certain results, and had determined that an angle of 45° pointing upwards was the best for a dock entrance.

Mr. Sidney Young felt that it would be ungracious on his part were he to withhold, on the part of those whose avocations, like his own, would make them practically the recipients of the benefits to be derived from such a discussion as the present, his best acknowledgments to his friend Mr. Redman, for the careful investigation he had undertaken, and to the meeting for the attention that had now been given to the subject.

To all the remarks and suggestions he had heard from Mr. Redman, in reference to the most convenient "angle to the flow of the tide" for placing dry docks, he gave his unqualified concurrence; nor did he think that any one who had opportunities of forming a practical opinion on the subject, would for a moment question their correctnesss. No better evidence of the important service now rendered could, he thought, be afforded than the great variety of the angles formed by docks in the Thames, as so ably exemplified in Mr. Redman's diagrams—proving, as it appeared to him, that this question, important as it was, had hitherto engrossed very little attention. The constructors of these entrances were, in many instances, probably too much restricted by local circumstances to allow of their placing them at so acute an angle as was now proposed; still, in the instance of dry docks, they might in almost every instance at least have adopted the same direction, with an angle so small as not perceptibly to affect the general distribution of the property. This would frequently increase the facility of moving vessels into and out of dock, especially in those wide situations which were exposed to a particularly strong set of tide, to an extent that could scarcely be appreciated by those who were not in the constant habit of superintending such operations.

With respect to the entrances of wet docks, the opinion of an experienced pilot should be held of more value than any other; but he was led to believe, from the remarks made by some gentlemen present, that the subject had been too much regarded as though vessels had only to be docked, and not just as often undocked whilst loaded. For the first purpose he was still of opinion that Mr. Redman's plan was equally applicable as to dry docks; but as undocking had also to be considered, he thought practically a right angle might be found sufficient, with a lower wing boldly splayed out, as in fig. 16, which frequently afforded the pilot an opportunity of setting sail before meeting the tide. Without such a provision the vessel's head would be carried up the stream, and the necessity of swinging her round would be involved. This would at all times be attended with great inconvenience, and, in comparatively contracted navigation, with much risk. In all cases, Mr. Redman's proposed dolphin on the upper side would undoubtedly be most advantageous. In reference to H.M. steam-frigate *Termagant*, now in their establishment, it was true that, from her great length and the slight acuteness in the direction of the dock, the action of the flood presented great impediments to placing her in position, and afforded therefore a powerful illustration of the advantages that might have been derived from Mr. Redman's proposed conditions for the directions of docks, and the addition of the dolphin, which would have prevented her being carried up "fore and aft."

Mr. T. B. Spence confirmed the statement relative to Messrs. Tebbutt's establishment, Limekiln Dock, and the general views of the paper. In their yard, a dock pointed up in nearly the direction proposed by Mr. Redman for dry docks, and it was found that ships were easily docked in it, with a moderate number of men; certainly with more ease than if it were at right angles to the stream. It was probable that the direction of this particular dock had been more influenced by the conditions of the property, than the fact that such a direction was the best for docking; and he explained, as the reasons for the direction, that it had been formerly a building slip, and the position of another dock had induced this particular direction to get greater length. Pilots had always found that when ships were launched from it, they had been easily brought head upon tide. Since it had been deepened and altered into a dock, it had been found that ships entered easily, and in going out came almost directly head upon tide. Where the form and position of the yard would admit of it, a direction pointing up the stream increased the facility of docking, and was therefore to be recommended for a dry dock. The conditions of the property would not, however, always admit of this; but the introduction of steam-power had lessened the inconveniences attendant upon docks at right angles to the stream, more so, however, in some cases than in others.

As regarded wet docks, Mr. Spence stated, that a direction pointing upwards likewise facilitated the introduction of loaded vessels, but that he considered a pilot the best authority on this subject; that, for undocking, it was necessary that the lower pier should point down, as was provided for in fig. 16; as, unlike ships coming out of dry docks stern foremost, and therefore readily swinging head upon tide, ships came out of all wet docks head foremost; consequently, unless the lower wing pointed downwards, the ship's head, in coming out on the flood, would have a tendency to drift upwards, instead of coming round head upon tide.

The dock in their yard which had been referred to, was rather embayed, as a reference to a map of the river would show; this increased the facility; but still he was strongly of opinion, that the convenience attached to it was chiefly due to its direction in reference to the stream. One great object in forming the entrance to a wet dock was to have it sufficiently wide, with diverging piers, so that when the ship was sheered to, her midship part might come against the upper pier, whilst her bow was at the lower side; she would thus enter readily. For this reason the direction of the lock did not appear to him so important as the form of the outer entrance. The Shadwell entrance of the London Docks, since the addition of the timber jetty on the upper side (pointing upwards), had acted admirably. Viewing fig. 16, a practical difficulty might present itself—viz., of entering one ship while another departed; but this was seldom, if ever, attempted. The outward-bound vessels generally left as soon as there was water for them, and homeward ships did not generally get up until towards high water. If a loaded ship came up whilst another was going out, she was obliged to keep out of the way of the entrance until the outward-bound vessel was clear.

Mr. Cubitt, V.P., said, the object was to get as many vessels as possible in and out at high water, in order to take advantage of the depth of water and the slack tide, which rendered less power necessary. For the purpose of obtaining still water, a deep and capacious fore-bay was sometimes made, as it was found materially to facilitate the entrance of the vessels; and whenever the locality permitted the formation, and means could be adopted for preventing it from silting up, it should be adopted. The examples which had been brought forward by Mr. Redman were useful, showing as they did, that although the trade of the port was carried on, practically, with efficiency at all the docks, still from the particular direction and conformation of some entrances, ships were docked and undocked much more readily at some than at others.

Mr. May drew attention to the entrance of the Ipswich Docks, constructed from the design of the late Mr. H. R. Palmer, and where he had free scope to do as he pleased; yet he had designed it at an angle pointing down the stream, like the Shadwell entrance of the London Docks. This appeared contrary to the received opinion, and yet the work was very successful and answered the purpose perfectly. The entire width of the river, at high-water, was about 150 feet, and the entrance was so placed, that a vessel coming up with the tide went directly into the dock without swinging.

Mr. Walker said, it must be evident there were practical difficulties occasioned by a downward direction being given to an entrance; they were, however, in some degree compensated for, by the formation of a deep recess or fore-bay, in which a vessel would be out of the run of the tide. This gave great facility for docking a vessel, which under all circumstances was a somewhat hazardous operation. In the case of Ipswich, it appeared that there was a certain difficulty to contend with, and, like a skilful engineer, Mr. Palmer had chosen the simplest method of overcoming it. In so narrow a river, it would have been difficult for the vessels to have swung, and therefore he preferred their entering directly into the fore-bay, in doing which they would be aided by the tide.

Mr. Murray said he had discussed this matter at some length with Mr. Walker, when examining the plan for the proposed docks at Sunderland, and being guided, in a great degree, by the opinion of the shipowners and pilots, it was settled that the entrance should be placed acutely up the stream, and that the exit should be the reverse. It was a great object at Sunderland to enable as many vessels as possible to enter and to leave the port on the tide; for which purpose a tidal basin of three acres in extent, with tide-gates, was intended to be constructed, for the vessels to enter and bring up in; from thence they entered through wide gates into the main dock. The tidal basin became in fact a great lock. The object was to get from three hours to three hours and a half for docking vessels on each tide. In the Thames, from ten to fifteen minutes were occupied by each vessel in passing a lock, so that the amount of accommodation was in fact restricted; but in other places, where the system he had described was followed, greater facilities were afforded. For instance, at Hartlepool, he had counted fifty-five vessels leaving in a tide, and he had heard of seventy vessels leaving in the same time. The forms of widened entrances, shown by Mr. Redman, approximated to the system Mr. Murray had recommended; he would present to the Institution a description and plans of the dock at Sunderland, as soon as the works were completed.

Mr. **Redman** remarked, that in the case of the Ipswich Docks, the particular direction was obviously entailed by the peculiarities of the site. The entrance was from an artificial cut, which was so narrow as not to afford space for swinging; and the entrance was, as Mr. Walker had explained, away from the channel, in an artificial recess or fore-bay, which created dead or slack water, and neutralised to some extent the effect entailed by an obtuse angle with the line of flood.

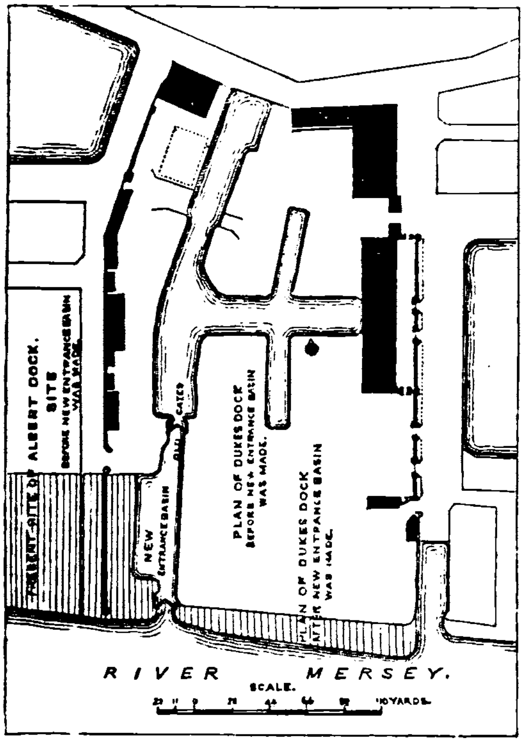


Fig. 17.—Duke's Dock, Liverpool.

Mr. **Cubitt**, V.P., quite agreed, that however desirable it might be to place the entrance pointing upwards, as had been suggested, and had been so frequently and successfully practised, still locality must in general govern the engineer in laying out his plans, and he must exhibit his skill, not only in the construction of the work, but, if possible, in the selection of a spot where an eddy of the tide or slack water could be obtained, and which at the same time possessed the other requisite qualities for a dock. Mr. Cubitt had recently put in practice at the Duke's Dock at Liverpool (shown in fig. 17), the system as proposed by Mr. Murray for the Sunderland Dock. A pair of gates had been adapted to the entrance of the outer dock, which had thus been converted into a tidal basin, whence the "trows" and other vessels could be passed into the dock with great facility, thus materially adding to its advantages. He believed that principle was generally found to answer, and he would advise its adoption wherever there was an extensive trade.

Mr. **Murray** exhibited a plan and enlarged diagram of the docks in progress of construction at Sunderland, of which he promised to give a detailed account on their completion. The original intention had been to leave a portion of the old pier, in order to form two entrances; but it was subsequently decided to remove all the old work, in order to afford as large a space as possible for the vessels to bring up and swing by their anchors, or to be towed by steamers into the tidal basin, whence thirty at a time would enter the half-tide basin and thence into the dock. By these means a very extensive trade could be accommodated, as was indeed necessary, when as many as 150 to 160 vessels required to leave on a tide.

At Hartlepool the lock was not used for passing the vessels; the gates were left open for an hour and a half at the top of the tide, and the vessels were towed by steamers directly into the dock.

Mr. **Rendel**, V.P., agreed with the commendations bestowed upon the industry and talent displayed in the paper; but he did not accord with the opinion, that any general rule could be laid down to suit all cases. Many points required careful consideration; the velocity and rise of the tide, the local currents, an eddy caused by a bend of the river, the width of the channel, the nature of the trade, and the size of the vessels would all influence the plans of an engineer, whose skill and talent should be displayed by his meeting and combating successfully, the natural difficulties. For this reason few entrances were similar, and it was evident that in practice it had been found impossible to establish any definite angle. If that were possible, one set of drawings would suffice for all cases, and the exercise of skill and judgment would no longer be required.

Mr. **Scott Russell** confirmed Mr. Rendel's views; the science of engineering had not yet arrived at such definite conclusions, as to enable given rules to be laid down for a subject embracing so many considerations. It was evident from the examples brought before the meeting, and from many others which were familiar to all engineers, that it was not possible to lay down any undeviating principle; but in comparing the examples, and considering local peculiarities, he thought it might be assumed that a step towards it had been arrived at. If, as was stated, facilities for docking a loaded ship upon the flow of the tide were given, by having the entrance pointing upwards at an angle of 60°, and for undocking a loaded vessel on the turn of the tide, by an entrance pointing at the same angle down the stream, it must be evident that the wide entrance, with the piers at opposite angles, as proposed in (fig. 16), would be advantageous wherever sufficient ground could be obtained; and if a deep fore-bay could be constructed so that it would not silt up, it would afford additional facility, as a vessel in entering would swing and come in without interfering with a vessel going out. This was only the first step to a tidal basin, which appeared to be a great convenience for an extensive trade. This however presumed that the docks were upon a wide river, and where land was not of very great value; but in a narrow channel, where the stream or the tide set heavily across the entrance, and where the value of the land on the banks was as great as in London, even that rule could not be observed, and the engineer must be guided by local considerations, in order to afford the greatest amount of facility at the least cost.

Mr. **Redman** expressed his regret, that Mr. Rendel had not been present when the paper was read, and that he had only partially heard the discussion upon it. It had certainly not been his intention to assume that there were certain angles for dock entrances applicable to all sites; on the contrary, he had distinctly stated, that all the circumstances of position, set of tide, &c., must be carefully attended to. The examples he had given for proposed entrances, were intended as examples of combinations of the good qualities of the different entrances on the Thames, and were laid down in accordance with the opinions generally entertained in the port of London, among ship-builders, pilots, and dock-masters, whose practical opinions upon such a subject were, he conceived, well worth attention. These examples, therefore, were only recommended where the site and the set of the tide would admit of such constructions. Neither did he understand the tone of the discussion to lead to the conclusion that one angle was suitable for all situations; for, on the contrary, the different attendant circumstances appeared to have been considered by the various speakers.

He could not agree with Mr. Scott Russell, that possessing a well formed fore-bay, the direction of the lock, or inner portion of the entrance, became of minor or secondary importance. It was necessary, having the upper wing pointing upwards at the angle shown, that the lock should be in the same line, in order that the vessel might be easily drawn in. Mr. Russell had also fallen into error in assuming that a vessel was undocked upon the ebb; if that were the case, the direction of the lower wing would be unimportant, as immediately the vessel's bow met the tide she would swing round into the desired position; such however, was not the case, as vessels were undocked upon the flood, and it was necessary to form the lower wing in such a manner, that by means of the warps attached to her larboard bow, as she left the entrance, she would be brought head upon tide, and swing in the requisite direction. If the lower wall pointed considerably up the stream, the labour in counteracting the tendency of the tide, and hauling her bow down stream, would be much increased. It might likewise be observed, as Mr. Russell had instanced, that a position where the tide set very strongly across the entrance, was the exact site for which such an entrance as that shown by fig. 16, was adapted; the reasons for this had before been given, and were, in his opinion, quite obvious.

Mr. Brunel accorded generally with the views expressed by Mr. Rendel; he thought, however, that although the Institution might not be able to fix any rules or principles, which would evidently have an injurious tendency, the meetings were extremely useful, in making the profession better acquainted with what had been done, and in affording opportunities for discussing the principles of construction and the results of certain works.

It did not appear, that any dock entrances had been actually constructed of the form and at the precise angle laid down in fig. 16; now there did appear to him certain disadvantages, attendant even upon that plan. Suppose, for instance, a rapid flowing tide, with the wind setting directly up the stream and across the entrance; he apprehended there would be much difficulty in bringing the vessel to, swinging her and hauling her down into the entrance. Therefore, wherever from the prevalence of certain winds, such a combination of circumstances would be liable to occur, no engineer would think of employing that particular form; but would endeavour to find a position for the entrance where an eddy existed naturally, or he would form a fore-bay to produce still water, in order to facilitate the entrance of the ship. It appeared also to him, that there would be considerable difficulty in bringing a vessel so directly against the tide, upon leaving, as was proposed. The examples that had been given were undoubtedly useful; it would, however, be dangerous to assume that they afforded sufficient data whereon to base arbitrary rules for cases which, to superficial observers, might appear identical; but the civil engineer, whose province it was to examine, and weigh maturely, all the considerations involved, would see at once that every case must differ, and his skill and experience must be exercised in meeting and providing for all the local difficulties. It appeared therefore certain that in this, as in almost every other branch of engineering, no arbitrary rules could be laid down to meet all cases, and the civil engineer must be guided by his scientific and practical knowledge; the great use of examples being to enable him to avoid a repetition of the errors which had been found to exist and to cause inconveniences in works previously executed.

Mr. Redman, in answer to Mr. Brunel, said there was no entrance on the Thames of the exact form laid down in fig. 16; but such a fact, would not, he conceived, be urged as an objection againt its adoption where circumstances would permit it; many entrances on the Thames possessed some of its individual features, —for instance, the lower wing of the Shadwell entrance of the London Docks (fig. 11), and the upper wing of the Blackwall entrance of the West India Dock (fig. 2); there were also numerous examples, shown in the drawings, where vessels were docked and met the tide, when leaving in the manner proposed. The consideration of the occurrence of a rapid flood, with the wind setting up, induced him to give the preference to an angle pointing up-stream, as being most available under such circumstances, and he believed that to be the general opinion of persons well acquainted with the system of docking vessels in the Thames. It was true, however, as had been shown in the paper, that diametrically opposite opinions had been entertained, which had induced constructions very different to those now proposed, but which, by the addition of supplemental outworks, resolved themselves very nearly into the form laid down in fig. 16. The object in pointing the lower wing down-stream, was to bring a vessel, when departing, head upon tide. It had been already shown, that there were numerous examples in the Thames, where vessels when outward-bound met the tide at a great disadvantage, from the lower wing not affording such requisite facilities; a vessel leaving such an entrance as that under consideration, with a warp attached to her larboard bow, swung immediately into the requisite position; but if the entrance pointed up, or was even square, she would have to swing completely round with a chance of tailing upon the ground. He could not understand the objection to the proposed forms, which he thought had been misunderstood, and if a vessel could not arrive in, or leave an entrance so formed, upon a river circumstanced like the Thames, it was difficult to imagine the particular conformation which would provide the requisite facilities. The fact of laying down general principles for cases of engineering such as these, founded upon the experience of the past, due consideration being given at the same time to all the attendant circumstances, would not, he conceived, lessen the duties of the engineer, as the variations in the level, the site, the foundation, and the construction, would still demand the exercise of his judgment and experience, as well as his constant services, as heretofore.

BELL ROCK LIGHTHOUSE.

(With an Engraving, Plate VIII.*)*

Sir—I gladly embrace the opportunity afforded me by your excellent *Journal*, to correct the errors in Sir John Rennie's statement in your number for March last (p. 77), as to the Bell Rock Lighthouse, which statement, while professing to be a reply to a letter which I addressed to him on the 26th December last, is in reality founded upon a long correspondence between Sir John Rennie and myself, which followed upon that letter. I should have been most willing to leave the public to form their opinion of the matter in discussion from that correspondence itself, which, representing both sides of the question, affords, I submit, more trustworthy data than the *ex parte* statement of Sir John Rennie, in which, I am sorry to say, by omitting some facts, and misrepresenting others, he endeavours to support his extraordinary position, that the late Mr. Rennie *designed and built* the Bell Rock Lighthouse.

I have, therefore, to request that you will publish at length the whole of the correspondence that has taken place, to which I refer all who are interested in the matter. On this, as I have observed, I should have been willing to rest the controversy; but certain statements of Sir John Rennie, which require to be exposed, compel me to trouble you with some preliminary remarks.

In the first place, then, I have to observe, that throughout the whole of Sir John Rennie's statement, I can trace an evident tendency to withhold what might seem to identify Mr. Stevenson with the original design and ultimate execution of the work, and to magnify, to the fullest extent, every fact that appears to support his own view,—a spirit which ought not to have a place in such discussions, and which has led Sir John into sundry errors; but, as I do not feel justified in making such a statement without proof, I must trouble your readers with the following instances.

Sir John says, that "on the 23rd December 1800, Mr. Stevenson wrote a Report to the Commissioners of Northern Lighthouses, wherein, after describing the locality and characteristics of the Rock, he proposed *two* designs for a Lighthouse,—one of cast-iron on pillars, and another of stone." He afterwards goes on to say, that the late Mr. Rennie was applied to by the Commissioners, and visited the Rock in August 1805, and, "on the 30th December following, made a long Report to the Commissioners, embracing the whole subject; and, after commenting at length upon the various designs submitted to him, *decided upon recommending* a stone Lighthouse; and observes, that as to the practicability of erecting such a work on the Bell Rock, I (Mr. Rennie) think no doubt can be entertained, with such examples before us as the Tour de Corduan and the Eddystone."—The tendency of these statements is undoubtedly to show, that Mr. Stevenson's mind was not made up as to the best structure, and that Mr. Rennie not only *settled* that it should be of stone, but decided that it was *perfectly practicable.* Now, Sir John states that Mr. Rennie's Report "embraced the whole subject," but he has suppressed the fact, that Mr. Stevenson's embraced the whole subject also; and further, he has stated that Mr. Stevenson proposed *two* designs, when, although he mentions historically that *three* plans had occurred to him, he proposed only *one for adoption*, viz. a stone tower, the practicability of which he, at the same time, pronounced to be certain. In proof of this I refer to the Report itself, dated 23rd December 1800, in which Mr. Stevenson first details minutely the characteristics of the Rock. He then describes the different works that had been executed at the Eddystone, the Longship, the Smalls, the South Rock, and the Tour de Corduan, all of which, excepting the latter, he had visited, in order to inform himself as to what had been done in similar situations. He then proceeds to say, "that until the moment he landed on the Rock, he was uncertain if a building of stone was applicable;" and that, previous to his survey of it, and in ignorance of its size, he had thought *first* of a floating light, and *secondly*, had made a design for a Lighthouse on iron pillars; but that an inspection of the Rock had convinced him of the practicability of an erection of *stone*, which, and which *alone*, he accordingly recommended, as the following extracts prove. His inspection of the Rock having satisfied him that the situation was more exposed to be acted on by any floating body than he at first imagined, he says, that "he found it difficult to suppose any set of pillars of adequate strength to resist the force of a loaded vessel, which must render the pillar-formed construction very uncertain." That the risk attending the exposure of the metal to the action of the sea ought not to be wholly overlooked "*in giving preference* to a circular building of stone;" and, in conclusion, that "he has estimated the pillar-formed Lighthouse at 15,000*l.*, and although that for the tower of masonry amounts to 42,636*l.* 8*s.*, yet, as it is treading a beaten path

which leads to *certainty, it is surely to be preferred* in a work of this kind: the foundation-courses of stone must be more tedious, yet in this there is *nothing impracticable;* and when the difficulties of the first courses are surmounted" (which, be it observed, were overcome by Mr. Stevenson himself) "the superiority of a fabric of stone over one of iron will be readily admitted." This is an opinion given *four* years before Mr. Rennie made his first Report, and clearly proves that Mr. Stevenson (and not Mr. Rennie, as Sir John's extracts imply) was the first to recommend and pronounce practicable the erection of the present Bell Rock Lighthouse Tower.

Again, I refer to that part of Sir John's letter, wherein, in his anxiety to show that the work was entirely under Mr. Rennie's direction, he says, that on 29th October 1807, Mr. Rennie made a Report, describing the progress of the works; and, among other things, reported that "the cofferdam (recommended by Mr. Stevenson) was not necessary." Now, on referring to the Report of 26th December 1806, which is a *joint* report, signed by Mr. Rennie and Mr. Stevenson, the following paragraph will be found:

> "*Sixthly*, A cofferdam will be wanted, to the height of 4 or 5 feet, so as to enable the workmen to continue so much longer than they could do were the tide allowed to flow over the foundation, when it rises above the level of the rock."

But Sir John has rashly made it appear, from the way in which he has stated the matter, that the said cofferdam was a *notion* of Mr. Stevenson's, condemned by Mr. Rennie; whereas the Reports in his hands not only show that it was *jointly* recommended, but also that it was *jointly* dispensed with, as appears from Mr. Rennie's Report of 29th October 1807, from which Sir John quotes, which, after stating "that the remainder of the articles mentioned in *our* Report of 26th December, should be provided as soon as possible," goes on to say, that it is "proposed to do the work without a cofferdam at all. There has been sufficient trial already made, to satisfy *us* respecting its practicability without a cofferdam."

Sir John is further anxious to claim for Mr. Rennie the *selection of the material* of which the tower was to be built, and says, that, in his Report of 30th December 1805, he recommended, for the exterior of the tower, *Dundee granite*, a stone which certainly does not exist, and could not, therefore, have been proposed by Mr. Rennie; but be this as it may, the selection of the stone was made after the joint Report by Mr. Rennie and Mr. Stevenson in 1806, in which they recommend *Aberdeen* granite in the following words:—"*We* have no hesitation in recommending that the under part of the building, at least as far as the first apartment, should be of *Aberdeen granite*," and this material was accordingly employed. The Dundee stone to which I suppose Sir John Rennie alludes, is the well-known old red sandstone of Kingoodie, which was used in the upper part of the Lighthouse.

Again, in attempting to show that the work as executed is not in accordance with Mr. Stevenson's original design, Sir John says, "the building as erected, it will be observed, differs materially from that proposed by Mr. Stevenson; the base is much wider." Now, in fact, the very opposite of this rash assertion is the true state of the case. *The base of the building in Mr. Rennie's sketch is wider*, but the tower, *as executed*, has a base of 42 feet, being the same diameter as that adopted by Mr. Stevenson in his original design.

Sir John Rennie also states, that his father *repeatedly* visited the works, and had the "entire responsibility, superintendence, management, and direction of the whole works." What Sir John's idea of *repeatedly* visiting a work of such importance may be, I do not know; but I cannot discover that Mr. Rennie was on the Bell Rock more than *twice* (it may be *thrice*) during the *whole four years* occupied in its erection. His first visit was in 1807, "when the workmen were preparing the rock to receive the foundation of the Lighthouse" (see his Report, October 29, 1807), and the second in 1808, after the work had been brought to a close for the season, at which time only three courses of masonry had been built; and if ever he was a *third* time on the Rock, it was not during the building operations. It thus appears, that Mr. Rennie never saw a single stone of the building laid; and Sir John's statement, that he had the "entire responsibility, superintendence, management, and direction of the whole works," and "repeatedly visited" it, stands, therefore, in striking contrast with the real facts of the case.

Again, Sir John Rennie says, that, "it does not appear from Mr. Stevenson's book that he made separate Reports to the Commisioners during the construction of the works." Now, to this I oppose the statement, made in my letter of the 9th February last, that Mr. Stevenson continued to report *directly* to the Lighthouse Commissioners as to the progress of the works; and the proof of this assertion is simple. Thus, among the Minutes of the General Meeting of Commissioners, of 8th January 1808, is the following:—"Read Report by Mr. Stevenson on the different operations connected with the Bell Rock Lighthouse, which the Commissioners approved of, and earnestly recommend the most persevering exertions in the prosecution of this undertaking." The minutes also notice the reading and approval of Mr. Stevenson's Reports on the progress of the Bell Rock works at the following dates, viz. 14th January 1809, 5th January 1810, and 14th July 1810, when the works were nearly completed, beside several reports, in the form of letters, in the course of the operations.

After the instances I have given, I think I am warranted in saying, that Sir John Rennie was bound, before publicly calling in question the merit so long and generally acknowledged as due to a member of the same profession, to have seen that his averments were more in accordance with facts; and as it must be as irksome to the reader as it is to me to follow him through the maze of error which his letter contains, I willingly proceed to another part of the subject, and leave him to account for such discrepancies and misstatements if he can.

Although I am desirous that all who take an interest in this matter should peruse the accompanying Letters, which passed between Sir John Rennie and myself, I am well aware that many professional men will not willingly take that trouble. For their satisfaction I have prepared the accompanying Plate, which shows, on one scale, Mr. Stevenson's original design of the Bell Rock Lighthouse of 1800, Mr. Rennie's sketch of 1807, and the work as actually completed in 1811, and also Smeaton's Eddystone. Referring to that Plate, I beg leave to make the following statement of facts, most of which are embodied in my appended Letters.

1st, In 1800, Mr. Stevenson, as Engineer to the Lighthouse Board, made the design of the Bell Rock Lighthouse, shown in Plate VIII. fig. 1, with detailed sections, and plans of floors, and courses (figs. 5, 6, 7, and 8); and I assert, without fear of contradiction, that it embraces all the peculiarities which distinguish the Bell Rock from the Eddystone.

2d, That, in 1800, Mr. Stevenson accompanied that design by an elaborate Report, in which, after detailing his inquiries and researches as to other works, and the various devices that had occurred to him for establishing a light, he concludes by "*giving the preference to*" a *stone tower*, and states that the practicability of its construction is *certain*.

3d, The Board, in 1803, consulted Mr. Telford; and in 1804 they applied to Mr. Rennie (I believe on Mr. Stevenson's suggestion) as the oldest and most eminent engineer of the day, for his advice as to the practicability of the proposed work. In this there was nothing extraordinary. It was very natural and proper that the Commissioners, before embarking in a work of such magnitude and difficulty, should wish to have the view of their own engineer confirmed by so high an authority as Mr. Rennie; but can this destroy the effect of the evidence, to which I have referred, that Mr. Stevenson originally projected the stone tower, or detract from the credit due to him for having done so?

4th, Mr. Rennie corroborated Mr. Stevenson's views as to the practicability of building a stone lighthouse, and recommended that it be adopted, and specially referred to the model prepared by Mr. Stevenson.

5th, The work was resolved on, and in 1806 a Bill was obtained to enable the Commissioners of Northern Lights to borrow money for its erection. In the memorial presented to Parliament on that occasion, the Commissioners state, that "The Memorialists have received several estimates of the expense of erecting a Lighthouse upon the Bell Rock. They have more particularly had recourse to the professional abilities of Mr. Rennie and Mr. Stevenson, civil engineers, from whose reports they have reason to believe that the sum will not exceed 43,000*l*." The following is an extract from the Report of the Committee of the House of Commons, to whom the Bill was referred:—

Extract from Report of the Committee of the House of Commons.

> "The Committee to whom was referred the Petition of the Commissioners of the Northern Lighthouses, and to report the matter to the House, as it shall appear to them,—
>
> "Proceeded to examine Mr. Robert Stevenson, civil engineer, who, in his capacity of Engineer for the Northern Lighthouses, has erected six Lighthouses in the northern parts of the kingdom; and has made the erection of a Lighthouse on the Cape or Bell Rock more particularly his study,—especially since the loss of about 70 sail of vessels in a storm which happened upon the coast in the month of December 1799, by which numerous ships were driven from their course along the shore, and from their moorings in Yarmouth Roads, and other places of anchorage, southward of the Frith of Forth, and wrecked upon the eastern coast of Scotland, as referred to in the Report made to this House in the month of July 1803; the particulars of which he also confirms: That the Bell Rock is most dangerously situated,

lying in a track which is annually navigated by no less than about 700,000 tons of shipping, besides His Majesty's ships of war and revenue cutters: That its place is not easily ascertained, even by persons well acquainted with the coast, being covered by the sea about half-flood, and the landmarks, by which its position is ascertained, being from 12 to 20 miles distant from the site of danger.

"That from the inquiries he made at the time the *York* man-of-war was lost, and pieces of her wreck having drifted ashore upon the opposite and neighbouring coast; and from an attentive consideration of the circumstances which attend the wreck of ships of such dimensions, he thinks it probable that the *York* must have struck upon the Bell Rock, drifted off, and afterwards sunk in deep water: That he is well acquainted with the situation of the Bell Rock, the yacht belonging to the Lighthouse service having, on one occasion, been anchored near it for five days, when he had an opportunity of landing upon it every tide: That he has visited most of the lighthouses on the coast of England, Wales, and Ireland, particularly those of the Eddystone, the Smalls, and the Kilwarlin, or South Rock, which are built in situations somewhat similar to the Bell Rock: That at high water there is a greater depth on the Bell Rock than on any of these, by several feet; and he is therefore fully of opinion, that a building of stone, upon the principles of the Eddystone Lighthouse, is alone suitable to the peculiar circumstances which attend this Rock, and has reported his opinion accordingly to the Commissioners of the Northern Lighthouses as far back at the year 1800; and having given the subject all the attention in his power, he has estimated the expense of erecting a building of stone upon it at the sum of 42,685*l.* 8*s.*

"Your Committee likewise examined Mr. John Rennie, civil engineer, who, since the Report made to this House in 1803, has visited the Bell Rock, who confirms the particulars in said Report, and entertains no doubt of the practicability of erecting a lighthouse on that Rock, is decidedly of opinion that a stone lighthouse will be the most durable and effectual, and indeed the only kind of building that is suited to this situation: That he has computed the expense of such a building, and after making every allowance for contingencies, from his own experience of works in the sea, it appears to him that the estimate or expense will amount to 41,843*l.* 15*s.*"

6th, Mr. Rennie was thereafter appointed, by the Board, Chief or Consulting Engineer, and acted jointly with Mr. Stevenson in reporting to and advising the Lighthouse Board; the value of his expected services, however, being not so much real and absolute as contingent on the event of anything going wrong in the hands of Mr. Stevenson, the Official Engineer to the Board, who was his junior both in years and in experience; and who, in sending his design and estimate to Mr. Rennie, says (in a letter dated 28th December 1805), "In handing you these plans I by no means should wish to be understood to do anything more than lay before you a subject which has cost me much, very much trouble, and consideration, without at all supposing that they are the best that may be thought of for the purpose." (Yet these very plans by Mr. Stevenson were substantially those which were afterwards executed.) "On the contrary, your great experience and practice, must make a subject of this kind familiar to your mind, and be highly improved in your hands."

7th, The only drawing furnished to the Board by Mr. Rennie is that shown in Plate VIII., fig. 2, which was prepared in 1807, six years after Mr. Stevenson's original design, and is a mere pictorial sketch, copied from the Eddystone, and not a working drawing. It is obvious that it was made merely for the purpose of illustrating Mr. Rennie's views as to the extension of the base of the Tower, a modification of the original design which seems to have been acceded to by Mr. Stevenson, as it is recommended in their *joint* Report of 29th December 1806, but which Mr. Stevenson afterwards found it was not advantageous to follow to the full extent indicated by the sketch alluded to, as the diameter of the existing Tower is only 42 feet, being the same as Mr. Stevenson's original design, instead of 45, as shown in Mr. Rennie's sketch. In other respects the sketch is a servile copy of the Eddystone, as will be seen by comparing it with fig. 4, which is a section of that work. It shows no details; not even the position and level of the door, which, in such a building, is a matter of no small moment. In fact, it is clear that it never was intended by Mr. Rennie to represent more than the line of the proposed extension of the base: the whole of the improvements on the interior work of the Eddystone having been introduced into Mr. Stevenson's original design.

8th, The Bell Rock Lighthouse, as executed, is shown in Plate VIII., fig. 3. Any professional reader will at once see, from the sections, that the interior work of the tower is in general accordance with that of the original design by Mr. Stevenson, fig. 1; and differs from the Eddystone, amongst other things, in this respect, that the arched form of floor is discontinued, and the thrust on the walls counteracted. It will also be apparent, that, as already noticed, the diameter of the tower at the base, as executed, is the same as the original design, being 42 feet, while the diameter of Mr. Rennie's sketch is 45 feet. It is farther worthy of notice, that Mr. Rennie recommended (in his Report of 30th December 1805, which, by the way, is strangely enough stated by Sir John as a proof of his having directed the details) that the solid part of the tower should be carried up 50 feet from the rock, whereas it is in reality only 30 feet, in terms of Mr. Stevenson's original design of 1800. It will also be seen, that the greater diameter at the top which characterises Mr. Stevenson's original design and the work as executed, forms an important distinction between Mr. Stevenson's and Mr. Rennie's views. Mr. Rennie, in his sketch, has followed the Eddystone, whereas Mr. Stevenson increased the diameter of the tower at its top, and thus obtained much better accommodation for the lighting apparatus.

9th, As to the extract from Mr. Rennie's Report of 2nd October 1809, on the strength of which Sir John Rennie tries to found a claim for his Father, as having set aside Mr. Stevenson's plan, all that can be drawn from that Report is, that Mr. Rennie recommended the addition of the dovetails of Smeaton's floors to the plan shown in Mr. Stevenson's design of 1800, which shows the floor-stones passing through the outer wall, and the radiated stones also connected to each other by means of feathers, as actually adopted in the work. Sir John Rennie marks in italics the description of the stones as "*radiated from a circular block in the middle;*" but this is the very description of Mr. Stevenson's plan (fig. 6, in the Plate), and the only change is the introduction of the Smeatonian dovetails at the centre-stone, as shown in fig. 9, in addition to the *feathers* on the sides of the stones. As to the other words italicised by Sir John Rennie, "I have already drawn out," I shall not oppose to them Mr. Stevenson's words (at p. 501 of *Account*), which were never contradicted, where, speaking of Mr. Rennie's sketch (fig. 2), he describes it "as the only plans or drawings furnished for this work by that eminent engineer;" but shall rather find a more natural explanation, by supposing that Mr. Rennie had casually made some sketch, showing his idea of adding Smeaton's dovetails in the centre-stone. Again, as to "the stones being deeper in the direction of the radius of the Lighthouse" (Rennie's Report of 29th October 1807), what is that, I would ask, but the method shown in Mr. Stevenson's original plan (see section, fig. 7), in which the stones, as already said, go through the whole wall, instead of resting in notches cut in it, as shown in Smeaton's section (fig. 12)? Let it also be borne in mind that Mr. Rennie, in this Report, is detailing what *had been done*, and is not setting forth what *is to be done*.

10th, But such a tower is, after all, merely a likeness of Smeaton's Eddystone; and the general conception of it,—if the details of the joggling, &c., and of the floors to prevent thrust, &c., be excepted,—implies nothing original. The great merit lies in the execution. Now, for four seasons, Mr. Stevenson personally conducted the operations with the greatest fortitude and perseverance, while Mr. Rennie, during that period, was only *twice* (perhaps *thrice*) on the rock, and never saw a single stone of the structure laid! In this respect, Mr. Stevenson followed the path of Smeaton, who laid aside every other engagement, and gave his personal attention to the execution of his great work.

11th, All that can be really said to be original in the design of the Lighthouse, or in the management of the works, is due to Mr. Stevenson, who proposed and designed the stone tower, planned the tying floors, the ring or band joggles, and laid out the gradually-diminishing thickness of the walls (see *Account*, p. 445; and Plate VII., fig. 6, of his *Account*). He also conceived the moveable jib-crane (*Account*, p. 91), the balance-crane, used in building the upper part of the tower (*Account*, p. 295); and, above all, the temporary wooden barrack, and the floating light (proposed in Mr. Stevenson's Report of 15th November 1806), without which the completion of the work would have been much retarded. The value of these suggestions, and the estimation in which they were held by the Board, will best appear from the following extract from the minutes of meeting of Northern Lights of 9th July 1811:—

"Read Report by Messrs. Hamilton and Duff,[*] of the following tenor:—

"In observance of the minute of the Bell Rock Committee of the 18th June, we went and inspected the models deposited in the store of the department at Leith, and found them all there entire, and in preservation, except the model for the cofferdam, which, being of a large size, and inconvenient to be preserved, has been broken up. Mr. Hamilton, however, remembers having seen it, so that there is no doubt that all the models mentioned were prepared by the engineer. *These were assuredly deserving of credit, and were highly necessary to induce the Commissioners to engage in the great undertaking of the Bell Rock; and we are both of opinion, that*

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[*] The Committee appointed to audit accounts.

without the temporary house upon the Rock, the model of which is the last article in the engineer's account remitted to us, the Lighthouse would not have been erected near so soon, and perhaps not even now. We therefore think this piece of mechanism deserves much commendation, and does credit to Mr. Stevenson's foresight and judgment. We farther observe, that Mr. Stevenson has been at considerable expense in various journeys to Ireland and elsewhere, in the furtherance of this great object; and that he ought to have some consideration, in name of interest, upon such outlays. As to the last article, which is blank, for designs, drawings, preparing an address to the Commissioners, &c., we rather think the matter falls under Mr. Stevenson's duty as engineer, and that we cannot, strictly speaking, take it much, if at all, into account; that upon duly considering the value of the outlay, the expense of the journeys, and the length of time, Mr. Stevenson has not been indemnified on these accounts, we are of opinion that it would be proper he should be paid the sum of 300 guineas for every thing set forth in the prefixed account; and we report the same accordingly.

(Signed) "R. HAMILTON.
"ADAM DUFF."

"Which Report being considered, the meeting approve thereof, and authorise the clerk and cashier to pay Mr. Stevenson the sum of 300 guineas accordingly."

12th, As a further test of the value and amount of work performed, it may not be out of place to state that, while Mr. Telford received fees to the extent of *77l.*, and Mr. Rennie to the extent of *428l.*, Mr. Stevenson received *4,052l. 16s.*, of which *315l.* above referred to, were for his original reports and designs made in 1800, and *a thousand guineas* of which were paid to him by the Lighthouse Board at the conclusion of the work, in terms of their vote passed before the operations were commenced.

13th, In proof of the opinion held by the profession on this subject, it may also be stated that the Council of the Institution of Civil Engineers, in their Introduction to the first volume of the *Transactions*, which was published in 1826, give sketches of the lives and works of various deceased Engineers. In speaking of Smeaton they call the building of the Eddystone his greatest work. Of Rennie they give an account from his earliest to his latest days; and although they enumerate upwards of twenty works in which he was engaged, their list does not include the Bell Rock Lighthouse; a feature in the report by the Council of the Institution of Civil Engineers, which contrasts very strangely with Sir John Rennie's assertion, that his father *designed* and *built* the Bell Rock Lighthouse.

14th, Mr. Rennie himself, in his letter of 7th September 1807, says to Mr. Stevenson, that, if successful in the work in which he was *engaged*, "*it will immortalise you in the annals of fame.*"

Lastly, What was the opinion of the Commissioners of the Lighthouse Board, to whom Sir John Rennie says, "the greatest credit is due for the public spirit, energy, and ability with which they brought forward and carried out to a successful conclusion this important maritime work?" This may be easily learned from the facts; *1st*, That, at their General Meeting of 14th July 1812, "on the motion of Mr. Hamilton, Mr. Stevenson, Engineer, was directed to prepare an Account of the building of the Bell Rock Lighthouse, from the commencement to the conclusion of the undertaking, and that under the direction of the Committee formerly appointed, viz., Mr. Solicitor-General, Mr. Hamilton, and Mr. Erskine; and the Clerk was authorised to answer the orders of that Committee for any sums not exceeding *400l.* to enable them to defray the expenses of this and the drawings that will accompany it." *2d*, From their frequent visits to the Rock, the Commissioners knew every step of the proceedings, and felt along with Mr. Stevenson in all his arduous toils; and they have, accordingly, recorded *their* approval by inscribing his name and erecting his bust in the Tower, in terms of the motion of Sir William Rae, Bart., then Lord-Advocate of Scotland, who moved "that a bust of Mr. Robert Stevenson be obtained and placed in the library of the Bell Rock Lighthouse, in testimony of the sense entertained by the Commissioners of his distinguished talent and indefatigable zeal in the erection of the Lighthouse."

All this, however, is nothing in the eyes of Sir John Rennie, who, in defiance of facts, and in absence of proof, states boldly that Mr. Rennie designed and built the Bell Rock Lighthouse, worked out the details, and, in fact, that nothing was done without being submitted to and receiving his approval. It is one thing to make a statement, and another thing to substantiate it; but it is the less wonderful that such an assertion should be made by Sir John after the rash statements to which I have already alluded at the commencement of this letter.

In his last letter, Sir John takes a somewhat different stand, and avows another ground on which he rests his claim, in these words: —"The simple fact of your Father having been appointed assistant engineer, under the late Mr. Rennie, and at his, Mr. Rennie's, request, independent of any other point, settles the question." So, then, the fact of Mr. Stevenson's original design, five years before Mr. Rennie heard of the subject, including, as I have shown, all the peculiarities of the work which distinguish it from the Eddystone; of his having, jointly with Mr. Rennie, reported on the work, and proposed the departures from Smeaton's outline, as well as his being coupled with Mr. Rennie in the Minutes of the Board, under the term "the Engineers," and of his having presented Reports on the progress of the work directly to the Commissioners, all go for nothing. Nay more, his having prosecuted the work at much personal risk, the late Mr. Rennie having frankly given him the whole credit, and the Commissioners having, both by pecuniary and honorary tributes, expressed their sense of his position, and their having also entrusted to him the task of preparing, at their expense, an Account of the work, are facts which, it should seem, are to be entirely cast aside on the mere collocation of the words "chief and assistant engineers." So wills Sir John Rennie; and having committed himself, by suppressing, in a formal notice of the Bell Rock Lighthouse, even the very name of the man who originally designed and actually executed it, we need not be surprised to find him persevering in the rejection of claims which he has already thus publicly denied. With such a course, the anxiety which he professes to render justice "to all concerned" forms an unseemly contrast, and like all other spurious virtues, it runs to excess in a devious path; for not only does he elevate the foremen of the carpenters and masons to the same platform with his father's coadjutor, but even singles out the Commissioners of the Northern Lights themselves, (whose merits are not the point at issue, and whose public-spirited exertions have been long since acknowledged in higher quarters) as the objects of his formal commendation. But I forbear further comment; and will only repeat two questions already proposed to Sir John Rennie, but which have not been replied to.

First, Since the example shown by Smeaton, what credit can possibly be due to any engineer in connection with the Bell Rock Lighthouse, which is not included under one or more of the three following heads, viz.:—

Either, the original proposal of Smeaton's Stone Tower, for a rock in an exposed situation, 15 feet under high water.

Or, the proposal of any improvements on Smeaton's design and mode of carrying on the work.

Or, the personal superintendence of the work, necessarily involving so much fortitude, zeal, and self-denial; and,

Secondly, Which of these sources of credit can be claimed for Mr. Rennie?

In conclusion, I ask, who will deny that Mr. Stevenson can justly lay claim to each of them?

With many thanks for the indulgence you have kindly granted to me, I am, &c.

Edinburgh, April 10, 1849. ALAN STEVENSON.

Correspondence between Sir John Rennie and Mr. Alan Stevenson.

I. Mr. ALAN STEVENSON to Sir JOHN RENNIE.

Edinburgh, 25 Regent Terrace,—26th Dec. 1848.

SIR—I am most unwillingly compelled to call your attention to a statement in your "Account of the Breakwater in Plymouth Sound," now for the first time brought under my notice. I allude to a passage on page 29, where in reference to the Lighthouse on the Breakwater, you state that "the masonry of the solid part of the Lighthouse Tower was to have been dovetailed and cased with granite, upon the same principle as that of the Eddystone Lighthouse Tower; and the hollow part of the tower, as well as the floors, was to have been constructed upon the *same principle as that adopted by Mr. Rennie, in the Lighthouse designed and built by him on the Bell Rock on the east coast of Scotland, in the year* 1806—*which system differs from that adopted by Smeaton at the Eddystone, inasmuch as the whole of the floors are formed by large stone landings, connected together in the centre by a key-stone, instead of being radiated in the form of an arch.* By this means the whole is joined and tied together in the most efficient and substantial manner, without the use of chain-bars, hoops, or other iron work, which is found to be preferable, as the lateral pressure upon the outer walls is thereby avoided, and the building rendered more secure."

Now, I am constrained to say, that the Bell Rock Lighthouse was not "designed and built" by Mr. Rennie, but by my Father; and, in proof of this, I refer you to the Report of the House of Commons, on a Bill to enable the Commissioners to borrow 25,000*l.* for the erection of the Lighthouse, which is quoted at page 103 of his "Account of the Bell Rock Lighthouse," and in which it is stated that the Committee began by examining Mr. Robert Stevenson, who had reported his opinion on the subject to the Commissioners, and had estimated the cost of the Lighthouse, so far back as the year 1800, at 42,685*l.* 8*s.*; and that they afterwards examined Mr. John

Rennie in support of the Bill, "who confirms the particulars in said Report" (viz. my Father's), and whose estimate differed from his by a mere fraction, being 41,843*l.* 15*s.* My Father's original design is given in Plate VII. fig. 6, and Mr. Rennie's at Plate VII. fig. 15; and the actual building, which differs in height and other circumstances from either, and may be called a compound of both, is shown at Plate XVI. Far be it from me to take from Mr. Rennie one tittle of any praise which may be due to him in connection with the Bell Rock Lighthouse. This, I am sure, no one has so fully awarded to him as my Father himself has done; for both in his *Account*, and throughout their correspondence during the erection of the Lighthouse, he invariably speaks of Mr. Rennie with that respect which is due from youth to age, especially when, as in his case, age is rendered honourable by professional eminence. So much, indeed, was this feeling manifested, that my Father, in their correspondence, asks Mr. Rennie's friendly advice as to the remuneration which he should seek for his labours at the Bell Rock. Mr. Rennie, who was at that time engaged with the Leith Docks, was, in fact, consulted by the Lighthouse Board, chiefly, I have reason to believe, on my Father's suggestion, as may indeed be gathered from a passage at page 445 of his *Account* (where he speaks of Mr. Rennie having "obligingly favoured" him by examining his original models). He accordingly speaks of Mr. Rennie as the "Chief Engineer" with whom he made joint Reports on the subject. But this in no measure derogates from the truth of my statement, that *Mr. Stevenson first proposed and designed, and eventually did actually build, the Bell Rock Lighthouse.* While, also, my Father frankly tells us, that, throughout the course of the work, he advised with Mr. Rennie, it is no less obvious that he sometimes differed in opinion from his adviser; and the executed work accordingly differs, as above stated, from the original designs of both engineers. In point of fact, also, Mr. Rennie merely furnished a plan (now before me), showing the diameter of the base proposed by him, but without any plan or section of the courses, together with an elevation or *pictorial* representation of a Tower like Smeaton's, which (see Stevenson's *Account*, page 501) *"are here preserved as the only plans or drawings furnished for this work by that eminent engineer."* If any detailed plans be in your possession, they are those which, at Mr. Rennie's request, were sent from my Father's office, after the execution of the work.

The only point which needs farther explanation is, that which you speak of as the *difference* between the Eddystone and the Bell Rock—viz. the advantage of converting the floors into *connecting-ties*, instead of permitting them to act with a *disuniting thrust;* but this, be it observed, formed a distinctive feature of my Father's design and model, in the year 1800, *six years* before Mr. Rennie's advice was asked, and is thus described by him at page 500 of his *Account*, in speaking of his original model and design:—"Fig. 7 shows one of the floors, each stone of which forms part of the outward walls, extending inwards to a centre stone, independently of which they were to be connected by means of copper bats, with a view to preserve their square form at the extremity, instead of dovetailing. These stones were also modelled with joggles, sidewise, upon the principles of the common floor, termed feathering in carpentry, and also with dovetailed joggles across the joints, where they formed part of the outward wall, as shown in this figure." This subject he again notices in the body of the narrative, where he says, at page 345,—"The floors of the Eddystone Lighthouse, on the contrary, were constructed of an arch-form, and the haunches of the arches bound with chains, to prevent their pressing outward, to the injury of the walls. In this, Mr. Smeaton followed the construction of the Dome of St. Paul's; and this mode might also be found necessary at the Eddystone, from the want of stones in one length, to form the outward wall and floor, in the then state of the granite quarries of Cornwall. At Mylnefield Quarry, however, there was no difficulty in procuring stones of the requisite dimensions; and the writer" (Mr. Stevenson) "foresaw many advantages that would arise from having the stones of the floors to form part of the outward walls, without introducing the system of arching. In particular, the pressure of the floors upon the walls would thus be perpendicular; for as the stones were prepared in the sides, with *groove and feather*, after the manner of the common house-floor, they would, by this means, form so many girths, binding the exterior walls together, as will be understood by examining the diagrams and sections of Plate VII." (above quoted) "with its letterpress description, agreeably to which he had modelled the floors in his original designs for the Bell Rock, which were laid before the Lighthouse Board in the year 1800."

It thus appears, that even this arrangement of the floors, which you so highly value as the great improvement on Smeatons's design, and for which, at page 30 of your work, you reiterate your claim in favour of Mr. Rennie in a somewhat feebler tone,—I say it appears that even this improvement was *entirely* due to my Father.

The real state of the case, therefore, is simply this:—That Mr. Stevenson alone *built* the Bell Rock Lighthouse, and that he did so after a design of his own, in some measure modified to meet Mr. Rennie's views, but, not as you would lead one to suppose, in respect to "the system" of tying the walls by means of the floor-stones, which formed, as I have already shown, part of my Father's original design in 1800. Such also is the general conclusion at which the public have arrived, for they well know who built the Bell Rock Lighthouse; and such was the opinion of the Lighthouse Board, who, on the motion of Sir William Rae, Bart., then Lord Advocate of Scotland, "resolved that a Bust of Mr. Robert Stevenson be obtained, and placed in the library of the Bell Rock Lighthouse, in testimony of the sense entertained by the Commissioners of his distinguished talent and indefatigable zeal in the erection of that Lighthouse." Such, above all, was the feeling of your venerable Father himself, who, in a letter to my Father (in my possession) of date "London, September 7, 1807," uses these remarkable words, not more unequivocal in awarding the praise where it is really due, than honourable to him who penned them: "Poor old fellow!" says he, alluding to the name of Smeaton, "I hope he will now and then take a peep of us, and inspire you with fortitude and courage to brave all difficulties and dangers, to accomplish a work which will, *if successful, immortalise* YOU *in the annals of fame.* With such perseverance as yours I entertain no doubt of final success."

I grieve sincerely to be forced to say that you have ventured to contradict this testimony by *entirely* omitting the *name* of the original projector, with whom your Father was merely conjoined as an adviser in this great work, the merit of which, you must well know, consists in the original boldness of the proposal to follow Smeaton's example in such a situation as the Bell Rock, which is submerged by the tide to the depth of *fifteen feet*, and still more in its successful execution. To both of these sources of professional fame you cannot possibly deny that my Father alone has any claim; for, as already shown, he proposed and reported on the work in the year 1800, and, like Smeaton himself, was present on the rock during every stage of the actual building of the Lighthouse.

If this statement shall give you any new light on the history of this matter, and thus alter your views, I shall rejoice to receive from you an acknowledgment of my Father's merits, and to give you in return an acquittal, in so far as I am concerned, from the serious charge which the facts above stated seem to imply.

I have taken this matter into my own hands, because I am unwilling that my Father should, at his time of life, be drawn into a correspondence of this kind. I remain, &c.

ALAN STEVENSON.

II. Sir John Rennie to Mr. Alan Stevenson.

London, 20th January, 1849.

SIR—I beg leave to apologise that absence from London, on the Continent, for above two months, and from which I have only just returned, has unavoidably prevented me from receiving and replying to your letter of the 14th ultimo, and which I hope you will excuse. I have read your letter through with much attention, and, in justice to the late Mr. Rennie, I feel bound to say that I see no reason to change my opinion as stated in my *Address*, and of which you complain; indeed, I think your Father's Book alone on the Bell Rock Lighthouse confirms it, where,—see Mr. Rennie's Reports of the 30th December 1805, 26th December 1806, 29th October 1807, 12th December 1808, 2d October 1809,—this last Report is not in your Father's Book,—you will find also, in page 179, cap. iii., your Father uses the following words:—"When the writer, who had now been secluded from society several weeks, enjoyed much of Mr. Rennie's interesting conversation, both on general topics, and *professionally on the progress of the Bell Rock works, on which he was consulted as* CHIEF ENGINEER!!" That excellent and able engineer, the late Mr. David Logan, who was cognisant of the facts, repeatedly told me that nothing was done without being previously submitted to, and receiving the approval of, the late Mr. Rennie; in fact, the whole responsibility rested with him, as Chief Engineer, *as admitted by your Father*, and, as such, Mr. Rennie is entitled to the credit of it. In saying thus much, I should be extremely sorry to detract from your Father's merit, as second engineer, acting under the superintendence of the late Mr. Rennie. It is my intention to collect the documents together, and to print them, since you have already done the same with your letter; and I feel much obliged to you for giving me the opportunity. I am extremely sorry to have any difference with you upon the subject; but, in justice to all parties, this is the proper course, and if I have made any error (which I do not apprehend), I shall have much pleasure in correcting it.—I am, &c.

JOHN RENNIE.

To Alan Stevenson, Esq.

III. Mr. Alan Stevenson to Sir John Rennie.

Edinburgh, January 29, 1849.

SIR—Your letter of the 20th reached me while on the eve of starting for the Solway Frith, whence I have just returned. I lose no time in saying that, as it does not contain one single fact beyond what is already given in mine of the 26th to yourself, it calls for little comment from me. To my letter, which states the case truly, I therefore again refer, as proof that your Father merely acted as chief or consulting engineer, and that my Father actually planned and erected the Bell Rock Lighthouse; and, in particular, that he alone designed what you have spoken of as the distinguishing peculiarity of that structure.

Your reference to your conversation with the late Mr. David Logan, formerly foreman of the masons in the Bell Rock workyard at Arbroath, and afterwards in your employ, is ill-judged; and, had you known that, in the course of the operations, my Father had found it necessary to supersede Mr. Logan as clerk, and restrict him solely to the duties of a foreman, yuo would not probaby have referred to him as your authority on the subject.

The entire suppression of my Father's name in your allusion to the Bell Rock Lighthouse, taken in connection with the tenor of your letter, now before me, satisfies me that you will never do justice to my Father, and that it is needless for me to waste time in farther correspondence with you on this subject. I am, &c.

ALAN STEVENSON.

IV. Sir John Rennie to Mr. Alan Stevenson.

(*Bell Rock Lighthouse.*)

London, 31st January, 1849.

SIR—I beg to acknowledge yours of the 29th inst., received this morning, and beg to observe, that it is no answer to mine of the 20th inst. In my *Address* (of which you complain) there was no room to enter into details, but in the work which I am about to publish on the Bell Rock, and which I have had some time in contemplation, I shall take care to do justice to your Father and all concerned.

With regard to your observations about the late Mr. David Logan, I have only to say, at present, that, after leaving the Bell Rock, he was appointed, by the late Mr. Telford, to superintend the works at Dundee, afterwards to the works at Donaghadee by the late Mr. Rennie, and by myself to those at Port-Patrick and Whitehaven, and he closed his valuable career as engineer to the Clyde Trustees, by whom he was selected from a numerous list of able competitors; and he enjoyed the entire confidence of the late Mr. Telford, Mr. Rennie, myself, and wherever he was employed. I must say, therefore, that after such testimonials to his ability, integrity, and general good conduct, your remarks are by no means appropriate, and cannot, in any degree, invalidate Mr. Logan's testimony. Since your style of writing is so irritable, I should be extremely sorry to prolong this correspondence, and quite agree with you that it can be of no service. The real merits of any case can only be decided by calmly and dispassionately considering the evidence upon which it rests; and I am satisfied in resting the claims of the late Mr. Rennie upon their merits.—I am, &c.

JOHN RENNIE.

To Alan Stevenson, Esq.

V. Sir John Rennie to Mr. Alan Stevenson.

(*Bell Rock Lighthouse.*)

London, 1st February, 1849.

SIR—In order to prevent you from committing yourself farther upon this subject, and upon which, I am sure that your proper sense of candour will induce you to admit at once that you have unconsciously been in error, I herewith send you copies of some minutes of the Commissioners of Northern Lighthouses. I cannot, for a moment, suppose that you were cognisant of them when you wrote your letters of the 14th of December last and the 29th ultimo; at the same time, I feel justified in saying, that I think it was your duty (considering your intimate connection with the Board of Northern Lighthouses) to have examined diligently these minutes before giving your statements to the world, as I think it would have prevented this unpleasant correspondence. As regards myself I willingly forget what has passed; and I trust that henceforward nothing will occur to prevent that harmony which ought to exist amongst members of the same profession.—I am, &c.

JOHN RENNIE.

P.S. Of course it is my intention to publish all the documents as I told you.

To Alan Stevenson, Esq.

Excerpt from a Minute of a Meeting of the Commissioners of the Northern Lighthouses, held at Edinburgh, the 3d December 1806.

"Present—The Lord Provost of Edinburgh.
Thomas Henderson, Esq., first Baillie of Edinburgh.
William Rae, Esq., Sheriff-Depute of Orkney.
R. Hamilton, Esq., Sheriff-Depute of Lanark.
D. Moneypenny, Esq., Sheriff-Depute of Fife.
James Clerk, Esq., Sheriff-Depute of Edinburgh.
John Rennie, Esq., Civil Engineer.

"This meeting having been called for the special purpose of taking preliminary steps for carrying into effect the powers vested in the Commissioners by Act of Parliament, for erecting a Lighthouse on the Cape or Bell Rock, and the different reports on the subject, particularly on the kind of building to be adopted, having been duly considered, and Mr. Rennie having verbally delivered his opinion on the subject—

"Resolved unanimously,—

"That the building to be erected for the purpose of a Lighthouse on the Bell or Cape Rock shall be of stone, and that the same shall be erected under the direction of John Rennie, Esq., Civil Engineer, whom they hereby appoint chief engineer for conducting the work.

"Mr. Rennie having stated to the meeting, in general terms, his opinion as to the form of the building, and the particular sort of materials to be used, &c., he was requested to furnish the Commissioners with plans; and as to the kind of stone, as he was about to proceed to Perth, he was requested to visit the Dundee Quarry, and also to inspect the Aberdeen granite, and report upon this subject.

"Mr. Stevenson was authorised to proceed along with Mr. Rennie, and to endeavour to procure a yard and the necessary accommodation at Arbroath.

"Extracted by C. CUNNINGHAM, Sec."

Excerpt from a Minute of a Meeting of the Commissioners of the Northern Lighthouses, held at Edinburgh, the 26th day of December 1806.

"*Present*—The Lord Provost of Edinburgh.
Thomas Henderson, Esq., first Baillie of Edinburgh.
Robert Hamilton, Esq., Sheriff-Depute of Lanark.
Edward M'Cormick, Esq., Sheriff-Depute of Ayr.
James Clerk, Esq., Sheriff-Depute of Edinburgh.
John Rennie, Esq., Civil Engineer.

"Messrs. Rennie and Stevenson having, in terms of last minute, proceeded to Dundee and Aberdeen, and examined the different quarries, they presented a joint report in the following terms: [Here the report follows, and the various orders made thereon.]

"Mr. Rennie proposed to the meeting that Mr. Stevenson should be appointed assistant-engineer to execute the work under his superintendence, and mentioned to the Commissioners that the mode of re-imbursing him for his trouble, and the risk attending the business which was customary in similar undertakings, and what he knew would be most agreeable to the Board of Treasury, would be to allow him a certain per-centage upon a limited sum of expenditure, with such a sum at the conclusion of the work as they may may choose to fix. And the Commissioners agree as to the appointment of Mr. Stevenson to be assistant-engineer under Mr. Rennie; but they delay taking into consideration the recompense to be made to him, both as to the amount, and the manner of doing it, until next meeting. "Extracted by C. CUNNINGHAM, Sec."

VI. Mr. Alan Stevenson to Sir John Rennie.

Edinburgh, February 9, 1849.

SIR—Your letter of the 1st inst., with copy of some Minutes of the Lighthouse Board, I received in course of post; but have not found time to reply till to-day. These Minutes only affirm what was long ago stated by Mr. Stevenson in his Account of the Bell Rock Lighthouse, and what I have repeated in my letters to you, that the late Mr. Rennie was employed as Chief or Consulting Engineer. You must be perfectly aware that I am not disputing about *names* but about *facts*; it is, therefore, indifferent whether this circumstance be stated as above, or whether the co-relative statement (which is so clearly implied in it) be added, viz., that Mr. Stevenson, who, be it observed, was Engineer to the Board, was nominated Assistant, or, as we should now say, Acting Engineer under the late Mr. Rennie. This is quite true, and has been amply admitted; but what of that? In no respect does it touch my averment, *that Mr. Stevenson*, and not Mr. Rennie, *designed* and *built* the Bell Rock Lighthouse.

Let me recapitulate, as briefly as possible, the grounds of my statement, as given in my letters to you; or as drawn from my Father's Account of the Bell Rock Lighthouse, and from the Minutes of the Lighthouse Board. They are as follows:—

1st, Mr. Stevenson, in the year 1800, made a design of the Bell Rock Lighthouse, with a report to the Commissioners, embracing the chief peculiarities which distinguish that structure from the Eddystone, such as the mode of diminishing gradually the thickness of the walls,—the introduction of ring or band-joggles,—and the tying of the walls by means of the floors, so as to avoid the outward thrust, which last improvement is erroneously claimed by you, in your work on the Plymouth Breakwater, for the late Mr. Rennie. Mr. Stevenson also, at that early period, made drawings and models of the work, and estimated the cost at 42,635*l.* 8*s.* It is also worthy of notice, that the Report alluded to distinctly shows that Mr. Stevenson was the prime mover in bringing about the building of the Lighthouse, and to his early exertions in a great measure are mariners indebted for its ultimate establishment.—(See *Account*, p. 442.)

2d, In 1804, Mr. Rennie was called in by the Lighthouse Board (and I believe on my Father's suggestion) as the oldest and most eminent engineer of the day, for his opinion as to the practicability of Mr. Stevenson's proposal to build a tower of masonry on a rock covered to the depth of 16 feet at high water of spring-tides, a work the successful issue of which was then much doubted, the first entire course of the Eddystone being on a level with high water.

3d, In the Evidence before the Committee of the House of Commons in favour of the Bill for authority to erect the Lighthouse and for power to borrow 20,000*l.*, Mr. Stevenson, the Engineer of the Board, was first called to explain his proposed plans and estimates, and to state his opinion as to the practicability of the work, while Mr. Rennie merely corroborated them. And, in particular, be it observed, that Mr. Stevenson's estimate, which, as above stated, was 42,635*l.* 8*s.*, differed from Mr. Rennie's, which was 41,843*l.* 16*s.*, by a mere fraction, thus showing that their views of the matter were identical; while Mr. Stevenson, the original proposer and prime mover of this great work, had the precedence of his future colleague by a period of at least six years.

4th, The only plan furnished to the Commissioners by Mr. Rennie is that shown in Plate VII. of the Account of the Lighthouse, the original of which still exists. It is a mere pictorial view of a tower without sections; and the Lighthouse, as actually executed, is not in accordance with it, but is a modification adopted by Mr. Stevenson, during the progress of the works, and embraces the best points of his own original design made in 1800, and of this sketch which was furnished by Mr. Rennie in February 1807. Even the height of the finished tower considerably differs from the sketch of Mr. Rennie.

5th, But such a tower as the Bell Rock, is, after all, merely a likeness of Smeaton's Eddystone suited to the situation; and the general conception of it implies nothing original. The great merit, therefore, lies in the execution of the work. Now, throughout the whole four years' operations, Mr. Rennie was only *twice* on the Rock for an hour or two during a tide; while Mr. Stevenson, for four seasons, personally conducted the operations on the Rock with the greatest fortitude and perseverance, and also superintended all the details in the workyard at Arbroath.

6th, All that can really be said to be original in the design of the Bell Rock Lighthouse, or in the management of the works, is due to Mr. Stevenson alone, who first proposed the measure at all, and designed a Lighthouse of stone; planning the tying-floors,—the ring or band-joggles (fig. 6, Plate VII. of his *Account*), and laid out the gradually-diminishing thickness of the walls, which, in particular, distinguish that Tower from Smeaton's (*Account*, p. 445). He also conceived the moveable jib-crane (*Account*, p. 191) and the balance-crane used in building the upper part of the Tower

(*Account*, p. 292). The erection of the temporary barrack on the Rock for the workmen (*Report*, 15th November 1806) was also an experiment of his equally bold and novel, without which it may well be questioned whether the work could have been completed even in double the time that was spent on it.

7th, The Testimony of Mr. Rennie himself, in his letter formerly quoted by me, and also of the Lighthouse Board by placing a bust of Mr. Stevenson in the Tower, while clearly showing to whom the merit of building the Lighthouse is really due, are facts, which, rightly understood, do not derogate from the *lesser* measure of credit due to Mr. Rennie for the "advice" given by him to the Board as the chief or consulting Engineer, the value of which was in truth not so much real and absolute as contingent upon the event of anything going wrong in the hands of Mr. Stevenson, the official and regular or stipendary Engineer of the Board. Nor let it be forgotten that part even of that advice was given by Mr. Rennie in a joint Report with Mr. Stevenson himself, who, besides this, reported periodically and directly to his constituents, and *not through Mr. Rennie*, during the progress of the work.

Upon these grounds I objected, and do still object, to the statement in your work on the Plymouth Breakwater (for I know nothing of the *Address* to which you refer); and I repeat, that Mr. Stevenson alone first proposed and finally built the Bell Rock Lighthouse, and that while the late Mr. Rennie *acted jointly with him* as the adviser of the Board, Mr. Stevenson, as above shown, actually introduced all the improvements into the design of the building, and the implements and methods of conducting the operations which in any respect distinguish the Bell Rock Lighthouse from the Eddystone. To Mr. Stevenson is also due the additional and much greater merit of having followed Smeaton in personally conducting the whole operations, sharing in all the risks, anxieties, and privations which attended it, and encouraging by his daily example of zeal and self-denial, the workmen who were resident for months together on that desolate rock. The late Mr. Rennie did none of these things; and he, therefore, in the letter above alluded to (which he addressed to Mr. Stevenson), most frankly and naturally gives the whole credit of the work to my Father, by stating that, if successful, the work would "immortalise him in the annals of fame;" and the Commissioners who, from their frequent visits, knew every step of the proceedings, and felt along with Mr. Stevenson in all his arduous toils, have, as already noticed, also recorded their approval by inscribing his name and erecting his bust in the Tower.

How strangely and painfully does your statement contrast with the testimony of your late Father, and of those who were most conversant with the facts of the case! You endeavour to raise a claim which Mr. Rennie himself never made, founded on the meaning of the words *Chief* and *Assistant;* and had you, in disregard of all the known facts of the case, strictly confined your statement to the literal terms which the juxtaposition of these words may seem to warrant, you would still have done real injustice to my Father by preferring an extravagant claim, not, however, so susceptible of a formal refutation as the present one; while I might, in that case, have been induced, by a desire for peace, to leave my Father's merits to that slower but not less thorough vindication which time not seldom mysteriously works out. But you have not been content with the middle course of claiming a moderate or even greater share of the praise, but have grasped at the whole. You have forgotten, or have shut your eyes to the fact, that Mr. Stevenson was the original proposer and designer of the work,—that he schemed all the peculiarities which distinguish it from Smeaton's great work; and that even, *technically* speaking, he was Mr. Rennie's coadjutor in it, and along with him jointly reported on it, and gave advice about it, and, above all, that he personally superintended the whole operations; and having passed over these facts, you have easily gone a little further, and have *entirely* suppressed all mention even of his name; nay, you have actually claimed for the late Mr. Rennie, as in your opinion the distinguishing peculiarity of the work, that very feature which very prominently appears in Mr. Stevenson's original design, *made four years before Mr. Rennie had ever heard of the subject.* You seem to offer, as an excuse for the suppression of my Father's name, the casual nature of your notice of the Lighthouse in your *Address*, which, as I have already said, I have never seen. It is not to any such casual notice that I refer, but to your deliberate statement, on pages 29 and 30 of your "Historical, Practical, and Theoretical Account of the Breakwater in "Plymouth Sound;" and I am therefore at a loss to comprehend your motive in repeatedly referring to your *Address*, which I have never seen nor heard of, and to which I have never alluded.

Finally, I ask two questions: *1st*, Since the example shown by Smeaton, what credit can possibly be due to any engineer in connection with the Bell Rock Lighthouse, which is not included under one or more of the three following heads:—

Either, the original proposal of Smeaton's Stone Tower for a rock in an exposed situation, 16 feet under high water;

Or, the proposal of any improvements on Smeaton's design and mode of carrying on the work;

Or, the personal superintendence of the work, necessarily involving so much fortitude, zeal, and self-denial? And,

2dly, Which of these sources of credit can be claimed for Mr. Rennie?

You speak of your intention to publish a "Work" on the Bell Rock Lighthouse, in which you will "do justice to Mr. Stevenson, and all concerned." What necessity can possibly exist for such a work from the hands of one who never saw the Lighthouse, after the public have been for twenty-four years in possession of an "Account" of it, prepared, at the command of the Lighthouse Board, by the Architect himself in his official capacity, and in which the services of every one employed, from the *sea-boy to the "Chief Engineer"* are so studiously set forth, and no one statement of which has ever been impugned, the public are best able to judge. Having said thus much, I should be unwilling, on grounds merely inferential, to assume that I know what you intend by doing "justice to my Father, and all concerned;" and I therefore abstain from expressing any opinion as to your motives in issuing your proposed work.—I am, &c.

ALAN STEVENSON.

VII. Sir JOHN RENNIE to Mr. ALAN STEVENSON.

(*Bell Rock Lighthouse.*)

London, 10th February, 1849.

SIR—I have this day received yours of the 9th inst., and have only to say, *that it admits the whole case;* and as it will be unnecessary to continue this correspondence, you will have an opportunity of seeing my statement in print, and the world will judge for itself.

You seem, however, to have forgotten two or three points,—Your Father in his book does not claim the merit of even *the first suggestion*, but gives it to Sir Alexander Cochrane—who proposed it to the Lighthouse Board in 1793; neither does your Father claim even the second place, for he gives it to Captain Brodie and Mr. Couper; and as for your saying that the late Mr. Rennie gave your Father the credit of it, this certainly is contrary to what I have always heard him say myself; and I have some copies of his letters, *commenting in very strong* terms upon your Father *attempting* to claim the merit. Mr. David Logan, Mr. Francis Watts, and all who were upon the work, have given nearly the same evidence. I mean the principal persons.

I am, &c.

JOHN RENNIE.

To Alan Stevenson, Esq.

VIII. Mr. DAVID STEVENSON to Sir JOHN RENNIE.

Edinburgh, 13th February, 1849.

SIR—In my Brother's absence I acknowledge receipt of your letter of the 10th, received this morning.

In order to prevent mistakes, I think it right to say, that my Brother's claim as to my Father's having originally proposed the erection of the Bell Rock Lighthouse, refers not to the mere establishment of a light or beacon, which, from the days of the Abbot of Aberbrothick has been before the public, as fully detailed in my Father's book, but to the proposal to erect a *building of stone*, which was first suggested by him in 1800.

It seems strange, if the late Mr. Rennie did not give my Father the credit of the work, that he should have written his letter of 7th September 1807 (for it is not a *small* degree of credit that can be said to "immortalise a man in the annals of fame"), and further, that he should never, either *directly or indirectly*, have intimated to my Father a contrary opinion. I confess I do not understand, after so great a lapse of time, the grounds of a claim of this kind, supported by an appeal to the statements of two foremen employed at the works, and *now dead*, whose testimony can never surely overturn that of my Father and of Mr. Rennie himself, as above alluded to. But if such evidence be to be founded on, we have ample reference to persons *now alive* who were employed at the works in similar capacities, and who give a very different account of the matter. I am, &c.

DAVID STEVENSON.

IX. Sir JOHN RENNIE to Mr. DAVID STEVENSON.

(*Bell Rock Lighthouse.*)

London, 15th February, 1849.

SIR—I beg to acknowledge the receipt of yours of the 13th, and have only to observe, that your supposition that the late Mr. Rennie gave your Father the credit of the Bell Rock Lighthouse is a mistake, for I have uniformly heard him say to the contrary. I view the extract of the letter you allude to wholly in a different light. The simple fact of your Father having been appointed *Assistant Engineer* under the late Mr. Rennie, and at his, Mr. Rennie's, request, independent of any other point, settles the question. It would be just as reasonable to give any of the gallant generals who commanded at Waterloo under the Duke of Wellington the credit of the battle of Waterloo, as to give an assistant engineer acting *under a chief*, and expressly appointed on that condition, the credit of the work of the *chief engineer.* I am sure that you will see that it is unnecessary to continue this correspondence. My statement is being printed, and the public will judge for itself. I am, &c.

JOHN RENNIE.

To David Stevenson, Esq.

(I did not think it necessary to reply to this Letter of Sir John Rennie; but there is obviously no analogy between the cases he compares, for the Duke of Wellington was present at the battle; but Mr. Rennie was not present at the work.)

A. S.

THE PHILOSOPHY OF NATURE AND ART.*

(Concluded from page 113.)

Mr. Fergusson's Fourth Chapter is on Etruria, his views with regard to which have already received some notice at our hands. He was, he says, originally opposed to the Lydian origin of the Etruscans, because almost every modern writer agrees in rejecting it. On the other hand, he found that almost all the old historians bear witness together for the Lydian origin. For it, we have Herodotus, Strabo, Pliny, Seneca, Plutarch, Paterculus, Tacitus, Appian, and Justin; and against it only Dionysius of Halicarnassus, and Hellanicus of Lesbos. Then, too, it is to be said, that hardly any modern writers agree as to what the origin is. The theory of Mr. Fergusson is the only one which is consistent with the old writers and the artistic evidence, while there is every appearance of likelihood in it.

Having laid it down that the Etruscans were a branch of the great Tartar race, and of the same blood as the Pelasgians, he is able to follow this out by a comparison with the artistic remains, which appear to support it. The Pelasgians in Greece so mixed with the Hellens, that the distinction was soon lost sight of,—but not until a great influence had been brought to bear on Greek art. The influence of Etruria on Rome was no less—perhaps more, for the latter took half her arts and civilization from Etruria; but the latter, until her fall, borrowed nothing from Rome.

Some who refuse the Lydian origin, assign an origin from Egypt; but Mr. Fergusson truly says, that, great as is the likeness between Etruscan and Egyptian works, they are not one and the same; and there has not been found in all Etruria, one single object of purely Egyptian character, or which would not raise wonder and perplexity on the banks of the Nile. A few scarabæi of the age of the Lagidæ must, of course, have been imported. That there is anything of the Egyptian spirit in Etruria our writer thinks the less wonderful, as the Egyptians held Asia Minor for five centuries before the presumed migration of the Etruscans.

The distinct shape of Mr. Fergusson's proposition is, that the Etruscans were a people of Lydia, or at least of Asia Minor, who, about a century after the time of the exode of the Jews from Egypt, or about as long before the Trojan war, in about the age of Ninus the Assyrian, and the year 8800 of the Decimal Era, emigrated by sea from Smyrna, the only port of Lydia, and landed and formally settled in Italy in the land of the Umbrians, between the valleys of the Arno and the Tiber, where they built or took twelve towns, in which they dwelt until the growth of people made them send off twelve bands of settlers to the northward, where they seated themselves in towns of the valley of the Po, subject to the old League. Afterwards, other twelve bands of settlers were sent off to the southward, who seated themselves in what was afterwards known as Magna Græcia.

As Mr. Fergusson says, this view solves at once one of the most difficult problems of ancient history, inasmuch as it states that both Greece and Italy received their civilization from the same source; and accounts for the great likeness between the arts and civilization of the two countries in the earlier ages of their being. This, too, accounts for the alphabetic characters of each, being of the same class, and not, as commonly assumed, by those of Etruria being borrowed from Greece. Both received them in Lydia from Phenicia.

This Etrusco-Pelasgic fellowship is so strong in the earlier times, that it is hardly possible to assign a distinct character to each;—so far from it, the works of either derive an illustration from the other; and no better commentary on the words of Homer and Hesiod can be found than the paintings from Cære or Vulci. If any one wants to see a contemporary illustration of the funeral games held by Achilles on the death of Patroclus, nowhere will he find a better than in the Etruscan room of the British Museum. There have we the charioteers, the riders, runners, wrestlers, boxers, and fencers; the hurlers of the quoit, and the darters of the spear. There have we the booths, with the lookers-on, and all the fashions of the high feast.

Mr. Fergusson remarks in Pelasgic Italy and in Pelasgic Greece the same want of temples; as too is to be noted in the motherland of Asia Minor. There was a worship for the same oracles, and the same love of soothsaying. In all these countries, the chief architectural remains are tombs; and these so like in make, as to be almost the same. The people worshipped the same gods, under almost the same names, and with the same rites; had the same eddas or mythology, and the same half-gods and heroes, of whom Hercules, the greatest, belongs almost as much to Lydia and Italy as to Greece.

Our writer having taken up the Lydian origin of the Etruscans, is willing to believe in the visits of Evander and Eneas to Italy. This tale has likelihood, but no good witness for it.

We think Mr. Fergusson decidedly wrong in the importance he attaches to the political form of the federation of the twelve towns. Republicanism is no more the characteristic of the Ibero-Pelasgic race, than kingship of the Indo-Europeans. The pages of Tacitus, and the early history of the English, will show that the Germani were essentially republican in their institutions; and whatever importance our writer may attach to those of the Iberi-Pelasgi, as influencing the freedom of Greece and Rome, the freedom of the world in this day springs from no such birth,—but from the laws of our forefathers in the marshes of Jutland.

Some time is given in the work before us to restoring what Vitruvius calls an Etruscan temple, but which is rather to be set down as Roman work. The suggestions of the writer are ingenious.

Of the tombs, we are told that they embrace a very wide period of time, and are well deserving of further investigation than they have received. The tumuli or barrows are a characteristic of the Etruscans, as of the whole race; and Mr. Fergusson gives many interesting illustrations of the Regulini-Galassi and other tombs, with an interesting restoration of the tomb of Porsenna, from the text of Pliny. This work was 400, perhaps 450, feet high, so that it was one of the most remarkable buildings in the ancient world. In this restoration Mr. Fergusson has introduced a roof, hat, or umbrella, to represent the *petasus* of Pliny.

Mr. Fergusson says that we shall never extract any new ideas of grand or monumental art from the remains of the Etruscans. In Greece, the temple and the theatre, with their accessories, supplied the focus to which the Grecian mind bent all its strength; in Egypt, the palace-temple served the same end: but in Etruria there were neither temples nor public buildings, other than tombs, for the development of art; and our writer thinks that tombs never are nor can be truly national monuments. He objects, that they were and must be the offspring of individual vanity or of individual superstition; and no nation ever was remarkable for tombs, when it was the custom to leave them either to successors or to national gratitude. That in Egypt, Etruria, and India, all the mausolea were raised by the great themselves in their lifetime, as their last resting-place. We cannot, nevertheless, agree that we, or the other Indo-European races, have a peculiar fear of death, but the contrary. The faith of Woden, even more strongly than that of Christ, held forth to the English greater joys to be had after death; and the fear of death is rather a characteristic of the Jews, than of Indo-Europeans. Still, it is the fact that the Indo-Europeans are not a tomb-building race: but that perhaps the rather because they have always attached more importance to the life hereafter than to the life of this world, and have not thought the latter wanted any remembrancer.

The chief development of the Etruscans was in the more useful arts, which the Greeks almost let alone. The roads and bridges of the Etruscans are still monuments of industry and constructive skill; their sewers and tunnels, after twenty-five hundred years' wear, are still unsurpassed by the great works of the Romans; and their town walls and castles are yet in being. They drained lakes and marshes, and tilled plains almost barren; so that they must have done much to bring Italy into a high state of civilization,—from which Mr. Fergusson thinks the Romans profited; and that they took the civilization of the Etruscans as their own, quoting "*Sic vos non vobis*": but if the Romans were in a state of barbarism on the fall of Etruria, the latter would be brought to the standard of barbarism—not the former to the standard of civilization.

In their engineering works, the Etruscans used several modifications of the arch, including the true arch, of which illustrations are given among the engravings.

If the Etruscans did not succeed in high art, in many of the lower arts they were most accomplished. Their jewellery, chains, bracelets, rings, earrings, &c., show an elegance which is even now unsurpassed. Their candelabra were sold in Athens in the proud days of Greek art. Their cabinet work of bronze and ivory reached a high degree of perfection.

From a review of the whole, Mr. Fergusson thinks we ought to assign a higher rank to the commercial people of Etruria than is commonly awarded to them. Their character essentially differs from that of the Egyptians in all its leading features, while Mr.

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* "An Historical Inquiry into the True Principles of Beauty in Art, more especially with reference to Architecture." By JAMES FERGUSSON, Esq., Architect; author of "An Essay on the Ancient Topography of Jerusalem," "Picturesque Illustrations of Ancient Architecture in Hindostan," Part the F[illegible]: Longmans, 1849.

Fergusson discovers a striking likeness to that of Assyria; and he urges the study of the antiquities of Assyria and Etruria, as a means of mutual elucidation. On every ground of art and archæology, however, the study of Etruscan antiquities is valuable and interesting.

The Fifth, and last Chapter of the volume as yet published, refers to Rome; and we think it needful to point out that Mr. Fergusson breathes as bitter a hatred of the Romans and all belonging to them, as he does a strong love for Greece and all that is Greek. The latter he looks upon as examples of what is to be followed; the former, of what is to be shunned. Of course, he has to deprecate the strong prejudices in favour of Rome; but we think his prejudices go as far the other way. He draws, therefore, a most unfair picture of education in England and abroad; and by too great violence misses the opportunity of giving useful advice.

As soon as a boy can spell short words in his own tongue, says our writer, he is sent to school to learn Latin; and from that hour till he leaves the university, nothing is dinned into his ears but Roman worth, Roman greatness, and Roman glory. Their learning, a low copy of that of Greece, is held up before his eyes as the richest and noblest the world has brought forth: the writers of his own people are kept from him; and the Christian faith still more carefully kept in the background, lest it should hinder his classical studies,—though these are avowedly as useless as they would be hurtful were it tried to carry them out They are, however, only learned to be forgotten, and the worst effect with us is lost time and misdirected ingenuity.

The above picture shows how passion may bewilder even the sharpest-sighted men, for hardly a word of it is true, and it will not fit England, France, or Germany. Latin is, it is true, taught—but so is Greek; the later writers are not unread, and no one can think but that theological teaching bears by far too great a share in the teaching of the English schools at any rate. The church catechism is a part of the examination for graduates, and men of bright minds have been plucked for giving answers in it, though with the right meaning, not in the very words.

We do not understand Mr. Fergusson to ask for the outlawry of Greek from the schools, but that it should be upheld; yet all that he says against Latin will tell as strongly against it—nay, it will tell against Hebrew and the Bible. "Neither an hereditary monarchy nor christianity formed any part of the institutions of Rome"—forsooth, neither did they of the Jews, Greeks, nor of our forefathers: indeed, such a ban would outlaw the learning of the world, and bring orthodox books within a narrower list than the *Index Expurgatorius* of the Vatican. The Bible, Homer, and Shakspeare all fall before such a sweeping law.

Scarcely less wild is the attempt to put to the account of the Latin classics, the various events of the French revolution; the good of which Mr. Fergusson sets aside, and the evil he exaggerates. We should say nothing about this, but in fairness to our readers we are bound to do so; for when a writer shows his weakness in such set shape, it is a warning against trusting him too far on other grounds. Many, too, will take the hint from his historical wanderings, to withstand his teachings on art.

Had Mr. Fergusson recommended the preference of Greek writers over those of Rome, he would have been consistent with himself, and done some good, for surely it is better to begin with the Iliad instead of the Eneid, as much as it is better to begin drawing from the round instead of copying from an engraving. As, too, the great purpose of classical studies in education is not to give immediate instruction, but to train the mind in habits of application and hard work,—and for which classical studies have advantages, peculiar to themselves as compared with mathematics and natural history,—the substitution of Greek for Latin, as the preliminary and preferential course, would be free from objections.

It is because Mr. Fergusson has not understood the nature of education, that he has fallen into a further mistake. He says, if there is one thing in which the common-sense of the English race has shown itself more than usually pre-eminent, it is the contempt with which the English treat their education, and their oblivion of it. It is because Greek, Latin, and mathematics only constitute the training machinery, and not the ultimate end of education, that they are set aside when the mind is trained, and the man is able to apply his powers to the business of the world around him. It is not that the Englishman contemns his education, but that he derives the best fruit from it,—that he does not want to carry his school-books about with him.

The mistake of the French and Germans leads to other results. They think that the great end of school education is to give immediate, special, and self-sufficing instruction: but the end is, that their men, fresh from school with the whole circle of the arts and sciences crammed into them, are unable to cope with our Englishmen, whose minds have been trained by hard work in their schools, and by the practice afterwards of that greatest of schools—the world. Some may think the Frenchman or High Dutchman better taught and more accomplished than the Englishman, but the evidence of facts is in favour of the superiority of the latter. What result the University of London, and the Useful-Knowledge-cramming system of the present day, may have in bringing down our superiority, remains to be seen.

If Mr. Fergusson is right as to his finishing stroke, the waning influence of Roman example, he might better have spared his onslaught: he would not have wasted his strength, nor wearied his allies.

The comment on the political history of Rome, tastes of the bitterness of the rest; but we can only grieve that a less partial analysis had not been applied, for the writer shows that he has the power, if he had the will, to make a fairer estimate of Rome than is commonly done. It wanted not virulent abuse and misrepresentation to teach us that Rome was neither greater nor better than ourselves: it wanted only a truthful investigation. He has brought to light many valuable reflections, on which we should like to comment,—but we cannot so well leave our beaten track as he can. By bringing the light of art to bear upon the political and social system, Mr. Fergusson has given a higher value to artistic studies, and has illustrated their importance. The fault now is, that the scholar is nothing of an artist, and the artist nothing of a scholar; and we therefore miss the entirety of ancient learning and art. Mr. Fergusson, therefore, legitimately discusses historical and political questions,—for, as he treats them, they belong to the domain of art; and any objections we may make apply to the doctrines, they demur to the allegations and not to the jurisdiction.

Were even Roman literature studied by the light of art, and in its entirety, Mr. Fergusson's diatribes would utterly miss.

We cannot refrain from observing, that if English literature were made to take the part of the classics in education, we should, it is true, get rid of the fondness for Roman worth, Roman greatness, and Roman glory; but we should be more given to self-glorification than we are—worse than the French, High Dutch, or Yankees. "La gloire de la France" would be outdone; the one, free, wise, and great Dutch folk would be out-talked; and "our most remarkable country" of the stripes and stars would swell itself up still more, in the strain to outboast the Britishers. It is better sometimes to think of Roman greatness and Roman glory, for they are no longer—they are with the dead: of the masters of the world we have nought but the ashes, and in the midst of the greatest empire that has yet been seen, lords of a fifth of mankind, we too may bethink us of the end of all things.

The remarks of our writer on Roman institutions are the key to those on Roman architecture; but they apply with more justice. Rome was certainly behindhand in art,—her architects, like our's, were copyists, and bad ones; originality she had none, and she could not derive inspiration from Greek art, for the breath of Greek art had fled; and of Etruria, she took rather the cerements of the dead than the fashions of the living.

Before the time when the Romans began to build, the Doric order had fallen from what Mr. Fergusson considers its early purity of style and design, and the Romans had neither carving nor painting with which to bedeck it. They took up the Doric order, but made it worse by thinning the columns, like the wooden posts of their Etruscan friends. On the Corinthian order Mr. Fergusson remarks at length. From its ornate character it well suited the purposes of the Romans, while it could be adapted as they pleased; and if the plan of the building needed little thought, the execution of the order needed still less, as there were no intricate spirals, no carving, and no painting, and all was purely mechanical—any stonemason could work it out. Our writer is willing, therefore, to consider it almost a Roman order, and the example in the temple of Jupiter Stator as the most perfect thing in architecture that Rome brought forth. He approves likewise of the Roman adaptation of a sculptured base.

The forms of the Roman temples are objected to as clumsy adaptations from the Greek. There is not a single instance of a perfect peristylar temple, and the buildings were small. The temple of Venus and Rome, commonly restored as a perfect peristylar example, 362 feet by 177, we think the writer justified in treating as two temple cells, placed back to back, and so joined together as to try to look like one temple.

The best specimens of temples of the Roman time are those built in the provinces, many of which, as those of Baalbec, must have been unmatched by anything at Rome, and the two temples at Baalbec unmatched by anything in the Roman world.

Of the Pantheon we believe our writer speaks fairly. He objects to the portico stuck on to the drum of the building, as a clumsy and unsuitable piece of patchwork, the lines of which do not range with the rest. The interior for conception is unmatched in the olden world. The simplicity of its proportions is dwelt upon as worthy of observation, though the details are Roman and clumsy. The proportion of the height being exactly equal to the width, Mr. Fergusson admires; and he thinks modern attempts fail from trying to combine the Gothic steeple with the Etruscan vault, and therefore the internal vault is carried high up into the external ornament,—thus ruining both its proportion and its size. Wren seems to have felt this, for his inner dome of St. Paul's is built up separately from his outer one, and kept down much lower. Mr. Fergusson, however, thinks it would have been infinitely more pleasing in proportion, and both it and the church have looked much larger, if, instead of being twice its width in height, it had sprung from the whispering gallery, or the stringcourse above that. Indeed, the dome of the Pantheon he would have brought ten or fifteen feet lower, because it now crushes the drum or perpendicular part, and makes its decorations look more insignificant than they should do.

We cannot complain of prejudice being shown against the civic buildings of the Romans, for they are treated as being as magnificent in their kind as any the world has yet seen. The Coliseum he selects as the type of Roman art, as he did the Hypostyle Hall of Karnac for Egypt, and the Parthenon for Greece.

The columns, and particularly the sculptured columns, of Rome, Paris, and London, Mr. Fergusson treats with severity; though, as he says, the Romans were the less to blame, as they placed the column of Trajan within the court of a basilica, having galleries from which its sculptures could be seen. Still, it would have been better had the same length of sculpture been made the frieze of a building.

The end to which he comes is, that the best and only satisfactory works of the Romans are those belonging to the engineer—the roads, bridges, aqueducts, harbours, and fortifications, the model of which was got from Etruria, and not from Greece. The distinctive merits of Roman works are the mass and the constructive magnificence,—marred sometimes, in architectural works, by clumsiness in the artistic details, for which engineering works offered little or no temptation.

If, says our writer, we have gone beyond the Romans in the two arts in which they were really original and successful—namely, law-making and engineering—why should we ascribe to them a superiority in literature and the fine arts, in which they were avowedly below the nations of antiquity?

We have thus followed Mr. Fergusson at some length through his elaborate work; we have followed him into every branch of research, and have not spared our pages or the time of our readers. We do not know if any ask that we should make an apology for so doing, but we feel that we have discharged a duty. Mr. Fergusson devotes talent, years, toil, and money to the execution of a work much wanted; and so far from treating his task as if it were to be slurred over, or as if it were unworthy, he has brought to bear upon it all the resources of a most cultivated mind, and all the illustrations of the most advanced state of knowledge. To do this is to uphold the nobility of art; and we should be sorry to stand idly by when such a service was done,—to neglect a work which has justly excited the greatest attention from the press and the public,—or to treat with coolness what has been wrought with such good will.

If we had wanted one reason above all others for noticing Mr. Fergusson's book, it is to uphold him under the accusation of introducing irrelevant matter; whereas we consider he has rendered a common service to the fine arts and the other branches of learning, by showing their intimate connection,—and the more particularly, by the reference of the fine arts to philosophy. He is only blamed for the idleness and ignorance of others; and instead of joining with them, we recommend to them his example.

The fine arts are either unworthy studies, or they belong to the general circle of learning, and admit of illustration from it. If the latter, our artists must become scholars, which so few of them are,—and our scholars must become artists. Whoever brings back one art or science to the common fold of learning, renders an essential service to all arts and sciences; and we think this merit is due to Mr. Fergusson, for treating systematically what the great men who have gone before him have given authority for by treating with partiality.

This work will be esteemed a useful and valuable one according to the use the reader makes of it. If he slurs over it, as requiring too much thought and care,—if he casts it aside as opposed to his prejudices,—or even if he blindly adopts its conclusions, he will not ascertain its value: but if he truly seizes the independent spirit of the author,—if he sets himself free from the shackles of cant,—and gets the power of thinking for himself in matters of art, he will have rendered a service to the fine arts, by giving them one true votary the more.

CANDIDUS'S NOTE-BOOK,

FASCICULUS XCIII.

> "I must have liberty
> Withal, as large a charter as the winds,
> To blow on whom I please."

I. It is equally matter for surprise and regret, that, instead of confining his study, as he appears to have done, to Palladio's buildings, Inigo Jones did not, while he was at Venice, direct his attention to the examples of the earlier Venetian style,—from which he could have culled much that was capable of being engrafted on the Elizabethan he had left at home, and by the aid of which he might have advanced the latter to a finished English style,—at least, have put it in the way of becoming such in time; for between both the styles just mentioned there are, with of course many differences, not a few points of contact also; and an infusion of the former might greatly have improved the latter. Instead of so doing, Inigo contented himself with importing the style of Palladio quite "*neat*." Thereby he has obtained among us the name of the English Palladio;—the plain English of which is, that as far as he was Palladio at all, he was so only at second-hand—a professed imitator and copyist.

II. It may very fairly be questioned whether professional men are the best judges of æsthetic quality in design, and capable of appreciating it impartially. Educated as they are at present—which is pretty much like being uneducated as regards the essential principles of their *Art*—architects are apt to contract prejudices which in turn contract both their judgment and taste; blinding them equally to errors and defects in productions of established repute, and to merits in those which happen to deviate more or less from conventional rules. The opinion which is unsupported, either way, by valid reasons for it, and rests only on an appeal to precedent, custom, and ordinary rules, is surely no better than prejudice; and even if it be one on the right side, it is no better than prejudice still. Nor are prejudices and contracted notions confined to professional men, since the generality of critics are equally chargeable with them, owing to their having imbibed them from the same sources as the others, and to their speaking by rote—"by heart," as it is called, and that is a very different matter from speaking *by head*, and with thoughtful consideration. For my own part, I should be inclined to trust rather to the verdict of a jury of artists, than to that of one composed entirely of architects; of course I mean only as far as composition and design are concerned. What strikes the eye of an artist as good, as harmonious and consistent in its proportions and *ensemble*, and otherwise effectful, may pretty safely be assumed to possess the merit of sound artistic quality, if no other. It is true, the followers of the other Fine Arts cannot be competent judges of the technicalities and processes of Architecture; but then if such ignorance ought to disqualify them from passing any opinion upon productions of Architecture, the same ignorance, or perhaps a greater degree of it, would disqualify the whole of the rest of the public; so that architects would have none but themselves to admire them, or to patronise their Art. As to the opinion entertained of architects by artists, I fancy it to be the reverse of flattering, for among the latter I have heard more than one accuse the former of obtuseness, and want of æsthetic perception and feeling—at any rate, of the non-exercise of them; therefore, although Architecture itself may be a Fine Art, it is now rarely exercised as such,—so that those who practise it merely according to precedent and routine, have little or no claim to the title of artists; for even although the structures erected by them may be satisfactory, scarcely ever do they put into them aught of design which emanates directly from their own minds.

III. The value of an artist's opinion in regard to Architecture is sufficiently apparent from what that of Reynolds has done for Vanbrugh. But for the honourable testimony borne to his peculiar merits by Sir Joshua, the name of that Sir John might still have had attached to it the ridicule endeavoured to be affixed to it by the puny wits of his day—or rather, by the puny witticisms which, in their utter ignorance of art, they levelled against him; seeing, as they did, no other quality in his buildings but that of heaviness. That Vanbrugh was exceedingly careless and faulty in his details —sometimes coarse even to slovenliness, is not to be denied; still, he showed himself to be a master in picturesque composition, especially if compared in that respect with his contemporaries. To unqualified praise he is assuredly not entitled, but assuredly also it is not difficult to discriminate between his defects and his merits,—not difficult to avoid the former, although not so easy, perhaps, to rival the latter.

IV. It would seem, however, that critical discrimination is not at all the *forte* of either architectural students or their teachers. It is not at all uncommon to find buildings that are exceedingly unequal in point of design, good perhaps in some respects, yet equally faulty in others, recommended—at least, so it would seem —as studies, without one syllable of caution as to their faults. Of some of them, indeed, the faults are so striking that they hardly need be pointed out; still there is danger in passing over them. Hence much mischief is likely to ensue from such works as Letarouilly's "Edifices de Rome Moderne," from which some are now freely borrowing subjects, which they exhibit as if they were most unquestionable models of design and good taste—nothing being said to the contrary. For such purpose, one publication has recently selected the façade of the Palazzo Costa, which, either in ignorance or unwarrantable audacity, it asserts to be "characterised by elegance, resulting from a study of proportion, fitness, and requirements;" whereas, the fact is, it shows itself to be characterised by the reverse of elegance, and by what, as far as the principal floor is concerned, may truly be called very dumpy proportions, the windows there being considerably less than a double square in height, and not even twice as high as the pedestal or dado beneath them; nor is that the only defect in the design. Another subject selected by the same publication from Letarouilly, is the elevation of a little palazzo, by Vignola, in the Piazza Navona. Although Vignola is a great name, the merit of that design of his is exceedingly small; consequently it ought not to be put forth as if it were such as to recommend itself to especial notice at the present day.

V. That all the views of the façade of the British Museum which have hitherto appeared should confine themselves to the central pile, and judiciously omit showing the wings, is so far from being complimentary to Sir Robert Smirke, as to be equivalent to a declaration that the latter do not at all belong to the other, and that so far from contributing at all to form a grand extended composition, they are to be looked upon as something altogether extraneous,—in other words, will not bear looking upon as adjuncts to the main pile. Pity, therefore, that those official residences were not, as they easily might have been, put quite in the background, and the sites now occupied by them left for the erection of additional galleries, as will, no doubt, be required at no very distant period. The tacit condemnation would be critical damnation enough of the façade as a composition, even were it not accompanied by a taciturnity on the part of criticism with regard to the rest, which gives us plainly to understand that not even a single syllable of praise can be plausibly uttered in favour of it. Setting aside the columns themselves, which are no more designed by Sir Robert than by the stonemasons who executed them —there is nothing whatever that amounts to design properly so called. Besides which, as here applied, the number of columns is made to produce far more of dull monotony than of richness and scenic effect; which, however, is not very surprising, since Smirke and Effect are the very antipodes of each other. As I have more than once before, I believe, expressed my opinion of the Museum, many—that is, what readers I have, will probably think I entertain downright spite against it. Well, I confess to the impeachment; for I do hold the building to be a miserable abortion in point of design, considering the purpose of the building, and the opportunity which it afforded. At any rate, if the public can be satisfied with the Museum, they have very little right to find fault with the National Gallery as they do. The latter, however, is made the scapegoat of our architectural sinnings, or the conductor to carry off the lightning of our criticism from many things that are infinitely worse. It may be freely admitted that the Gallery is neither what it ought to have been, nor so good as it is still capable of being made, both in its interior and exterior, by some partial alterations; yet, as regards the interior, no alterations can be planned for it properly until it be finally determined whether the Academy are to retain the portion now occupied by them, or the whole be appropriated to the national collection of pictures. At all events, it cannot be said even now that Wilkins's structure disgraces Trafalgar Square, the latter and the buildings on its other sides being quite graceless in themselves. Those, too, who can shut their eyes to the uncouth taste and vile deformities of St. Martin's Church, and open them only to admire the portico, or rather the columns, might surely do the same with regard to the Gallery. Still it is not very difficult to guess why they do not do so, the true reason being simply this: the one has been greatly cried-up, and the other cried-down.

VI. St. Stephen's, Walbrook, is another greatly cried-up affair; and as in matters of architectural taste former judgments are never revised, but seem to be regarded as irrevocable verdicts,—it continues to be still spoken of as a masterpiece—that is, whenever it is now spoken of at all. In my opinion, the defects in its design so greatly exceed its beauties as completely to neutralise them. There is much in the interior that is positively mean and ordinary; and with more than light enough, there is no effect of light,—on the contrary, a most disagreeable kind of spottiness in that respect is occasioned by the ugly little oval holes in the walls for windows; whereas, had the whole been lighted *hypæthrally* through the dome,—with perhaps one or two smaller secondary openings for light in other parts of the roof, the effect both as to light and otherwise would have been greatly superior. I have seen a drawing by Allom, of an interior—a design, I believe, for a chapel—which was so undisguisedly borrowed from St. Stephen's, Walbrook, that it might be considered a *rifacciamento* of it; and the outline of the idea—so to speak, was there filled up gracefully and artistically, and the original skeleton transformed into life and beauty.

VII. At the risk of shocking the straitlaced prejudices of many, I venture to question the propriety of invariably putting churches, as we have done for some time past, into mediæval costume, to the exclusion of any other style. In villages, and other country places, it is in character and at home, but seems quite out of keeping in streets where every other object wears quite a modern air, and denotes the reverse of mediæval times and habits. I admit that one tolerably sufficient, or I might call it cogent, reason there may be for having recourse to a style at variance with that of all surrounding buildings—namely, the very fact of its being so much at variance, that the mere adoption of such costume stands in lieu of other character—of that distinctive character which an architect would else have to work out of design. Do I then wish that for churches in the metropolis we should turn to Wren for models, or return to that *soi-disant*-classical style which was in vogue among us some twenty or thirty years ago? Most assuredly not: for while the old churches in the City are almost without exception barbarously uncouth, the modern ones are, with the exception of that of St. Pancras and Hanover Chapel, desperately dull and mean; and even St, Pancras and the other might be greatly better in many respects than they now are.—If such be the case, why should I advocate the return to a style in which so little that is satisfactory has been performed for church architecture? Why, it is precisely for the very reason that so little has been done in it properly, and answerably to the capabilities of such style, that I could wish to see it resumed,—but treated in a very different spirit, and so converted, as it easily might be, into something very superior to what has hitherto been made of it. Here I ought, perhaps, to explain that "Easily" refers rather to the plastic capabilities of the style itself, than to the capacity of the present race of architects for properly availing themselves of those capabilities. One thing that would be an improvement in itself, and also lead to other improvements, would be the adoption of *hypæthral lighting*, either according to the mode which Mr. Fergusson shows to have been practised by the Greeks, namely, by upright openings in a clerestory in the roof,—or else by lanterns or skylights, after which last manner the German Walhalla is lighted. For artistic effect nothing can equal such mode of admitting light; whereas, even leaving effect out of the question, the windows now employed for churches are little better than architectural blemishes both internally and externally. Of course I mean in those churches which are not in the Gothic style, because there windows are among the principal characteristics and beauties of the style, and the source of great variety of design; while for so-called Grecian or modern church architecture, they are just the reverse. So far from being made ornamental in any way within the buildings, they are there left mere naked apertures, without any sort of dressings or attempt at such embellishment as might be conferred upon them; and there being nothing corresponding to mullions and tracery to fill up the apertures themselves or give occasion to design, their appearance is that of nakedness, blankness, and poverty: the consequence of which is, that the more there is of ornament bestowed on other parts of such an interior, all the meaner do the windows show themselves, especially as the glazing itself is invariably of a very mean description, and has a cold and dingy look. Yet, surely it would not be difficult to remedy the last-mentioned defect by employing metal-work instead of lead, and making it of various ornamental patterns that should be in conformity with the style of the architecture. Internally, the metal-work might be either entirely gilded, or partly gilt and partly bronzed, accordingly as a greater degree of enrichment might be found suitable. Hardly necessary is it to observe, that both stained and diapered glass might also be employed with excellent effect; although, of course, it would require to be treated in quite a different manner from the painted windows in Gothic churches, so that the resemblance should be only that of material, and not of style and ideas. And why should the use of coloured glass be confined to one particular style, any more than other materials are?—"Gentle Shepherd, tell me why."

ON THE OBLIQUE BRIDGE.

By F. Bashforth, Esq.

Spiral Courses.

Mr. Buck, in his "Essay on Oblique Bridges," directs the "twisting rules" used in working the beds of the arch-stones, to be placed at a greater distance apart at the extrados than at the intrados. There could be no objection to such an arrangement, provided the dimensions of the "twisting rules" were determined accordingly: but it has long appeared to me that the method by which Mr. Buck has arrived at the difference of the widths of the two ends of one rule ($=l\tan\delta$), supposes that they are to be applied in *parallel* directions on the bed of the stone, at a distance l apart.

Let R, r, be the radii of the extrados and intrados respectively;
Φ, ϕ, the angles of the extrados and intrados;
l, l', the distances apart of the intradosal and extradosal ends of the twisting rules;
$\Phi-\varphi=\delta$; and $R-r=e=$ the thickness of the arch.

$$\text{Then } l'=l\frac{\sec\Phi}{\sec\varphi}.$$

In Example 2, page 25, $R=20{\cdot}32$ ft.; $r=17{\cdot}32$ ft.; $e=R-r=3$ ft.; $l=42$ in. $=3{\cdot}5$ ft.

$$\Phi = \angle\text{ of the extrados (Mr. Buck's }\varphi) = 59^\circ\,23'\,7'';$$
$$\phi = \angle\text{ of the intrados (Mr. Buck's }\beta_2) = 55^\circ\,13'\,49'';$$
$$\delta = \Phi-\varphi = 4^\circ\,9'\,18'';$$
$$l\tan\delta = 42\tan 4^\circ\,9'\,18'' = 3{\cdot}05\text{ inches};$$
$$l' = l\frac{\sec\Phi}{\sec\phi} = 47{\cdot}03 = 47\text{ inches nearly.}$$

Mr. Buck directs two strips of wood to be provided (AB, CD, fig. 1), each in length $R-r=3$ ft. The opposite sides of one, AB, are to be parallel, and of the other the end D is to be greater than the end C by $l\tan\delta$, or 3·05 inches in this case. A, C, are to be applied at the intrados at a distance l, or 42 inches, apart; B, D, are to be at the extrados, and at a distance $=47$ inches apart.

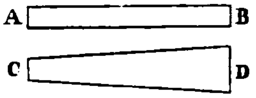


Fig. 1.

The twisted beds of the arch-stones may be supposed to be generated in the following manner:—Let the straight line AC (fig. 2) have an arm BDE rigidly attached at right angles to it; and let D, E, be two points, such that $BD=r$, $BE=R$. Suppose AC to coincide with the axis of the intrados of the oblique arch, and have a *uniform* motion in the direction of its length AC; and also let the arm BE revolve *uniformly*. Suppose these uniform velocities to be so adjusted that BE may revolve through 180° whilst any point B in AC describes a space $L=$ the axial length. Then DE will describe the twisted surface proper for the beds of the arch-stones, and the equations to the path of D will be

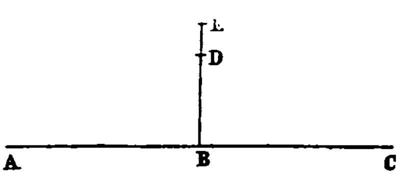


Fig. 2.

$$z=r\cos\theta,\quad x=r\sin\theta,\quad y=\frac{L}{\pi}\theta=\mu\theta\;\ldots\ldots\ldots\ (1)$$

the horizontal axis of the cylinder being the axis of y, and a vertical line with which BD coincides when $\theta=0$ being the axis of z.

Also, the equations to the path of E will be

$$Z=R\cos\theta,\quad X=R\sin\theta,\quad Y=\mu\theta\;\ldots\ldots\ (2)$$

And if, in equations (1) and (2), we give θ the *same* value α, the corresponding values of $x\,y\,z$, $X\,Y\,Z$, will be the co-ordinates of the points D, E, respectively, for one position of the arm BE; and these points may be considered to be coincident with two corners of the bed of an arch-stone. Also, by giving to θ another value, β, we may determine the co-ordinates of the remaining two corners of the same bed.

Suppose that P, p, Q, q, are the four corners of the bed of an arch-stone, pq being the intradosal, and PQ the extradosal coursing joints. Let $X'Y'Z'$, $x'y'z'$; $X''Y''Z''$, $x''y''z''$, be the co-ordinates of P, p, Q, q, respectively. $\theta=\alpha$ for P and p; $\theta=\beta$ for Q and q.

$$\begin{array}{cccc}\text{For P.} & \text{For } p. & \text{For Q.} & \text{For } q.\\ \left.\begin{array}{l}X'=R\sin\alpha\\ Z'=R\cos\alpha\\ Y'=\mu\alpha\end{array}\right\}(3) & \left.\begin{array}{l}x'=r\sin\alpha\\ z'=r\cos\alpha\\ y'=\mu\alpha\end{array}\right\}(4) & \left.\begin{array}{l}X''=R\sin\beta\\ Z''=R\cos\beta\\ Y''=\mu\beta\end{array}\right\}(5) & \left.\begin{array}{l}x''=r\sin\beta\\ z''=r\cos\beta\\ y''=\mu\beta\end{array}\right\}(6)\end{array}$$

Let $z=Ax+By+c$ (7) be the equation to a plane passing through the three points P, p, q.

Then, since (3) and (4) are points in (7), substituting, we get

$$Z'=AX'+BY'+c;\qquad z'=Ax'+By'+c;$$
$$\text{or, } (R\cos\alpha) = A(R\sin\alpha)+B\mu\alpha+c\;\ldots\ldots\ (8)$$
$$r\cos\alpha = Ar\sin\alpha+B\mu\alpha+c\;\ldots\ldots\ (9)$$

Subtracting,

$$R\cos\alpha-r\cos\alpha = A(R\sin\alpha-r\sin\alpha);$$
$$\text{or, } (R-r)\cos\alpha = A(R-r)\sin\alpha;\qquad\text{or, } \cot\alpha = A.$$

And therefore equation (9) becomes

$$r\cos\alpha = r\cot\alpha\sin\alpha+B\mu\alpha+c = r\cos\alpha+B\mu\alpha+c;$$
$$\text{or, } 0 = B\mu\alpha+c;\qquad\text{or, } c=-B\mu\alpha.$$

Equation (7) now becomes

$$z = x\cot\alpha+By-B\mu\alpha = x\cot\alpha+B(y-\mu\alpha)\;\ldots\ldots\ (10)$$

And the point (6) is situated in this plane; hence,

$$z'' = x''\cot\alpha+B(y''-\mu\alpha);$$
$$\text{or, } r\cos\beta-r\cot\alpha\sin\beta = B(\mu\beta-\mu\alpha) = B\mu(\beta-\alpha);$$
$$\text{or, } \frac{r\sin(\alpha-\beta)}{\sin\alpha} = B\mu(\beta-\alpha);\qquad\text{or, } B=\frac{r\sin\alpha(-\beta)}{\mu(\beta-\alpha)\sin\alpha}.$$

Substituting in (10), we get the equation to the required plane passing through P, p, and q,

$$z = x\cot\alpha+\frac{r}{\mu}\frac{\sin\alpha(-\beta)}{(\beta-\alpha)\sin\alpha}(y-\mu\alpha)\;\ldots\ldots\ (11)$$

Suppose now that the distance pq (fig. 3), measured along the intradosal arris of the arch-stone, $=l$; and that the angle $qpm=\phi$. Let fall the perpendicular pm on qm. Then mpq may be considered to be a portion of the development of the soffit, pm being parallel to the top of the abutment.

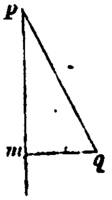


Fig. 3.

$$pm = y''-y' = Y''-Y',\text{ in (3), (4), (5), \& (6), } =\mu(\beta-\alpha)$$
$$= pq\cos\varphi = l\cos\varphi\;\ldots\ldots\ (12)$$
$$\text{Also, } l\sin\phi = mq = r(\beta-\alpha)\;\ldots\ldots\ (13)$$

Now, the length of a perpendicular let fall from a point $X''\,Y''\,Z''$, on a plane $z=Ax+By+c$, is

$$Qn=\pm\frac{Z''-AX''-BY''-c}{\sqrt{1+A^2+B^2}}\quad\textit{Hymers' Geom. of 3 Dimensions. }\text{Art. (37)}$$

And substituting from equation (11) the values of A, B, and c, we get length of the perpendicular let fall from X'', Y'', Z'', on the plane (11),

$$Qn = \pm\frac{Z''-X''\cot\alpha+\dfrac{r}{\mu}\dfrac{\sin\overline{\alpha-\beta}}{(\alpha-\beta)\sin\alpha}(Y''-\mu\alpha)}{\sqrt{1+\cot^2\alpha+\left(\dfrac{r}{\mu}\dfrac{\sin(\alpha-\beta)}{\sin\alpha(\alpha-\beta)}\right)^2}}$$

$$= +\frac{\dfrac{R(\sin\alpha\cos\beta-\cos\alpha\sin\beta)}{\sin\alpha}+\dfrac{r}{\mu}\dfrac{\sin(\alpha-\beta)}{(\alpha-\beta)\sin\alpha}\mu(\beta-\alpha)}{\sqrt{\operatorname{cosec}^2\alpha+\dfrac{1}{\sin^2\alpha}\left(\dfrac{r}{\mu}\dfrac{\sin\overline{\alpha-\beta}}{(\alpha-\beta)}\right)^2}}$$

$$= \pm \frac{\mathrm{R} \sin(a-\beta) - r \sin(a-\beta)}{\sqrt{1 + \left\{ r \dfrac{\sin\left(\frac{l}{r} \sin\varphi\right)}{l \cos\varphi} \right\}^2}} = \frac{(\mathrm{R}-r) \sin\left(\frac{l}{r} \sin\phi\right)}{\sqrt{1 + \left\{ \dfrac{r}{l} \dfrac{\sin\left(\frac{l}{r} \sin\phi\right)}{\cos\phi} \right\}^2}} \quad (14)$$

$l = 42$ in. $= 3{\cdot}5$ feet; $(\mathrm{R}-r) = 3$ feet; and $\phi = 55° 13' 49''$.

$\frac{l}{r} \sin\varphi = {\cdot}1660$, which is the circular measure of 9° 30′ 40″;

$$1 + \left\{ \frac{r}{l} \frac{\sin\left(\frac{l}{r} \sin\phi\right)}{\cos\varphi} \right\}^2 = 3\ 0558;$$

$$\mathrm{Q}n = \frac{36 \times \sin\left(\frac{l}{r} \sin\phi\right)}{\sqrt{3{\cdot}0558}} = 3{\cdot}403 \text{ in.} = 3{\cdot}4 \text{ in. nearly.}$$

Now, manifestly, $\mathrm{PQ} : pq(l) = \mathrm{L} \sec\Phi : \mathrm{L} \sec\varphi = \sec\Phi : \sec\varphi$;

$$\text{or, } \mathrm{PQ} = l \frac{\sec\Phi}{\sec\varphi} = 42 \frac{\sec(59° 23' \ 7'')}{\sec(55° 13' 49'')} = 47{\cdot}03 = 47 \text{ in. nearly.. } (15)$$

If the "winding strips" be applied in the manner directed by Mr. Buck, the difference in the widths of the two ends of the one that has not parallel sides ought to be 3·4 in., instead of 3 inches as there given.

If, on the contrary, the winding strips be so applied that the distance of the intradosal ends A, C, and also the distance of the extradosal ends B, D, be 42 in. apart, the twist $(l \tan\delta) = 3{\cdot}05$ in. is quite correct. If $\mathrm{AC} = 42$ in., and $\mathrm{BD} = 47$ in., then we get for the twist $3{\cdot}05 \times \frac{47}{42} = 3{\cdot}41$ in., which differs only by $\frac{1}{100}$th of an inch from the value of Qn found in (15).

It is quite true, when an arch-stone for an oblique bridge (not a quoin) has been properly formed, that the *length* of the extradosal arris PQ will be greater than the intradosal arris *pq* of the same bed, in the proportion of $\sec\Phi : \sec\varphi$. But, on the other hand, the sole use of the winding strips is to obtain two straight lines a certain distance apart, such that if two other straight lines be drawn parallel to them through a given point, these two straight lines may contain a given angle.

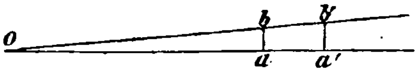


Fig. 4.

If tangents be drawn to the extradosal and intradosal helices at the points E, D, corresponding to one position of the arm BD, these tangents will be inclined at an angle $\Phi - \varphi$. Hence, if the winding strips are to be applied *parallel* at a distance $(\mathrm{R}-r)$, and in the *direction of the length* of the stone, make the angle $boa = \Phi - \phi = \delta$; take $oa =$ the length of the rules, and draw ab at right angles to oa. Then $ab = oa \tan\delta$ is the required twist. Again, if the strips are to be applied *across the stone*, they must each be in length $= \mathrm{R} - r$. Suppose they are to be applied parallel, and at a distance $l = oa'$; draw $a'b'$ at right angles to oa' meeting ob' in b'; then $a'b'$ will be the excess in breadth of one end of the rule over the breadth of the other end of the same rule.

In Mr. Buck's Essay, pages 13, 22, and 27, the difference of $\frac{4}{10}$ths of an inch in 3 inches appears to be worthy of notice; but it may be remarked that the obliquity of the bridge in this example is 30°. In the generality of cases, the difference of the twist would not be nearly so great as in the above example; but as it is both more accurate and more convenient to apply the winding strips in parallel directions, there appears to be no reason why any trouble should be taken to calculate the *divergence* of them.

The value of Qn at (14) may be put under the form

$$\mathrm{Q}n = \frac{e \sin\left\{\frac{l}{r} \sin\phi\right\}}{\sqrt{1 + \tan^2\phi \left\{ \dfrac{\sin\left(\frac{l}{r} \sin\phi\right)}{\left(\frac{l}{r} \sin\phi\right)} \right\}^2}} = \frac{e \frac{l}{r} \sin\varphi}{\sqrt{1 + \tan^2\phi}} \quad \text{nearly}$$

$$= \frac{el}{r} \sin\varphi \cos\phi = \frac{el}{2r} \sin 2\phi = 3{\cdot}408 \text{ inches}$$

(since ϕ is never much greater than 45°, and r is always much greater than l).

St. John's College, March, 1849.

REVIEWS.

A Dictionary of Architecture, Decorative and Constructive, &c. By Walter Bernan. Part I. 18mo. London: Williams and Co., 1849.

We have here a novelty,—a novelty, at least, in its shape, for although we have had more than one dictionary of the kind before, this is, as far as we are aware, the very first that has appeared in so convenient and popular a form. It goes, perhaps, to the opposite extreme from some of its predecessors; and we think that a size larger—one adapted to the book-shelf, rather than the pocket —would have been preferable, and if similarly printed in double columns, quite as economical. Judging from this First Part, which though it contains sixty-four pages, goes no further than the term "Architholus," the volume must when completed be an inordinately bulky one,—unless it be intended that the work shall eventually form more than one volume, of which however no intimation is given; neither is it stated in how many parts it will be completed. What is chiefly certain is, that it is designed to be a popular manual for the use of artificers and workmen, as well as architects, engineers, and students of architecture; which being the case, we cannot help being of opinion that the editor has overdone it, and in his ambition to introduce "many hundred words that have not been inserted in any previous architectural dictionary," has crammed into it a great many which are quite out of place except in a professedly archæological glossary. To give those terms belonging to mediæval architecture which are now in use, is proper enough; but to thrust in those which have long been altogether obsolete, which cannot be now revived, and which are not at all needed, the same things being now described by more familiar words, is not only injudicious as far as the work is concerned, but injudicious in its principle, inasmuch as instead of enlarging and enriching, it only encumbers the vocabulary of the art with antiquated and useless lumber. Whether, as it certainly ought to do, this dictionary will give us such really convenient and useful terms as "Astylar," and several others that have been employed by recent writers, remains to be seen when it shall have been more advanced. We find the term "Æsthetics," but the definition—such as it is—is only a borrowed quotation; from whom is not said, but apparently from Mr. Joseph Gwilt, for if the words be not precisely the same, they certainly express his sneering opinion of a term which, in the glossary appended to his treatise on "The Orders," Mr. Leeds has shown to be singularly expressive and useful.

The explanation of the term "Anti-Vitruvian" is also partly borrowed, and apparently from the same source, the remark printed as a quotation being as follows: "Erroneous opinions adverse to the classical authority of Vitruvius on architectural topics, expressed by some modern professors to attract notoriety." This seems to be pointed against Professor Hosking; but others, among whom are both Fergusson and our own Candidus, have been equally strong, therefore equally erroneous, and no doubt from the same unlucky ambition of "attracting notoriety." Yet, after all, it may be questioned whether error does not lie rather on the side of Vitruvius's admirers,—his defenders we cannot possibly call them, since they say nothing whatever to rebut the sneers of his *notoriety-seeking* opposers. Now, if any one be Quixotic enough to take up his cudgel fairly in behalf of Vitruvius, and in good earnest belabour with it his depreciators, let him do so; but the merely calling their opinions erroneous is not very far from admitting them to be correct; nor has Mr. Bernan attempted to settle the dispute. We rather fancy that some of the remarks which he himself has occasionally indulged in, will, if they do not actually involve him in dispute, prove not a little offensive to many. The following, for instance, which occurs under the term "Architect," is tolerably strong and pungent: "In spite of the opinion of the ignorant public, re-echoed by the dull and costive-brained (!) of the profession, which confounds the means with the end, the merit and fame of an architect must rest on his talent for *invention;*"—the italics are not ours—"without it all the constructive knowledge of his age will not raise him above the rank of a builder-mechanic: and he alone is to be accounted happy in his art to whom the gods have granted the creative spirit. The supremacy of the gift is apparent from its rarity."—Bravo! Bernan: for that matches Fergusson's "monkey styles of modern Europe;" or the piquant escapade in Leeds's treatise on "The Orders," viz., where copyism is defined to be the process for converting design into manufacture, and an architect into a machine. Verily, architectural heresy seems to be spreading—some will say, most alarmingly,—or as others will reply in rhyme, most charmingly. "Amateur-Architects" are treated by Mr. Bernan more mildly than "costive-brained" professionals. He admits them to be "useful pioneers in diffusing a taste for the art among the public;" nor will we quarrel with him for speaking of "their actual ignorance in general of the rudiments of the art." The ignorance of such persons is, undoubtedly, to be regretted, but is no more the necessary effect of their being amateurs, than it is the cause of their becoming such. But in ignorance both they and the rest of the public are likely to remain a long time, before the professionalists endeavour to enlighten them by supplying them with the sort of elementary instruction needed for properly pursuing the study of architecture in its character of a Fine Art. Confessed it must be, that those who at present pass for amateurs—because they happen to be the one-eyed among the blind—are, for the greater part, mere dabblers,—persons without any real artistic knowledge or feeling; apt, as is here said, to be "unwearied talkers," but talkers of mere nothings, retailers of *dates* and such matters, very much in the style of "In the name of the Prophet! Figs." As to talking, however, they seem to have rivals in those whom Mr. Bernan styles "PALAVERING ARCHITECTS"! Even so; for he has actually ventured to introduce, or rather thrust into his Dictionary, a term which we suspect he has invented for the nonce,—viz. "ARCHITECT VERBORUM. A palavering architect; one who is loquacious evermore, and produces trifles; one who supplies the lack of artistic invention by verbal knackery, &c. &c." Really our friend Candidus is meek as a sucking dove in comparison with Bernan.

Materials for a New Style of Ornamentation, consisting of Botanical Subjects and Compositions drawn from Nature. By H. WHITAKER. London: Weale, 1849.

A work of this kind is a proof of the healthy growth of public opinion in matters of art. The author has been impressed with the want of originality in the ornamental details of our architectural works, the servile copying of classic models, and the demand that now exists for a better application of our artistic resources. It is not that the classic models are bad, for many are most beautiful; it is not so much that they are hackneyed—because beauty can never pall,—but that the monopolitan adherence to former types involves the neglect of all else that is beautiful in nature.

We have all those plants which the Greeks so justly admired and studied; but we have access, as they had, to many others,—and still more, we have access to the vast field of nature which was beyond their reach, and which daily yields to us new forms, from the same Mighty Hand, and endowed with the same admirable attributes. It is this neglect, this abnegation of the great domain of the beautiful in nature, which has constituted one of the greatest reproaches on our modern school of art. With material resources greater than the Greeks, we remain their copying slaves,—as much enthralled as if we could be sold by an Atticus, a Cassius, or a Seneca, who bought and sold learned and artistic slaves.

Mr. Whitaker has, without any presumption, undertaken to apply some of the materials within his reach, and has, from plants unknown to the ancients, elaborated foliage well worthy to be compared with any designs of the best schools of old. He has not attempted to lay down the law as a teacher: he only shows the way in which others can direct their studies; and he gives most useful examples. This manual will be the more valuable, not for the designs it contains, for they are necessarily limited in number and scope,—but for the practical directions and exemplifications it affords for the guidance of the architect and student.

With the progress of public taste the architect has assumed more extended functions; and instead of copying a plate from the authorities, and leaving the details to the stucco merchant, he is called upon to exercise his inventive faculties on the architectural decorations, external and internal, the furniture, fittings, paper, and carpets; and where he does not design, he has to check the designs of the inferior artists, men now well trained in the Schools of Design. He has likewise to obey the requisitions of patrons more fastidious, because possessing a better knowledge of art; and the architect has therefore only one means of making his way, and that is by working hard. The day of copying is doomed, and those who will not give in to the new movement, will be themselves given up. Already we perceive in our public works a happier disposition, and strong indications of the professional ardour, though rather in the way of promise than of performance.

HYDRAULIC ENGINEERING.

1. *Remarks on the Improvement of Tidal Rivers, illustrated by Reference to works executed on the Tay, Ribble, Forth, Lune, and other rivers.* By DAVID STEVENSON, C.E. Second Edition. London: Weale, 1849.
2. *Report of the Committee appointed by the River Dee Commissioners.* Chester, 1848.

There is no branch of engineering so obscure as that which relates to the improvement of rivers and harbours, and perhaps it is so from the want of good collections of observations and facts. If anything is published, it is commonly a report suggestive of works, or a treatise in behalf of some particular theory, supported by local experience. As the difficulties of forming any general theory are the greater from the diversity of geographical features, so it is not to be expected that any work can ever provide a specific mode of construction in individual cases; but herein consists the special claim to distinction of hydraulic engineering, as one of the highest branches of the profession. A railway or canal can, with very few modifications, be laid down from one general model in any particular district; but no attempt can be more unpropitious than to apply a successful harbour plan to another locality. Each plan must have a special and severe study, in which the engineer must set his brains to work, and not rely upon being able to copy the labours of any one else,—although he should be fully able to avail himself of the experience of others.

Unhappily, hydraulic engineering is commonly looked upon as a mere question of construction; and our great engineers think they have nothing to do but to run out a pier, or build a sea-wall, of the best masonry, and that the work is done. That the strong walls should be thrown down, or the enclosed harbour be choked up, they do not dream of; and the more particularly, if they have what they call a scouring power.

A canal or railway cutting, or embankment, has only to deal with the present; but a pier or sea-wall, when once put up, produces a change in the local operations; so that it is necessary not to provide for the present, but to calculate what will be the future result of the works. This, again, is a proof of the powers of mind needful for the proper exercise of this branch of engineering.

It has likewise this peculiarity—that it has baffled many of the greatest engineers; and what have been received as established modes of practice have, in the progress of time, been proved to be gross absurdities. Thus, for instance, in 1755, Smeaton proposed on the Clyde the erection of a dam with locks at Marlingford, below Glasgow. Had this been done, the fate of Glasgow as a harbour would have been sealed, and the lower part of the river ruined. Golburne projected to narrow the stream by a succession of jetties and groynes, which result in making a river a course of ponds or pools and bars, as in the cases of the Clyde, Tay, Dee, and Ribble; from all of which, except the Dee, the groynes have been removed.

It does no credit to English engineers that there is no good book on hydraulic engineering,—not even a compilation of the many scattered publications; and the result is, there are more blunders committed in hydraulic works than in the whole range of civil engineering, and for this sufficient reason—that the blunders of the past are constantly repeated. This state of affairs is the more to be regretted, for our rivers and harbours are of the very greatest importance to us in a commercial point of view, and in our unreclaimed shores we have a source of agricultural wealth which no wise nation should neglect. Sir John Rennie is now engaged in recovering a surface on the coast of Lincolnshire worth eighty pounds an acre, and worth nearly three hundred thousand pounds in the whole. We are quite within compass in saying that lands worth ten millions can easily be recovered on the shores of these islands, and which would yield food for above half a million of people.

Mr. David Stevenson, who is the author of the work "On the Civil Engineering of North America," and engineer to the Convention of Royal Burghs of Scotland, has been employed on four considerable tidal rivers, in the improvement of which he has been very successful, and he has done the further good service of publishing his observations. The first edition of these has been already noticed, but they acquire so much more importance from the additional observations, and the subject itself is of so much interest, that we feel it calls for some attention at our hands.

Mr. Stevenson establishes the classification of three sections or compartments of river engineering, which are useful to be borne in mind, as tending to avoid confusion of ideas. These three sections are—first, the non-tidal part of the river; second, the tidal portion of the river; and third, the sea portion, or "sea proper."

Each of these compartments having very different characteristics, requires a totally different class of works for effecting improvements.

In this short book, Mr. Stevenson limits himself to the consideration of the works he has executed within the tidal compartment. The volume of the fresh-water stream is, he says, a constant quantity, and cannot be augmented by works of art; and, therefore, the engineer must direct his endeavours to produce "an increase in the duration of tidal influence," as the surest means of effecting improvement.

This he considers may, to a certain extent, be attained in all instances by lowering the bed of the river, and removing all obstructions to the free flow of the tide, so that the propagation of the tidal wave may be hastened. This, Mr. Stevenson, from his own experience, shows very satisfactorily may be accomplished.

The great value of such works is their tendency to increase the backwater, by which the sea channels are kept open, for no works can be of any use which disregard this purpose; neither are they any better, which operate on the seaward compartment without directly operating on the tidal compartment.

The causes of retardation commonly found in operation are—the winding of the rivers, the slopes of their beds, the downward flow of the fresh water, and the projection of obstacles into the stream,—the latter often the production of engineers. The combined effect of these causes is so powerful, that the water is sometimes heaped up in the rivers in an extraordinary way, so that in the Dee, Mr. Stevenson found that after the tide had risen 18 feet 4 inches at Flint, it had not begun to flow at Chester, 12 miles up the river. Now, the fall of the bed of the Dee being 11 feet from Chester to Flint, there was therefore a fall at this time of tide of no less than 7 feet 10 inches from Flint to Chester, or a fall *up* the river.

Applying his principles to practice, Mr. Stevenson was able, in the Tay, to get at Perth inland a depth of 5 feet at low, and 15 feet at high water of ordinary spring tides; instead of, as formerly, 1 foot 9 inches at low, and 10 feet at high water. He has, therefore, enabled steamers of small draught of water to ply regularly at low water from Perth to Dundee, and vessels drawing 14 feet can now come up to Perth in one tide with ease and safety, instead of grounding or being otherwise obstructed, and losing the tide for Perth,—a misfortune, as he says, which at those times when the tides were falling from springs to neaps, often led to the necessity of lightening the vessel, or keeping her waiting till the next springs. The works cost 53,000*l.*, and 841,480 tons of material were excavated.

On the Ribble, our engineer got an increased tidal range of between three and four feet, and an acceleration of the tidal wave of about forty minutes,—so as to make Preston a port, and quadruple the tonnage dues. The cost was 40,000*l.*

On the Forth, Mr. Stevenson is still at work, with the view of getting ships up to Stirling, and has been successful in his operations so far as he has proceeded.

Another river on which he is engaged is the Lune, and although the works were only begun in November 1847, he has already depressed the level of low water at Lancaster 1 foot 4 inches, accelerating the spring tides about 25 minutes, and the neap tides about 50 minutes, the time of high water remaining the same. There is a gain of an increase of depth of not less than 4 feet in the navigation up to the quays at Lancaster.

The pamphlet which we have named in the heading to this article, discloses a case of great neglect and mismanagement on the part of the River Dee Company, who have not completed their covenants for improving the river Dee—but rather impaired it, so that the trade of Chester is most seriously impeded. The Dee Commissioners, who publish this statement of their case against the Company, are powerless for want of funds, and it is not surprising that they advocate handing over the management of the river to the Tidal Harbour Commissioners,—on the principle, we presume, that they cannot be worse off; though, from what we have seen of government commissions, there is little good to be hoped from them.

From the Dee many thousand acres of land might be reclaimed, and the navigation improved, without its costing the country anything more than the temporary advance of the funds for the prosecution of the works: but that river remains in a state which is ruinous to the city of Chester, and, to our minds, disgraceful to the engineering science of the country.

If hydraulic engineering were properly prosecuted as a professional study, we should not find our resources so shamefully neglected, nor such a wasteful outlay of the public money in misnamed harbours of refuge, while the country would be adequately provided with harbour accommodation. With a proper administration, neither Fleetwood nor Great Grimsby would be private works, but would be national enterprises, carried out to afford accommodation to populous and thriving districts. While, however, hydraulic engineering savours of quackery, the government will be able to carry on their miserable system of alternate neglect and jobbery.

REGISTER OF NEW PATENTS.

GAS IMPROVEMENTS.

Alexander Angus Croll, of the Gas-works, Tottenham, Middlesex, for "*improvements in the manufacture of gas, and in apparatus to be used in transmitting gas.*"—Granted August 22, 1848; Enrolled February 22, 1849.

The improvements consist, first, in setting retorts and apparatus for making gas from coal. Secondly, for a mode of employing steam passed through highly-heated carbon, and then mixing with carburetted hydrogen as it is distilled from coal. Thirdly, for so employing sulphurous acid gas as to combine with sulphuretted hydrogen gas and to cause the sulphur of the gases to be thrown down or precipitated. Fourthly, for apparatus to be used in transmitting gas.

It has heretofore been proposed to employ long retorts capable of being fed at each end, and in such manner that the products of gas from the last charge shall pass over the charge which has been for a length of time in the retort, for which purpose each such retort was provided with a rising-pipe at each end, to carry off the gas evolved first from one end of the retort, and then at the other, the different ends of each retort being fed at distant intervals, so that the two charges therein will at all times be in a different state of process, one charge being comparatively fresh whilst the other charge will be comparatively spent.

The first part of Mr. Croll's invention consists of using similar retorts, which can be fed at each end, but in place of having two rising-pipes, one at each end, as heretofore, for carrying off the produced gas, he has only one rising-pipe which he applies at one end of a retort, and then, in place of feeding the two ends alternately, and at distant periods one from the other, he charges both ends at the same time, by which arrangement considerable advantage results in the manufacture of gas.

The second part of the invention has for its object the use of steam passed through carbon at a bright red heat, and then causing it to pass over or amongst the charge of coal which is being distilled in a retort. For this purpose he prefers to use retorts as above described, and at the end most distant from the rising-pipe is charged the retorts with coke, and there is a steam-pipe to convey steam into the retort at that end, and at the other end of the retort a charge of coal is supplied at every five hours, and steam is allowed to flow in for about the first three hours of each charge. About fifteen gallons of water evaporated and caused to pass into retorts for each ton of coals (that is, when Newcastle coal is used, but when Kennel coal is used the quantity should be increased), produces the most advantageous working, but he does not confine himself to the use of that quantity. The object being to obtain a larger quantity of gas of a fair illuminating power and a less produce of tar.

The third part of the invention is for the use of sulphurous acid in such manner as to deprive carburetted hydrogen gas of the sulphuretted hydrogen gas with which it is contaminated, and thus to obtain the sulphur of both compounds in the form of flour of sulphur.

He first makes a solution of sulphurous acid in water by connecting a vessel or vessels of cast-iron (arranged as a Woulfe's apparatus used for impregnating liquids with gases) with an oven or other suitable apparatus for carrying on the combustion of sulphur; and by means of an air-pump or other arrangement for producing a draught connected with the vessel containing the water or liquid to be impregnated, a current of sulphurous acid gas from the burning sulphur is made to pass through the water or liquid, and by which it is largely absorbed. This is done till the liquid is nearly saturated with sulphurous acid, and to effect this about six ounces of sulphur will require to be burned for every gallon of water.

The sulphurous acid thus made is transferred to the first of a series of three vessels, (or, it may be, other number of vessels), constructed and arranged exactly in the same manner as the wet-lime purifiers in common use at gas-works; the other two vessels are charged with a weaker solution, derived after the process has been once put in operation from the washers to be afterwards mentioned, and by a portion of the sulphurous acid which is disengaged from the first vessel. Each of these vessels is charged exactly as is done with the liquid in the wet-lime purifiers, so that the gas may pass through and come into extensive contact with the solution of sulphurous acid; the gas is made to pass first into the vessel with the strong solution, and thence into the second, and thence again into the third. In thus passing through these successive purifiers the sulphuretted hydrogen in the coal-gas and the sulphurous acid are both decomposed, and sulphur is abundantly deposited. When the sulphurous acid in the first vessel has been all decomposed, or nearly so, the contents must be discharged into a suitable reservoir, where the liquor may settle or be filtered, and the sulphur obtained and dried. The vessel must then be charged with a new solution, and the process proceed as before. In practice, instead of using a separate vessel, as already described, for preparing the solution of sulphurous acid, two sets of purifiers are used alternately, and therein to charge the liquid with sulphurous acid in the one set when the coal-gas is being passed through the other; and instead of using fresh water for this purpose the liquid is transferred, already partially charged, from the second to the first, and the contents of the third transferred to the second, as in like manner the third has been charged from the washers now to be described.

On account of the volatility of the sulphurous acid, a portion of it is carried over with the gas, and, therefore, to free it from this impurity it is made to pass through other three vessels, called washers; and finally, that every trace of impurity may be removed, it is passed through a common dry-lime purifier. The freedom from impurity may be ascertained at any stage of the process by the usual test of acetate of lead for sulphuretted hydrogen, and by the smell, if there be even a most minute portion of sulphurous acid present.

These washers are arranged so as to be put in connection with either series of purifiers at pleasure, and any construction may be adopted by which there is a free passage for the gas and a thorough exposure of it to the water, and for this purpose the ordinary lime purifiers already referred to answer very well. In the washers these are charged with water only, and as it becomes impure it is transferred through the series onward, and then into the purifiers, the last vessel of the series being always supplied with fresh water, and care being taken that it never gets so charged with sulphurous acid as to allow of its being disengaged with the gas. Such is the general mode of procedure, that in practice it is not necessary to discharge or transfer the contents of the purifiers every time they are impregnated with sulphurous acid, but only when the accumulation of sulphur, tar, &c., renders it necessary, and also if more water be required in the washers than it is necessary to transfer to the purifiers, then it may be run out, and, after depositing its sulphur, may go to waste.

It has heretofore been proposed to have gas-holders fixed at a distance from the works, in order that they may be near where the supply is to be given, and it has been proposed to aid the transmission of gas from the works by means of exhausting apparatus. Now, the fourth part of the invention consists of so working that the gas in the main between the gas-works and the exhauster, in the vicinity of the gas-holder, at a distance may be maintained at a proper degree of pressure for supplying the intermediate district. For this purpose Mr. Croll causes the exhausting apparatus to be capable of taking the gas to such an extent as to exhaust the gas-main, so that if no provision were made for maintaining the gas at a proper degree of pressure in the main, no supply of gas to the intermediate district could take place from the main. When the exhausting apparatus is at work, he causes there to be a branch-pipe from the main to the gas-holder, such branch-pipe being connected at a point from the gas-holder beyond the exhausting apparatus, and on such branch-pipe is applied a governor, which he prefers to be such as are now used at gas-works to regulate the pressure of gas in the mains. By this arrangement, although the exhausting apparatus will at all times when at work be propelling gas into the gas-holder from the gas-main, with a tendency to exhaust the main, a quantity of gas will pass from the gas-holder by the branch-pipe into the main, which quantity will be regulated by the governor, which will thus keep the gas in the gas-main at the desired working pressure, and the gas-holder or gas-holders at a distance from the works will only be supplied by the exhausting apparatus with the quantity of gas, which would otherwise cause the gas in the main to rise in excess of the desired working pressure.

MANUFACTURE OF IRON.

John Davie Morries Stirling, of Black Grange, N.B., gentleman, for "*improvements in the manufacture of iron and metallic compounds.*"—Granted October 12, 1848; Enrolled April 12, 1849. [Reported in the *Mechanics' Magazine.*]

This invention relates to the manufacture of malleable iron, and to certain combinations of alloys of malleable iron and cast-iron, and of malleable iron or cast-iron, or malleable and cast-iron with other metals.

The improvement in the manufacture of malleable iron consists in mixing a quantity of scrap-iron with cast-iron in the proportion of $\frac{1}{16}$th to $\frac{1}{8}$th or even $\frac{1}{4}$th part, by weight, of the former to the latter, whereby the refining process may be wholly or partially dispensed with. The malleable scrap-iron may be introduced into hollows in the bed of the pig-furnace containing the cast-iron, and melted with it; after which it is boiled and puddled, or puddled only, in the ordinary manner. Or, the malleable, scrap, and cast-iron may be melted in a suitable furnace, and then run into pigs or slabs, or into a puddling furnace. Or, the scrap may be heated in a furnace, but not sufficiently high for the pieces to stick together, and the melted cast-iron then run into it, and the fusion of the two completed. These proportions will, of course, have to be varied according to the nature of the cast-iron. The quality of the malleable iron will be much improved by mixing with it refined iron or steel scrap, when either of these materials can be easily and cheaply obtained.

The patentee then specifies several combinations of malleable, scrap, and cast iron with different metals, which are as follows:—

1. A given quantity of the preceding combination is mixed with from $\frac{1}{150}$th to $\frac{1}{250}$th part of its weight of block or grain tin; or,
2. With $\frac{1}{100}$th part of its weight of zinc, or any one of its oxides (calamine being preferred;) or,
3. With from $\frac{1}{150}$th to $\frac{1}{200}$th part of its weight of copper mixed with one per cent. of the black oxide of manganese of commerce.

In order to mix the zinc with the iron, the molten metal is run out of the cupola or other furnace, and the blast-pipe closed. The zinc is then placed upon the coke, and, when melted, runs through it and combines with the iron which adheres to the sides of the furnace. The proportion of zinc to iron should be between 4 and 7 of the former to 1 of the latter, and may be employed, when mixed with a small quantity of lead to prevent its heating, for bearings, &c. And

Lastly. The patentee proposes to manufacture a substitute for gold, which he terms "British Gold," by mixing 1 part of the zinc alloy of iron with 4 parts of copper and manganese; and a substitute for silver, by mixing 6 parts of the zinc alloy of iron with 2 of nickel and 10 of copper.

The combination of copper and manganese is effected by placing them in a crucible covered with a suitable flux, and applying heat until they fuse. The proportion of manganese to copper should be from one to two per cent.

[The patentee makes no claim to any of the various processes and combinations described in his specification.]

BORING MACHINE.

Daniel Watney, of Wandsworth, Surrey, distiller, and James John Wentworth, of the same place, for "*improvements in machinery for drilling metals and other substances.*"—Granted October 12, 1848; Enrolled April 12, 1849.

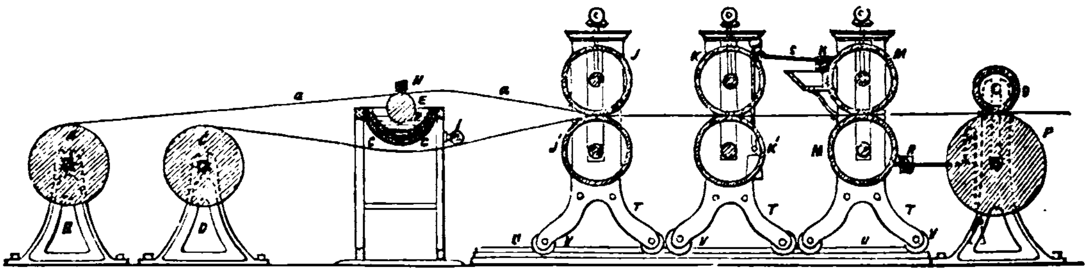
The apparatus consists of a rectangular metal frame, supported loosely on a foot by a screw and nut, which allows it to turn freely in any direction, and is furnished at top with a screw, carrying a circular disc, which is also free to revolve thereon. This frame is maintained in a vertical or horizontal position by having the foot and disc screwed into contact with the floor and ceiling, or to the two sides of a chamber or mine. A block of metal slides up and down the space of the frame, and is fitted with clamp pieces and a screw, carrying at one end a socket-head, and at the other a nut, whereby it may be maintained stationary at any required distance from the foot-piece. This socket carries a screw, having a hole bored in its head, to serve as a bearing to the drill, so that it may be made to work in a horizontal or vertical line, or in a direction at any desired angle to either of them. Motion is communicated to the drill from a prime mover in the ordinary manner.

VENEER-JOINING MACHINE.

Pierre Armand Le Comte de Fontainemoreau, of 4, South-street, Finsbury, Middlesex, for "*certain improvements in the machinery for cutting wood, and in laying and uniting veneers.*" (A communication.)—Granted May 25, 1847.

Having in our last number (p. 115) described the machinery employed by the patentee in cutting wood into veneers, we now give the remaining portion of the specification—namely, for "improvements in apparatus for pasting and doubling veneers, and their application to useful purposes, such as for hangings of apartments, &c."

Fig. 9.



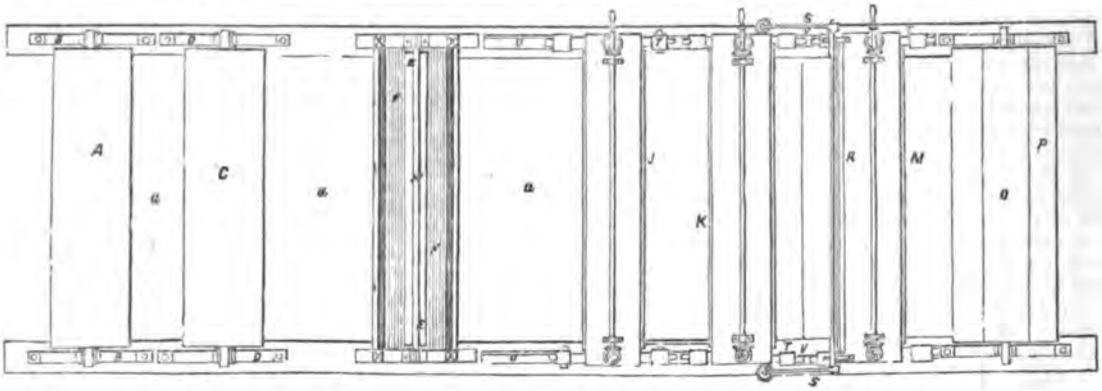


Fig. 8.

The application of sheets of veneers to several useful purposes, and especially to cabinet-making, is well known, but until now on account of the processes for cutting wood into veneers having only produced sheets of small dimensions, the manufacturer has been very limited in their use and application, as he could not lay on or cover large surfaces by a single and same sheet.

This is obviated by means of the wood-cutting machine, described in last month's *Journal*, for cutting logs into extremely thin sheets, of an almost indefinite breadth, so that such new mode of producing veneers naturally offers several easy and useful applications of those sheets, not only for veneering in general, but also for hangings, floorings, carpeting, &c., which they can replace with the greatest success.

The usual veneer sheets, as obtained by the ordinary processes of sawing, are directly glued when they are to be applied on the woods which they are to cover. Instead of operating in that manner with the large sheets cut by the process before described, and to render them fit for the new applications to be made by this process, it is intended by the new process to paste them on all their width on canvas, thin cloth, or any other similar tissues whatever; by that means those thin sheets obtain a very great stability, which permits afterwards to use them with the utmost facility for veneering or covering every kind of surface, whatever may be its width and surface.

In order to put such improvements into execution, that is to say, to lay glue perfectly well, all the surface of those large and thin slices or sheets of wood upon the tissue or cloth in such a manner that their superposition and adhesion should be complete, firm, and permanent, the hereinafter described apparatus has been found to answer in every respect.

Fig. 8 is a general plan of the machine above alluded to; fig. 9 exhibits a longitudinal section drawn through the centre of the apparatus. Similar letters of reference apply to the same parts. It is easy to understand, by examining them, the general disposition of the machine and its manner of working. The linen cloth *a*, which is to serve as a lining to the veneer, is previously rolled over a cylinder or drum A, the axes of which are so adjusted that they move freely in the grooves of the upper part of the cast-iron supporters B. The sheet of veneer made by the cutting machine which, as before stated, is of a great length, is also rolled over a second cylinder C, the axes of which also move freely in their forked supporters D. The sheet and the cloth are both at once and together unrolled from the surface of the cylinders, and soon meet beyond the glueing apparatus, which is placed at a short distance from the cylinder C. That glueing apparatus consists of a cylinder or brush E, which dives in a pan F, filled with paste previously heated in a *balneum maræ*, or sand bath, by steam, by means of a second pan G, which encloses it, or by any other suitable means.

The cylinder E, receiving a continuous rotative movement, is constantly impregnated with a certain quantity of paste or glue, which it spreads in abundant quantities over the surface of the cloth or stuff, as this last passes over its circumference, and on which it is forced bare by the pressure of a sort of right angular ruler H, set directly above it, and which at both its extremities is kept and led in grooves O O. That ruler H, could be replaced in case of need either by a weight or springs, or any other suitable contrivance. The veneering sheet passes only under the pasting cylinder E, or rather, under the *balneum maræ*, and is directed by a rod or long moveable roller I, purposely placed on the frame V, towards the two large and strong cylinders J and J^1, between which it must pass at the same time as the cloth, so that they may be both sufficiently pressed together, and adhere to each other uniformly in all their length and breadth. The cylinders are so disposed that the necessary degree of pressure to ensure the complete adhesion of the cloth and sheets is given at once.

When egressing from these cylinders, the cloth and the veneering seem to to form but one single body like a very thin pasteboard, but they are too wet to have a good solidity, wherefore it is necessary to dry them with the same rapidity as the pasting and uniting action has been affected by the pressing cylinders. For that purpose, it has been considered that the most convenient and rational means consisted in using steam, which is made to enter into some hollow cylinders like those long used in paper-making machines.

However, as it is most essential that the drying should not be too quickly obtained, for fear either of unpasting or preventing a thorough equal pasting, care must be taken that the steam which arrives from the boiler in the two first cylinders K, K^1, which are placed close to the pressing cylinders J, J^1, be not too hot, and that the steam which reaches the last range of cylinders M, M^1, be the hottest. It would be very easy, in case of need, to cause the same steam to run successively in like manner in a greater number of cylinders, in order to obtain more surely in the meantime, by that said operation, a perfect, smooth, even union, and a regular pasting and drying without any trouble or difficulty.

It is understood that the sheets of veneer being united to the cloth, passing thus from one to the other pair of cylinders, and receiving successively more and more heat, are dried gradually without any chance of being over-heated by that process; when they arrive at the last pair of heated cylinders, they are entirely dry, and form one single and only sheet, which is rolled over the drum P, to which a convenient rotary motion is given according to the direction described by the arrow, as shown in the engraving.

As that cylinder in receiving the united veneer and cloth becomes progressively larger, it is necessary to lessen the velocity of its rotation in order to keep as much as possible rectilineal motion of the united veneer and cloth.

For that purpose, that cylinder P, is put in motion by means of a pulley, and of a distender, which bearing more or less heavily, and to the required degrees, on the strap of the pulley, causes this last to be drawn with more or less velocity, and in order that the united veneer and cloth should remain well distended over the circumference of the cylinder P, without being unpasted, a pressing cylinder, the weight of which is evidently proportioned to the velocity, is conveniently placed above it.

To take away from the surface of the pressing and heating cylinders the superabundant paste, which, by the pressure, egresses through the sides of the united cloth and veneer, some moveable scrapers or knives have been adapted; they are set on the axes of those cylinders, and as they bear on them, care must be taken to maintain them constantly at their proper position by means of weights suspended to levers which are adjusted to those axes, and on the outside of the machines.

To vary also, in case of need, the distance between these pressing and heating cylinders, their cast-iron frames have been so disposed as to allow them to roll upon two parallel bands or rails. Thus, at the feet of each of those frames are adjusted some cast-iron small wheels or rollers, by means of which the position of the cylinders can be easily changed, and consequently they can be made to advance or recede as it is judged convenient.

ON SIR BALTHAZAR GERBIER'S "COUNSEL AND ADVICE TO ALL BUILDERS."

On the Contents of a work by Sir Balthazar Gerbier, written in the 17th century, and entitled "Counsel and Advice to all Builders." By Sydney Smirke, Esq.—(Read at the Royal Institute of British Architects, March 19.)

The small volume of which I am now about to give you some account, possesses very slender claims to literary merit—nor has it much intrinsic professional value; yet it has, I think, still, great claims on our attention, as being among the very earliest of our native literary productions exclusively on the subject of our art.

The earliest edition of Sir Balthazar's Counsel and Advice is 1663. The early date, therefore, of this book gives it a value,—and a stronger interest attaches to it in our eyes, as giving some insight into the practice of architecture at the period of our great master, Sir Christopher Wren. Sir Balthazar was born at Antwerp, in 1592, and was brought up as a miniature painter. He was knighted by Charles I., and was employed by him, in conjunction with Rubens, to negotiate a treaty with Spain; he also resided at Brussels in a diplomatic character. He was subsequently employed as an architect by Lord Craven.

The treatise commences by adverting to the author's previous work, which he describes as a little "manual, concerning the 3 chief principles of magnificent building—viz. solidity, conveniency, and ornament;" wherein he "notes the incongruities committed by many undertakers of buildings." He points to the Grecians and Romans as the best builders, and urges that men should not be subject to fancies nor "inslaved by weather-cock-like spirits, to make their buildings according unto things *à la mode*." He further condemns the incongruity committed by surveyors, "who were minded to show that they were skilled in describing columns, cornishes, and frontispieces, although, for the most part, placed as the wilde Americans are wont to put their pendants at their nostrils."

The author then proceeds to treat more particularly of his advice to all builders. "Whoever," he says, "is disposed to build, ought, in the first place, to make choice of a skilful surveyor, from whose directions the several master workmen may receive instructions by way of draughts, models, and frames." I should here say that the author throughout uses the terms surveyor and architect as perfect synonyms; there is no indication whatever of that distinction which is now, in England at least, universally received. He then adverts to some of the requirements of architects, and especially dwells on the knowledge of perspective as essential; he teaches that the architect should consider the ground whereon the building is to be erected, and then govern himself as the ground will give him leave; or, as Pope has since more elegantly expressed it, "consult the genius of the place." He must place the front of a country house towards the east, "by which means he may shelter his double lodging rooms from the north-west." I cannot say that this piece of instruction is very intelligible. We can hardly regard the north-west as the aspect most to be shunned. The author here adds, what he quaintly calls a *nota bene* to builders viz., "he must cause all the back of his stonework (which stands within the brickwork), to be cut with a rebate 3 inches broader than the breadth of his jambs and cornish, which will hinder the rain from piercing into the inside of the wall, and through the meeting of the brick and stone." He deems it necessary to make a sort of apology for this advice, as implying that "surveyors and master workmen in this refined age which abounds in books, with the portractures of the out and inside of the best buildings, are to seek the first points of their apprentiship; of whom I ask the reason why modern buildings are so exceedingly defective; and whether it is not because many of them have been but apprentices lately, and too soon become journeymen; and that surveyors (who either affect more the building to themselves a strong *purse*, or are blind to the faults which their workmen commit), like careless postillions, hasten with the packet maile to the post-office, be it never so ill-girted, whereby it oft falls in the midway."

The author then advises how to try the capacity of a surveyor. "The readiest way to try him," he says, "is to put him to draw a ground plot in the builder's presence; to make him describe the fittest place for a seat; the ordering of the rooms for summer or winter; to contrive well the staircases, doors, windows, and chimneys,—doors and windows so placed that they may not be inconvenient to the chimneys,—the bedstead place from the doors and windows, and of a fit distance from chimneys."

He then adverts to the "seelings of rooms," adapting their height to the size, character, and use of the room. A bedchamber of state may be 30 feet wide, 40 feet in length, and 16 or 18 feet high; whereas a closet, 10 feet square, adjacent thereto, if made of the same height, would be "preposterous, and like a barber's comb-case." The dimensions here set down for a state bedchamber seem somewhat extravagant; but it must be remembered that our author's advice is apparently addressed to royal or noble builders; and in the 17th century business was transacted, and morning visitors were received, usually in the bedchamber, a practice which, at the present day, has not fallen altogether into desuetude on the continent.

The author then proceeds to the subject of exterior architecture. He points out the necessity of cornices over doors and windows, to prevent rain from falling on them, which he illustrates in his usual quaint way, by comparing a "cornish" to "the broad brim of the good hat of a traveller in a rainy day."

"The good surveyor," he adds, "will order ornaments to the front of a palace according unto its situation: shun too much carved ornaments on the upright, whereat the southerly windes raise much dust;" also "shun those spectacle-like cant windows which are of glass on all sides, for it may be supposed that the inhabitants of such houses and rooms with cant windows (exposed to the north-west) may well imitate a merry Italian fisher, who in a winter, windy, rainy day, had been stript to his skin, and having nothing left to cover him save his bare net, wherein he was wrapt, put his finger through one of the holes, asking of passengers what weather it was out of doors." It is here to be observed, that at the period when our author wrote, classical architecture, on its revival, was still struggling with the Gothic forms that had prevailed for so many centuries previously. These cant or bow windows were peculiarly characteristic of the Tudor and Elizabethan ages, and so firmly rooted were they in the domestic habits and usages of the time, that the revivers of classical architecture were driven to make many attempts to retain the old favourite form with a new dress; and down to the present day we seem to have remained true to the old spectacle-like cant window of our forefathers, which, whilst it is almost universal in England, can scarcely be met with in modern architecture on the continent.*

Sir Balthazar then proceeds to give us advice of not a very important nature on the subject of balconies, balustrades, and cornishes. He says that the Grecian and Roman surveyors ever made the cornishes and ornaments about the windows of the upper stories to be bigger than those on the lower; and illustrates his remark by a somewhat pedantic reference to Michaelangelo, Raphael d'Urbin, and Albert Durer. He then teaches us as to the proportions of doors and windows. The chambers of a palace, he says, should have the doors wide enough for two to pass at once, and the height to be double the width; all other chamber doors should be convenient for a man of complete stature to pass with his hat on. Windows must be higher than they are wide, because light comes from above, and the middle transome should be above 6 feet from the floor, otherwise the transome would be opposite a man's eye; "hindersome," as he says, "to the free discovery of the country. The leaning-height of a window should be 3½ foot, and not so low that wanton persons may sit on them and break the glass, or that they may show themselves *in cuerpo* to passengers. "A good surveyor," he says, "shuns the ordering of doors with stumbling-block thresholds, though our forefathers affected them, perchance to perpetuate the ancient custom of bridegrooms, who, when formerly at their return from church, did use to lift up their bride, and knock her head against that part of the door, for a remembrance that she was not to passe the threshold of their house without their leave."

"Doors, he says, should be on a row, and close to the windows, that when the doors are opened they may serve for screens, and not to convey wind to the chimney."

The hearth of a chimney ought to be level with the floor; and chimney mantles ought to be of stone or marble. It is necessary to cover the top of chimneys to keep out rain and snow; the smoke holes can be very conveniently made on the sides of their heads. Had the knight lived in these times he would doubtless have been very severe, in his quaint way, upon the monstrous fashion of modern chimney-pots.

"Roomes on moist grounds do well to be paved with marble," and "a good surveyor shuns the making of timber partitions on the undermost story." "The good surveyor doth contrive the repartitions of his ground plot so as most of the necessary servants may be lodged in the first ground-story, whereby there will be less disturbance, less danger of fire, and all the family at hand on all occasions." "Finally, he ought from time to time to visit the work to see whether the building be performed according unto his directions and moulds." The author then proceeds to a chapter on clerks of works. "A clarke of the werkes," he says, "must be verst in the prices of materials and the rates of all things belonging to a building; know where the best are to be had; provide them to the workmen's hands," and so on, adding that "though nails to some seem not very considerable, yet ought the clarke of the werke to be discrete in the distributing of them to some carpenters whose pockets partake much of the austruche's stomach." "His eyes must wander about every workman's hands, as on those of the sawyers at their pit, so that they waste no more than needs in slabs; on the laborers' hands in the digging of the foundation for the bricklayers, that all the loose earth may be removed and springs observed."

Some of the ordinary duties of a clerk of the works are then enumerated; as, that he should prevent bricks being tumbled out of the cart; that he should suffer no sammell bricks to be made use of, and that he should not suffer the bricklayers to lay any foundation except the ground be first rammed, though it seem never so firm. "No great and small stuff," he says, "should be huddled together in the foundation, but all laid down as even as possibly can be, to ram it the better and the more equal, and must be of solid hard stuff with no concavities daubed over with store of mortar," and he adds here in a marginal note that these precautions were observed in building the foundations of Solomon's Temple, but he does not give us his authority for this information.

The clerk of works is further to see that the line-and-plumb rule be often used; that the bricklayers make small scaffling holes, and never suffer them to begin scafflings in the morning, but before leaving of their work; "for if in the morning," he says, "most of them will make it a day for the gathering of nuts."

Then follow some injunctions respecting mortar, that I scarcely need particularise—and the author proceeds to the subject of masonry. The workmen must observe exactly the surveyor's molds, and work close and neat joints, using but little mortar between them, not only because much mortar will be washed away, but that cornishes will also appear like a rank of open teeth; and they must not forget to shore up the middle part of the head of the windows, as well as the sides, to prevent an unequal settling of the work, and, consequently, cracks. There here ensue, for the next thirteen pages, detailed directions for the proportioning of the several orders.

"It is the rule of the ancient masters, whose reliques, to be seen throughout most places of Italy, make many strangers that come their gape so wide as that they need no gags."

The author now enters upon the subject of carpentry. He teaches "That the carpenters should be good husbands in the management of the builder his timber; on the cutting of the scantlings; their sparing to make double mortices, which do but weaken the summers. To lay no gerders which are needless and hindersome to the bording of a room; no summers to be laid except the ends of them are either pitcht, or laid in loam to preserve them from rotting," "and therefore in Italy, France, and Germany, and among the most prudent and solid builders, the free masons, put stone cartouches in the top of the inside walls which are bearers to the summers, as such cartouches are seen in divers churches, and some of them are carved in ornamental figures." He alludes, no doubt, here to the stone corbels upon which we sometimes see the ends of principal timbers resting: an excellent old practice which we in our own days follow, although in a much less picturesque way, by inserting the ends of our timbers into cast-iron shoes projecting from the face of the wall. The utilitarian tendencies of modern practice have been very subversive of the old picturesque ways of our ancestors, whether on costume, furniture, or architecture. An upholsterer now ascertains with precision the size of the piece of oak that will just carry his table; he seeks till he finds the safe minimum scantling, and this successful discovery is the triumph of his art. Whilst our forefathers would take a log of oak, unregardless of this politico-economical search after the greatest possible strength with the least possible stuff, and would carve it into one of those ponderous and fantastic legs which charm us by their quaintness, although they defy our efforts to lift them.

In further illustration compare the broad, deep, capacious fireplaces, whereby our forefathers would warm themselves, with the scientifically-constructed, snug, rumfordized stove, with bevelled cheeks, no hobs, contracted openings, all contrivances admirably adapted to meet our modern requirements of convenience and economy; but how destructive to the poetry of our grandsires' ruder arrangements!—men of a rough, bold stamp, who, provided they secured to themselves a warm chimney corner, appeared to regard with great indifference the minor evils of smoke and blacks.

Then follow many other details of the manner the carpenter is to lay his timber, and the author adds that the clerk of the works must be very careful not to suffer the carpenters to lay any timbers under the chimneys, "whereby many houses have been set on fire, and burnt to the ground." We have then a variety of scantlings for the timbers of floors and roofs, which scantlings he gives as fit for substantial structures, but which are "not usual in lime-and-hair bird-cage-like buildings"—a remark that leads us to the conclusion that the flimsy structure of modern speculators was not wholly unknown to our ancestors. The care of the clerk of the works must also be on "materials of weight, as sauder, wherewith an unconscionable plummer can ingrosse his bill." In this respect we see that 200 years' experience has not advanced us—we have still "unconscionable plummers." "The clerk is to see sauder weighed and well managed, and in the attesting of bills have a care not to pass his eyes *slightly* over them, lest when a plummer sets pounds of candles used about his sauder, that trick prove as insupportable as that of one who, having played away a round sum of his master's stock in a journey to the East Indies, set down in his bill to have paid a hundred pound for mustard." "He must likewise have a clear insight on the glass paines of the glazier; suffer no green paines of glass to be mixed with the white. He must with his eyes follow the measurer of the work, his rod or pole; so the line wherewith the joiner's work is measured, that it be not let slide through the measurer's fingers, since the joiner's work hath many goings in and out, and a leger-de-mayne may be prejudicial to the paymaster's purse. It were likewise better to agree with painters to have their work rated on running measure and on the straight, as the carpenter's work, who, (being of an honest Joseph's profession), are as deserving to be well payd as the

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* Lord Bacon, who wrote somewhat before the date of this book, had none of our author's prejudice against these embowed windows. "I hold them," says he in his well known essay on building, "of good use, for they be pretty retiring places for conference; and besides, they keep both the wind and sun off, for that which would strike almost through the room doth scarce pass the window."

painters, who do but spend the sweat of wall nuts (to wit, oyle), the carpenters that of their browes."

"As for coverings of buildings, lead is best for churches, for who would rob them but Goths and Vandals? Blue slates are most comely for a nobleman's palace," "a roof covered with them is of an equal color, when as red tiled roofs the least breaking of them makes great chargeable work for the tiler, who often removes ten tiles to lay two new ones in their place, and renders the nobleman's roof like a beggar's coat."

Our author then proceeds to some remarks on the making of bricks, and recommends the clerk of works to look well to the working of the clay, which, if not well wrought, will never make good bricks. He says, that it is usual to pay *5s.* per thousand for making and burning bricks, the clay-digging therein comprehended. He then goes into some details as to the relative expense of making bricks, and purchasing them made; whereby it appears that only *6s. 8d.* is saved in 20,00 bricks, by making them. He says, that of clam-burnt bricks, 500 out of 20,000 are unfit for work.

Various other details are entered into respecting the making and use of bricks. Men dig clay, he says, for *6d.* the thousand; lime is burnt at *4s.* per load, and cost *40s.* a load. Touching the use of chalk in building walls, he says, that "those that mend the making use of chalk in their walls must be contented (if the ground hath springs) with the green mold which breaks thro' the whitened walls within doors. Walls about a parke or court may be *fited* with chalk, which may be digged for *18s.* per load, and brought for *2s. 6d.* the load." "Good country bricklayers do work at *27s.* the rod, the bricks not being rubbed. Good London bricklayers will work the rod for *40s.* with rubbed bricks; the inside for *33s.*, arches comprized."

Then follow some remarks about lime burning, describing the mode of burning it "in China and other parts of the Indies," wholly with wood and not in kilns.

Our author now proceeds to a new division of his work, which he heads, "As for Choice of Master Workmen." "King Henry the Eighth," he says, "showed a good precedent when the serjeant plummer, calling his workmen to caste, in his presence, a leaden medal which was given him:" the king told him, "he would have no walking master-workmen." Those, therefore, which are fit to be employed are working masters, and not those who walk from one building to another; "nor will any master-workman deny to have had as much more done and well, by bestirring their hands and tools in their workmen's presence than otherwise." I cannot refrain here from calling your attention to the singular social change that has taken place since King Henry inflicted his reprimand on the *walking* instead of the *working* master. Fertile as he is said to have been in oaths, certainly no *usual* oath would have sufficed to express the royal indignation had he lived in these times, to have seen the master-workmen not walk, but *drive* up to his works in as fair an equipage as that of any of his most favoured courtiers.

We have next a division of the work entitled "As for the builder and Proprietor." He advises the builder (by which term he always means the employer) to buy his own materials, and to have in reserve such a stock of his own as he can well spare, and also, he adds, "against the mistakes of workmen, a stock of patience;" nor to begin building walls before March, nor after the middle of September.

The next twenty-eight pages contain a variety of miscellaneous and not very well assorted notes respecting the prices of materials and workmanship.

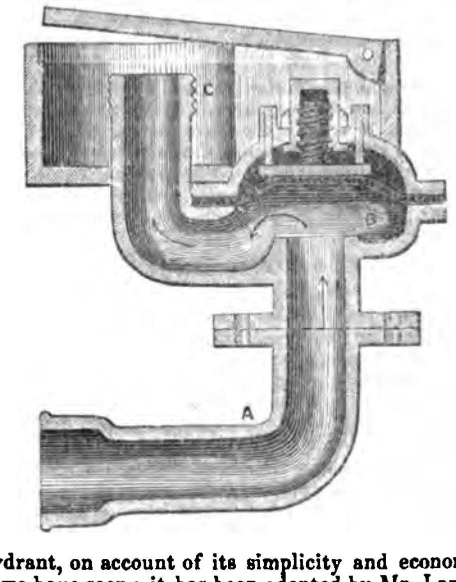
Touching the paving of courts, to prevent the overgrowing of grass and the charge of too often weeding, he says, "it would not be amiss to lay chalk or lime under the paving, and to do the same in gardens under gravel walks"—a piece of advice which is well worthy of notice.

With respect to street paving with pebble stones, he alludes to a Mons. Le Cœur having recently introduced great improvements in paving works done under the commissioners. This French undertaker appears to have formed a company for carrying out a new invention in paving, "whereby they are not only able to make a most substantial good pavement, but are likewise capable by that same new invention to maintain it durable for twenty-one years." Our author (who, as must have been observed, is remarkable for the want of order and method in his remarks), brings his book to a close with some, what he calls *necessary* notes. "What contributes more to the fatal end of many a good mother's son is ill-building: paper-like walls: cobweb-like windows: doors made fast as with packthread, purposely made to tempt men who, through extreme want, are become weary of a languishing life, and to whose fatal end ill-builders are in a manner accessory." He says that the scarcity of thieves vaunted of by the Hollanders, German and other northern nations, is to be attributed to the defence they are wont to make againt thieves: he then describes very particularly the Hollanders' mode of making outside window-shutters so secure by fitting them very closely to the reveals, and by a careful arrangement of the bolts and hinges,—precautions which, however necessary, certainly do not lead us to entertain any exalted idea of Dutch honesty in the seventeenth century.

The entrance to a hall, he says, is not so proper in the middle as at the end, or at all events, set as much as possible near the end. He urges, that the principal floor of a building should not be level with the ground; he then introduces "his story of one in authority, who, passing by a town wherein the people generally did not outlive their thirtieth year, caused all the backs of their houses to be made the front; and the windows which were forward to be made up, to free them from that infectious aire that did shorten their lives, which had its effect accordingly, and it is therefore I do so much insist on the point of placing a building where good aire is, and that neither chimnies nor doors may be so placed as to serve for the attraction of infectious aire, which kills more than the sword, or the sea overturnes ships." A truth, which, although uttered in 1663, we seem now, in 1849, only just beginning to perceive the importance of. The book closes with some desultory remarks of no great importance as to the choice of clerks of works and surveyors, from which I need only quote the following portion:—

"Let all owners [of houses, he means] be prepared to *repent*, whether they build or *not*, for it is like the fate of many who marry, or marry not. Let both the one and the other lay, as in a scale, their several charges, vexations, cares, labours, and pleasures, they will find this to be true—viz., if they build they must be at great present disbursements, vext with as many oversights, and to be over-reach'd in bargains concerning their materials. If they build *not*, they are subject to the inconvenience of houses built according to the fancies of [other] owners; and when they shall cast up the summs of money spent in the rent, besides many chargeable alterations, they shall finde that they might have built a better and more fit habitation for them and their posterity."

LAMBERT'S HYDRANT.



This hydrant, on account of its simplicity and economy, is the best that we have seen; it has been adopted by Mr. Laxton at the Falmouth Waterworks, under a pressure of 170 feet, with success. It is formed in three parts: A, elbow-pipe to be attached to the main; B, one of Lambert's 2-inch diaphragm cocks, made of cast-iron, with a screw-nozzle to receive the swivel of the hose; and C, a cast-iron box, with cover. The top is fixed flush with the pavement. The cost of the hydrant is, for a 2-inch cock, *22s.*; box and cover, *6s*; flange, elbow, and bolt, *3s. 6d.*: making in the whole *1l. 11s. 6d.*

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.

March 27 and *April* 3.—William Cubitt, Esq., V.P., in the Chair.

The paper read was a "*Description of the Groynes formed on the South Rocks, the site of the new docks at Sunderland.*" By Mr. W. Browne, Assoc. Inst. C.E.

These groynes have been erected for the purpose of retaining the deposited materials excavated from the new docks, and of arresting the sand and shingle which naturally travel southward, in order to form a barrier beach, that should effectually exclude the sea from beyond a given line. The three first, whose lengths varied from 326 feet to 358 feet, were erected at a height above ordinary high-water mark of 2 ft. 6 in. and 10 feet at the seaward and inner ends respectively. The exterior was composed of ashlar work; the interior partly of the excavated magnesian limestone, and partly of rubble set in mortar; the batter of the north sides was two and a half inches to a foot, that of the south sides one to one, and the crest was formed into an arch, with a radius of 5 ft. 6 in. The four other groynes were constructed of a different form, in consequence of those first erected not retaining the deposited excavations, and accumulating other materials as was desirable, and from their having been injured by the sea during a heavy storm which occurred at the time of the equinoctial tides during the spring of 1848, when a breach was made in the first and third groynes, and at the same time some of the stones in the second groyne were loosened; these effects were produced at about the same point in each, namely, the intersection of the inclination of the groyne with the line of ordinary high-water mark; and it was found, from observation, that the momentum of the waves was greatest at about the time of high water. The sides of these groynes were semi-cycloidal, each being generated by a circle of 12 ft. 9 in. in diameter, and uniting at the apex; the seaward and inner ends are respectively 7 feet and 10 feet above ordinary high-water mark, and their lengths varied from 510 feet to 579 feet. The foundations of these groynes consisted of a course of freestone, laid at an average depth of 2 feet below the surface; the sides were also of coursed freestone, set header-and-stretcher alternately, and the hearting of large sized rubble, closely packed, the vacancies between it and the ashlar work being filled with small stones set in Roman cement, so as to ensure a solid bed; at a depth of 6 feet below the crest of the groyne, and resting upon the rubble hearting, coursed ashlar was introduced, and carried as near to the crest as possible, the vacancy being filled with small rubble and Roman cement. The construction of these groynes commenced at the seaward point, and they were placed at distances of from 350 to 450 feet apart; the quantity of material excavated and deposited between them was stated to amount already to 730,000 cubic yards; it consisted partly of hard blue clay and partly of marly rock or soft magnesian limestone, and the barrier beach formed by them had completely withstood all the gales which occurred during the winters of 1847-8, and 1848-9.

During the discussion, Mr. Murray explained very clearly his views in the design for the docks, and for the direction of the groynes, and the various works in the harbour for arresting the waves in their progress up the river. The investigation of this subject elicited some very interesting remarks as to the action of waves striking walls and groynes at various angles, when instead of being reflected they were in part retained and guided along the face. This was a peculiarity which, it was, stated, should be taken advantage of in hydraulic works.

April 17.—Robert Stephenson, Esq., M.P., V.P., in the Chair.

The paper read was "*On an application of certain Liquid Hydrocarbons to Artificial Illumination.*" By Mr. C. B. Mansfield, B.A.

The paper first noticed, that liquid hydrocarbons had been comparatively little used for the production of artificial light; and that in the instances in which they had been applied, their liquidity, and not their evaporability, had been turned to account. In the use of the common volatile oils, the excess of carbon in their composition was the great difficulty; but when that was surmounted, that excess became an actual benefit.

There were two methods of rendering this carbon efficient as "light fuel," when advantage was taken of the volatility of the substances: one was to cause the vapour, as it escaped from a jet, to mix rapidly with the air. The other, to mix the vapour, before combustion, with other gaseous matters containing less carbon. The adoption of the first of these was instanced in Holliday's recently patented Naphtha Lamp. The second, consisted of the new arrangement described in the paper.

This principle was carried into practice in two ways. The first (which was illustrated by a lamp then burning on the table) was effected by mixing the hydrocarbons with some other inflammable spirit containing very little carbon. The mixture was described as being made in certain definite proportions, which ensured a perfectly white light, and from which any deviation would result in a flame of inferior quality,—pale, if the hydrocarbon w[illegible] deficient,—smoky, if the mixture were poor in spirit. The ingredients [illegible] accessible in this country were stated to be, wood, spirit, and a vola[illegible] from coal naphtha, in the proportions of two-thirds of the former [illegible] third of the latter. Alcohol and oil of turpentine had been similar[illegible] on the continent, though the former was too dear f[illegible] England.

The other adaptation of the same principle, and that which it was the chief object of the paper to describe, was the dilution of the hydrocarbon vapours with permanent gases of inferior, or even of no illuminating powers.

That application might be called the napthalization of gas, or the gasization of naphtha, according as its main object was to enhance the services of the gas, or to utilise the liquid: the latter was the object of the new proposal described in the paper. The former had been already accomplished by preceding inventors.

The first invention was that of Mr. Donovan in 1830, who proposed to confer illuminating power on gases that were inflammable, but not luminiferous, by charging them with the vapour of hydrocarbons; but from the want of a sufficiently volatile fluid, he was compelled to have a reservoir close to every burner. The next application was that of Mr. Lowe, who increased the light obtained from coal gas by passing it over surfaces of naphtha. Mr. Beale's air light was then noticed; its object was to use hydrocarbons for illumination, by passing a current of air through vessels containing those liquids. There existed, however, the same obstacles to this plan as to that of Mr. Donovan, viz., the heat required to evaporate the only liquid hydrocarbons then accessible.

The paper represented that at length the difficulty had been solved, by the discovery of a liquid hydrocarbon, as volatile as spirits of wine, but containing sufficient carbon for the most perfect light, and obtainable in any quantity. This hydrocarbon was procured from coal tar, and was called "Benzole." Its volatility was such as to enable it to naphthalise atmospheric air as effectually as ordinary naphtha did coal gas.

The system proposed by the author (which was illustrated in the room by a working apparatus) consisted in conducting a stream of almost any gas, or even of atmospheric air, through a reservoir charged with Benzole or some other equally volatile hydrocarbon; the gas or air so naphthalised being then conducted like common coal gas through pipes to the burners. It was stated, that the system was applicable on any scale, from the dimensions of town gas-works to the compass of a table-lamp. In the apparatus exhibited, a small gas-holder, filled by a pair of bellows, supplied common air through pipes. The gases formed by passing steam over red-hot coke would answer well for this purpose, and it would depend on local circumstances whether this mode of generating the current would be preferable to the expenditure of the mechanical force necessary for driving atmospheric air through the pipes. Pure oxygen charged with the vapour would explode on ignition; it was therefore suggested that this might prove a useful source of motive force. It was, however, stated to be difficult to form an explosive mixture of the vapour with common air. By decomposing water with the voltaic battery, naphthalising the hydrogen with Benzole, and burning it with the aid of the equivalently-liberated oxygen, a simple light of intense power might be obtained. The system was shown to be a great simplification of the ordinary system of gas lighting, as no retorts, refrigerators, purifiers, or meters were required, and the products of combustion were as pure as those from the finest wax. It was expected that the elegance of the material and the simplicity of the apparatus would induce its introduction into buildings and apartments where coal gas was not now considered admissible.

The apparatus and conditions necessary for the success of the method were, a flow of cheap gas, or of air, driven through pipes by any known motive power, and a reservoir of the volatile spirit through which the main pipe must pass in some convenient part of its course; these pipes and reservoirs being protected from the cold. It was stated, that though the liquid did not require to be heated above the average temperature of the air, it was liable to become cooled by its own evaporation, so as to require an artificial supply of warmth. This was readily effected by causing a small jet of flame of the gas itself to play upon the reservoir, and by a simple contrivance, called a "Thermostat," by which the flame was shut off when necessary, the temperature could be made self-regulating, so as never to rise above or fall below a proper degree. The cooling due to the evaporation, would, of course, be inversely proportionate to the quantity of liquid in the reservoir. If atmospheric air was used as the vehicle for the vapour, the jet-holes in the burner, from which it escaped for combustion, must be slightly larger than those for coal gas. Some burners, contrived for the purpose of accurately adjusting the size of the orifice to the quantity of luminiferous matter escaping, were exhibited and described; they were made so that by moving a part of the burner, any required quality of flame, from lightless blue to smoky, could be obtained, there being a medium point at which the most perfect brilliancy was arrived at. The burners would answer equally well for coal gas, though that material could not, even by them, be made to evolve so white and pure a light as that from Benzole vapour.

In conclusion, some data were given on which a calculation of price was founded. It was stated, that a gallon of Benzole, of the degree of purity requisite for the purpose, would cost about two shillings and sixpence; to this, the expense of the air current and the interest of the original outlay on apparatus was to be added. This the author presumed would not raise the cost to more than four shillings for the consumption of the Benzole. It was stated, that one ounce of that liquid would give a light equal to four [illegible] candles, of four to the pound, for one hour; or one gallon for about [illegible]ndred and twenty hours. It was inferred, that a gallon of this mate[illegible] equivalent to about one thousand cubic feet of coal gas

[illegible] for comparison with coal gas at a distance from the mines, it was [illegible] to produce one thousand cubic feet of gas, at least two [illegible]l must be transported, one gallon of Benzole did not weigh more than seven pounds; this, in carriage, would give Benzole an advantage of twenty-eight to one over coal as a source of light.

In the discussion which ensued, high encomiums were passed upon the talent and patient labour exhibited by Mr. Mansfield in the investigation of this important subject, which promised to lead to most remarkable results, as an extension of gas lighting to positions where it had not before been considered applicable.

April 24.—William Cubitt, Esq., V.P., in the Chair.

The paper read was "*On the Construction of Locomotive Engines, especially those modifications which enable additional Power to be gained without materially increasing the Weight, or unduly elevating the Centre of Gravity.*" By Mr. T. R. Crampton, Assoc. Inst. C.E.

It was contended, that the durability of the working parts of the engine, the stability of the permanent way, and the freedom from oscillation so essential for the comfort of travelling, all depended upon the steadiness of the engines when at high speeds. This consideration led the author to introduce several modifications of the ordinary construction of locomotives; the driving-wheels were removed from the centre of the engine to behind the fire-box, placing all the weight on and between the extreme points of support. The centre of gravity was so reduced, that on the narrow-gauge railways, the angle of stability equalled that of the broad-gauge engines. All the moving parts of the machinery were removed from beneath the boiler and placed on the two sides, within the easy inspection of the workmen, and enabling the repairs to be effected with ease and dispatch. These dispositions had the effect of enabling a larger amount of heating surface to be given in the boiler, within a certain length of engine, than even in the larger class of engines of much heavier weight; thus, in fact, simultaneously concentrating the power and reducing the weight.

Upon this principle, some engines of a smaller class had been constructed, containing the water and coke tank within the same frame and on the same wheels as the boiler; this arrangement became practicable in consequence of the removal of the machinery from beneath to the two sides, leaving a convenient space for the tank, and the whole weight was placed within the extreme wheels, reducing, at the same time, the centre of gravity of the mass; for it was argued, that the two points of importance were to place the weight on and between the extreme wheels, and to bring the line of traction identical with the centre of gravity of the moving mass.

These positions were illustrated by a set of diagrams, showing the various constructions of engines that had been induced by the requirements of railways, and the demands, whether for economy of fuel, or increase of speed; and demonstrating that the class of engines having the driving-wheels under the centre of gravity of the boiler, was that which oscillated most at high speed; but that the class possessing the greatest amount of steadiness, was that in which the driving-wheels, and the weight which must accompany them, were removed to the hinder extremity of the engine.

The paper gave the details of the various changes, and the arguments for and against each class of construction, and the author requested, that if his reasonings were proved to be fallacious, some rules should be laid down for guiding the general practice of engineers in the construction of locomotives.

In the discussion which ensued, the arguments chiefly went to show, that it was the length of the base, or the area of the space covered by the wheels, rather than their position, and that of the weight upon them, that induced steadiness. On the other hand, it was contended, that although additional steadiness had been obtained in the old engines by thus extending the length of the base, yet that if, as had been shown to be practicable, a greater degree of steadiness could be obtained from an engine of less length between the extremities, when the driving-wheels were removed from the centre to the extremity, it was manifestly advantageous to adopt such a form of construction. This was practically instanced by a small engine, of less than nine feet between the centre of the wheels, running with perfect steadiness at high speed; whereas, with the old class of engines, it had always been considered necessary for safety to have at least eighteen feet between these centres.

SOCIETY OF ARTS, LONDON.

April 11.—B. Rotch, Esq., V.P., in the Chair.

"*On the Oxalis Crenata.*" By Baron De Suarcé. Specimens were exhibited.

The Oxalis Crenata has been known to the scientific agriculturists of Europe for some years: it is a tubercle the culture of which, however, upon a large scale has been little practised. This tubercle is stated by Baron de Suarcé (who has cultivated about two acres and a half of it upon his own estate in the south of France) to possess a larger degree of nutriment than most of the farinaceous plants which form the basis of human food in our climate. The total weight of the crop produced upon the above land by the Baron was ten tons, from which three tons of flour was obtained. From the stems of the plant, which may be cut twice a-year, and can be eaten as a salad or spinach, 90 gallons of a strong acid was obtained, which, when mixed with three times its bulk of water, was well adapted for drink. The acid, if fermented and brought to an equal degree of acidity with vinegar, is superior to the latter when used for curing or preserving meat, as it does not render it hard, or communicate to it a bad flavour. The flour obtained from the Oxalis Crenata is superior to that obtained from the potato, maize, or buckwheat, as it makes an excellent light bread when mixed in the proportion of one-fourth corn flour: this is not the case with potato, maize, or buckwheat flour. The Baron concluded his paper by expressing his willingness to make any further communication to the Society on the subject, as he would consider it a great happiness to be enabled, with their aid, to introduce into England the culture of a tubercle which seems destined to become a resource of food for the lower classes, more precious perhaps than even the potato.

In reply to a series of questions, the Baron stated that the Oxalis Crenata came originally from South America; that it is hardy, and unaffected by the change of temperature; and grows readily in any soil, it being difficult when once introduced to eradicate it.

"*On the importance of the Animal Refuse of Towns as a Manure, and the method of rendering it available to Agricultural purposes.*" By Dr. Ayres.

The author commenced his paper by calling attention to the necessity of preserving the animal refuse of towns, and the importance which is attached to it in China and Flanders, in many departments of France, Tuscany, &c.; and also to the various forms in which it is applied to the earth. Having alluded to the importance of this subject in connection with the improvement of the sanitary condition of towns, and the injurious effects upon the inhabitants of London in particular, by allowing the putrid matter to be carried into the Thames, there to be tossed upon the waves, and left exposed upon the shores at each retrocession of the tide,—he proceeded to consider the contents of the cesspools of London alone, which he has calculated can not yield less than 46,500 tons of perfectly dry matter annually—a quantity, according to the analysis of Liebig, sufficient to fertilise at least 1,000,000 acres of land, and the monetary value of which cannot be stated at less than 340,000*l.* Having next alluded to the plans which have hitherto been proposed for drying and rendering this great mass of matter portable and available for agricultural purposes, Dr. Ayres proceeded to describe a plan which he has recently patented for effecting so desirable an object. His process, he stated, essentially depends on the fact that all the gaseous and volatile products of putrefaction are combustible, and are resolved into the ordinary products of combustion when carried over any incandescent surface, or over or through burning fuel when mixed with atmospheric air. Thus ammonia is resolved into nitrogen and water; sulphuretted hydrogen into sulphurous acid and water; carburetted hydrogen into carbonic acid and water; and phosphoretted hydrogen into phosphoric acid and water. The volatile organic matters associated with the gases are completely destroyed; carbonic acid alone passes through the fire unchanged. All these gases, with the exception of ammonia and carbonic acid, exist only in very small proportions in putrescent animal matter. It follows from what has been stated, that all the volatile products of putrefaction are thus resolveable into the ordinary products of combustion, which are well known to be innocuous. It suffices to conduct these gases and vapours through a fire to effect their entire decomposition and destruction. The apparatus by which this process may be worked is susceptible of many modifications, but those to which he particularly desired to direct the attention of the Society, consist in drying the animal refuse by the application of heat, either obtained from steam-pipes or otherwise, and at the same time destroying the volatile products of putrefaction by burning them.

A lengthened discussion followed the reading of the paper, at the close of which the thanks of the meeting were presented to Dr. Ayres for his communication.

April 18.—T. Webster, Esq., F.R.S., V.P., in the Chair.

"*On the supposed Influence of Oxygen on the Colour or Tint of Flint Glass.*" By F. Pellatt, Esq.

The author in commencing his paper stated that the remarks contained in the same are entirely the result of experience in the manufacture of glass in large quantities, it being only under such circumstances that many of the changes there noticed can be observed, because they are so minute that in dealing with small quantities their occurrence would not be perceptible. In speaking of white glass the term is comparative, as no glass is perfectly colourless, and to the practised eye of the glassmaker there exists no two pieces of the same tint or shade: the word *colour* therefore is used to denote that particular tint or shade, whatever it be, which all white transparent glass possesses. With these remarks, the author proceeded to consider the action of oxygen as affecting the colour of flint glass in two distinct particulars—first, its action upon the glass mixture during its melting or founding, whilst in a state of fusion; and, secondly, during its annealing or gradual cooling.

The constituents of flint glass are silica, lead, carbonate of potash, and nitrate of potash. The silica is found sufficiently pure as fine sand which abounds in some districts; that from Alum Bay, Isle of Wight, is much esteemed. The protoxide of lead (litharge), or the deutoxide (red lead), is the state in which the lead is used; and the potash is the ordinary curl and nitrate of potash of commerce. These, when mixed in certain proportions and subjected to a strong heat for sixty or seventy hours, produce flint glass. The purer the material, the more transparent the glass: but although all the materials be chemically pure, a colourless glass is not the product,—owing to some chemical change which takes place during the melting, the glass is tinted with green. This is generally stated to arise from the presence of oxide of iron, but the author believes that in most instances it is owing to the want of a necessary proportion of oxygen in the mixture,—which the following experience will go far to prove.

The tint of green is always minus when the lead in the glass mixture is in the highest state of oxygenation—that is, when red-lead is used; and lowest when litharge is employed in the mixture. When an excess of carbonate of potash is used, the green tint is deep, but may be entirely overcome by the use of the nitrate of potash, and superseded by a purple tint when no metal but lead is present.

Oxygen being the agent by which these changes in the colour of the glass are effected, the glassmaker, in order to overcome the green tint always present when oxygen is minus, uses the oxide of manganese, which has the property of giving off its oxygen very slowly. An excess of manganese gives to glass a purple tint, and where altogether absent the glass is always green.

Having thus called attention to the peculiar composition and mode of manufacturing flint glass, he proceeded to describe the changes which take place in the colour or tint of glass, and the methods employed by the glass manufacturer to convert the mass from a green, purple, amber, or other tint, to a pure or colourless metal; and brought forward examples tending to prove that the changes in the colour of glass are due to the presence or absence of a given proportion of oxygen. Manganese, as a metal, gives no colour to glass, although by the oxygen it yields to the lead in the mixture a purple colour is produced, because by reducing the quantity of oxygen, either by polling or subjecting the glass to a long continued heat, or by submitting it to the action of carbon, the purple colour is removed, though the manganese still remains. Iron and copper also assume different colours when combined with different proportions of oxygen. If this be true, may not all colours of the oxygen of other metals, such as iron, copper, and lead, be due to the combination of certain proportions of oxygen with the metal or metals present, so as to induce a particular molecular arrangement, from which the glass has the power of absorbing a particular colour?

A lengthened discussion followed the reading of the paper, in which Mr. A. Pellatt, Mr. Christie, Mr. Wilson, Mr. Palmer, and other gentlemen connected with the manufacture, took part, at the close of which the thanks of the meeting were presented to Mr. F. Pellatt for his communication.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

March 19.—Ambrose Poynter, Esq., V.P., in the Chair.

A letter was read from Mr. B. Ferrey, containing a sketch of the life of the late Mr. Miles, an associate of the Institute, who died recently at the early age of thirty-two years.

Mr. Geoghegan exhibited a rubbing from the frieze of an Elizabethan mantelpiece, discovered lately during the alterations to Wiarton House, near Staplehurst, Kent. In the original, which is elegantly executed in the Kentish rag-stone, the pattern is very slightly incised in the stone.

Mr. Sydney Smirke, V.P., read a paper "*On the contents of a work by Sir Balthazar Gerbier, written in the 17th century, and entitled 'Counsel and Advice to all Builders,' together with some remarks suggested thereby.*" (See *Journal*, p. 153.)

The Chairman observed that, although Gerbier's work was undoubtedly one of the earliest on the subject in our language, it was not the first. Walpole mentions a treatise by John Shute, a copy of which had recently been recovered by Professor Willis.

Mr. Taylor, jun., described his patent method of facing walls with stone. It was mentioned, in connection with the subject, that the tower of Chelsea new church was faced after the brickwork of it was finished, and that the masons began at the top and worked downwards. Projecting courses had been worked in.*

April 16.—Sydney Smirke, Esq., V.P., in the Chair.

The Chairman announced that the Royal Gold Medal of the Institute for the year 1848 was awarded to the Signor Cavaliere Canina, of Rome, as the Historian of Architecture from the earliest period, and for his antiquarian researches,—he having published a series of important works on the various styles of art, and likewise on the Tombs of Etruria, the cities of Latium, and other antique remains.

The Report of the Council relative to the competition for the "Soane Medallion" and the "Medal of the Institute," was read and adopted; when the author of the successful Essay on Palladian Art was announced to be Mr. Wyatt Papworth.

A paper was read "*On the Hollow Brick Ceiling recently turned over St. George's Hall, Liverpool.*" By Robert Rawlinson, Esq.

Having stated that it had been the intention of the late Mr. Harvey L. Elmes, the architect of this building, to construct the ceiling with patent compressed bricks, Mr. Rawlinson observed that he in using the hollow bricks had only adopted a mode of construction known to the ancients, and also applied to some of the early Christian churches in Italy—and in buildings of a more recent date. He stated that, although not much in use of late years, these hollow bricks are now likely to be more generally applied; as, owing to a relaxation of the excise laws and the application of machinery, they can be manufactured at a less cost than solid bricks—while they possess the advantage of being lighter. It has been suggested, too, that the hollow bricks may be economically applied in the construction of the partition and external walls of cottages and other buildings, with the advantage of combining dryness with facility of ventilation.

The construction of the arch in question was of some importance from its size, the span being sixty-eight feet and its thickness one foot. The bricks used by Mr. Rawlinson were twelve inches in length and four inches square, with a longitudinal perforation two inches in diameter. The weight and cost of the arch thus constructed was one-fourth less than they would have been had solid bricks been used. The work was set in mortar (formed of Halkin lime used fresh and made in a steam-mill), with the exception of five feet on each side of the key, which is set in cement. The spandril walls are similarly constructed, at distances of four feet six inches, with circular openings which afford a passage along the sides. On removing the centerings, the arch was found to have deflected only three-eighths of an inch.

ROYAL SCOTTISH SOCIETY OF ARTS.

March 12.—George Lees, Esq., A.M., V.P., in the Chair.

The following communications were made:—

"*On the Warming and Ventilation of Dwelling Houses.*" By Captain John H. Hall.

A communication on the economical warming and ventilation of dwelling-houses by means independent of open fires in the several rooms—consisting, first, of general observations on the inefficiency and wasteful character of the existing method of warming houses; and, secondly, describing certain arrangements for insuring an uninterrupted supply of warmed fresh air to any one or more, at pleasure, of the several apartments of a house, by the use of one stove or warming apparatus.

"*Description of a Tubular Railway Bridge of a new construction.*" By Daniel Miller, Esq., C.E.

In this design it is intended to form a construction of malleable and cast iron, so as to apply their respective properties in the most advantageous manner to resist the opposing strains of tension and compression which are brought into action in a structure of this nature. A drawing shown represented a design on this principle for a railway bridge to cross the Clyde at Glasgow Harbour in two spans of 200 feet each. Each span consists of three girders, each 18 feet deep, which divide the bridge into two lines of rails. The upper part of each girder is formed of a circular tube of cast-iron, 2 ft. 9 in. diameter, which is of the best form and material for resisting compression. The upper side of the tube is thicker than the lower, as the inner circumference is eccentric to the outer. The lower part of the girder consists of a rectangular tube, 3 feet deep by 2 ft. 9 in. broad, formed of plates of malleable iron chain, rivetted and strengthened at the corners by angle-iron. This is considered the best form for resisting the tensile strain and preserving the necessary rigidity. These two tubes, forming the upper and lower sides of the girder, are united by frames of toughened cast-iron, which are cast of an open trussed form, so as to secure lightness and strength. At intervals of 15 feet, brackets are attached on each side of the centre of these frames, from the extremities of which proceed wrought-iron rods to the top and bottom, for the purpose of increasing the lateral strength and rigidity of the frames. The girders are united to each other transversely, both at top and bottom, by an arrangement of braces and struts of wrought and cast iron. All the cast-iron in the structure is proposed to be of Mr. Stirling's toughened cast-iron, which, by the recent government experiments, is proved to possess remarkable advantages in elastic resistance, and in resisting compression and tension; and removes the objection hitherto prevailing against employing cast-iron for railway bridges of large span, or where exposed to vibratory action.

The author considers that this combination of malleable and toughened cast-iron will fulfil the principal conditions required in such a structure, in economy, rigidity, elastic resistance, and ornamental appearance.

"*On a new Electro-Magnetic Coil-Machine.*" By Dr. Thomas Wright, F.R.C.P.

Dr. Wright stated that his machine consists of a bundle of thin iron wires, seven inches long by six-tenths of an inch in diameter, wound with thirty yards of No. 16 copper wire. It is fixed by half its length in a frame of wood, the other half being free, to permit a thick brass tube to slide over it. It is furnished with a self-acting adjustment for interrupting contact with the battery, an account of which was published by the author in Sturgeon's "Annals of Electricity" for March 1840, and which is, the author believes, used in all electro-magnetic coil-machines. The great power of this instrument was stated to depend upon the accuracy of the construction of the electro-magnet. A great number of experiments were instituted by Dr. Wright, for the purpose of determining the proportion to be observed between the coil wire, the iron to be magnetised, and the battery; this differs with the kind of battery used, but for general purposes the arrangement above described appears to be the best. Dr. Wright stated that it is most essential that the coil wire be brought as close as possible to the iron; and that to effect this, the coil wire is simply insulated by a single layer of the thinnest tissue paper, instead of the coverings of worsted or cotton which are generally used. Dr. Wright stated that an instrument thus constructed,

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* Facing the brickwork with stone after the building is erected is not new: it was adopted by Sir Robert Smirke, in the Temple, to the new Chambers, and also at the British Museum.—Ed. C.E. & A. Journal.

besides giving a succession of powerful shocks, possesses an extraordinary power of effecting chemical decomposition: the electro-magnetic machines he had hitherto seen scarcely affording more than a few bubbles of gas when employed in the decomposition of water, while Dr. Wright's machine gives a torrent from the electrodes of the voltameter. Dr. Wright stated that a most powerful machine may be packed in a box 8 inches by 2½, which can be carried conveniently in the hand. In medical practice, Dr. Wright found that the still smaller machine, which he exhibited, is more than sufficiently powerful, though its size is only 3½ by 1½ inches.

March 26.—John Cay, Esq., F.R.S.E., President, in the Chair.

The following communications were made:—

"*Description of several new and simple Stereoscopes, for exhibiting as Solids, one or more representations of them on a Plane.*" By Sir David Brewster, F.R.S.

This paper contained the description of a particular stereoscope, constructed with two semi-lenses, or two quadrants of a lens, united as spectacles, but in such a manner as to give double images of objects, or of drawings of solids, as seen by each eye separately. When two of the images thus produced were united, as in the instrument, the solid, either raised or hollow, from which the drawings were taken, was reproduced. Another stereoscope, called the Total Reflection Stereoscope, was described, which required only one drawing of the solid, the other drawing being created by the instrument and united with the picture seen by the other eye. Single and double reflecting stereoscopes, of great simplicity, and easily constructed, were also described; together with microscopic stereoscopes, which can be carried in the pocket.

"*Description of a Time-Signal for Railways, Steamboats, &c.*" By James S. Torrop, Esq.

The present instrument has been devised to meet a great want, which has long been felt, for some certain and effective means of informing or warning the public of the approaching departure of passenger trains. Bells rung within or near the station, cannot answer the purpose, the sound being easily stifled, and apt to be regarded, when loud enough to be heard at any distance, as a nuisance. Clocks are still more useless, as they are visible only at short distances, even when they can be placed on conspicuous positions. This time-signal, or railway trains' monitor, consists of a moveable ball mounted on a lofty pillar, wound up to the top by clock-work, and taking a definite time to descend. For railways this time is set to ten minutes. When the ball is seen at the top of the pole or pillar, passengers approaching the station are informed that they have ten minutes; if half-way down, five minutes, and so on. Being capable of being made a conspicuous object, its indications can be distinguished at a considerable distance by intending passengers, who are thereby saved all unnecessary excitement and uncertainty in making their way to the station, while the officials are also saved from the annoyance of questioning as to the time the train is due.

"*Notice of a peculiar property of Gutta Percha.*" By James S. Torrop, Esq.

Gutta Percha, when cast and rolled into sheets, assumes a property belonging to fibrous substances; it acquires tenacity in a determinate direction. When in the roll or sheet this tenacity is longitudinal, but if a strip be cut from the breadth two peculiarities occur—the strip is susceptible of a definite elongation to nearly five times the original length, and its direction of tenacity is reversed. When it is considered that Gutta Percha is originally a fluid substance, or gum, these peculiarities are curious and remarkable.

"*Description and Drawing of a Rapid Filter, adapted for the perfect Filtration of Water for the supply of Towns, or for any other purpose where a large quantity of pure water is required.*" By Messrs. T. and W. Stirling, Bow-Bridge Slate-works, Stratford, Essex.

The objects and advantages of this apparatus were stated to be—1st, While it is capable of being so combined as to filter large quantities of water, it also acts upon each gallon that passes, with the same minuteness and delicacy as the chemist employs for his most careful operations. 2d, It is made of a material upon which water has no decomposing effect. 3rd, While it may be readily cleansed, it is in no degree liable to get out of order. 4th, It occupies but a small space compared with the quantity of water filtered by it; and 5th, It is so arranged as to be guarded from the disturbing effects of frost or rain, and protected from soot, smoke, and dust.

A series of slate boxes or cisterns, the size and number of which are regulated by the quantity of water required to be filtered, as shown in the drawing submitted to the Society, are so placed that the reservoir or pipe from which they are supplied shall have a head of water of about two feet six inches. The water passing along the main-pipe, enters each filter at the bottom through a branch-pipe, and passes through three strata of filtering medium (the lowest of which rests upon a hollow basis, across which a fine wire-gauze is stretched), through which it rises to the top of the filter in a perfectly pure state. The filtered water then passes from the top of each filter through a small pipe into a slate channel, along which it runs into the pipe, reservoir, or other receptacle for the filtered water. The filtering medium consists of three strata of incorrodible mineral substances, and the chamber in which they are placed admits the introduction of a hair-brush such as is used for cleaning bottles, and with this the bottom of the filter-bed is readily cleaned of all residium in a few minutes. The apparatus can be adapted to filter any quantity of water from 500 to 50,000,000 gallons, and may be applied not only to domestic use, but to the purposes of paper-makers, brewers, distillers, chemists, bleachers, wool-staplers, printers, and other trades for which large quantities of pure water are indispensable. The usual method of filtering water supplied to towns is by means of reservoirs of subsidence and filter-beds, which occupy a large space of ground, and at best effect the object very imperfectly. This apparatus, however, can be so managed as to occupy only about one-twentieth part of the space required by the other methods now in use, and may be enclosed in a covered building, so as to protect it from rain, soot, and dust, and, when necessary, warmed by flues to prevent the action of the filters from being impeded during severe frost.

"*Notice on the Ventilation of Public Buildings and Private Dwellings with peculiar reference to the method adopted by him in the New Police Office, Edinburgh.*" By R. Ritchie, Esq., C.E.

Mr. Ritchie brought under the notice of the Society the method of ventilation he had carried into effect at the new police buildings, Edinburgh, which plan was founded upon the principle for which, in 1847, this Society had awarded to him a silver medal and plate, value ten sovereigns. He stated that the certainty of operation of this process and its efficiency had now been fully attested. He described that a furnace, placed at the basement of the building, was made to heat, with the utmost simplicity, a very powerful patent hot-water apparatus, placed 70 feet above it at the roof, for extracting the foul air. The various rooms and cells in the building were each provided with a conduit to carry off the exhaled air, and these conduits terminated in a long gallery under the roof; the extracting apparatus was erected at one part of the gallery at the bottom of an ascending shaft. This shaft terminated in a louvre, so arranged that the orifices of discharge could be regulated (according to the direction of the wind) in the furnace-room at the basement. By means of this powerful appparatus, the exhaled air drawn from the rooms and cells into the gallery, passed without obstruction into the atmosphere. He pointed out that this plan of ventilation possessed the obvious advantage, that it was free from the risk of the reflux of foul air and vapours of combustion into the rooms and cells, and it is likewise free from danger of fire. Mr. Ritchie stated that this mode of ventilation could easily be adapted for one or for many apartments; and he considered it applicable to mining ventilation. The consumption of fuel for the ventilating apparatus at the police buildings was exceedingly small for the effect produced. He also described the means provided for supplying fresh air for renovation, which in winter was warmed by means of a mild hot-water apparatus, and the air regulated in moisture in a chamber of preparation. He stated that this method had been applied most successfully by him at various buildings, and referred, amongst others, to St. John's Chapel, Prince's-street, which was equally heated with one fire, which was substituted in place of two stoves formerly used. The success of this plan was attested by the Chairman. He also made some suggestions as to the great advantages which would arise, were systematic arrangements for ventilation incorporated with the construction of buildings generally; and he mentioned various modes for making the conduits for exhaled air.

THE ARCHITECTURAL EXHIBITION.

Sir—In the last number of your periodical you have alluded to a drawing which I forwarded to the 'Architectural Exhibition,' as appearing again under a *change of names.* From some cause, probably that of a hasty compilation of the catalogue, the drawing was inserted therein as a "Design for a Library,"—whereas, there still existed at the back of the frame the original description, and to which the catalogue was revised in the *second edition*, without my having named the matter to the parties concerned in its formation. You will therefore perceive that the alteration did not proceed from any intention on my part to make one design answer for a different purpose.

I am, &c.,

Wyatt Papworth.

10, *Caroline-street*, *April* 20, 1849.

Drying Closet.—Some recent experiments with a new drying closet at the Middlesex Hospital, show that it is not necessary to have an external air drain. The closet is 6 feet by 8 feet, and 7 feet high, heated by radiation from the flue of an ironing stove which passes through it. The closet was previously tried with an air drain, and it has been found not to be so good as one without a drain.

	6 Blankets.	18 Rugs.
	lb.	lb.
Weight when put in	44	169
Weight when taken out	23½	87½
Water evaporated	20½	81½
Time in evaporating	2 h. 33 m.	
Temperature of closet when rugs were put in	200°	
Ditto when taken out	160°	

Fuel consumed equal to one-fourth the weight of water evaporated.

Gutta Percha Tubing.—This tubing is such an extraordinary conductor of sound, that its value, not only to deaf persons, but to the public generally, will speedily be appreciated. It has already been fitted up in dwelling-houses, in lieu of bells,—as speaking tubes for giving and receiving messages in mines, railway stations, prisons, workhouses, hotels, and all large establishments, it is invaluable.

New Motive Power.—Count de Werdinsky has communicated to the 'Mining Journal' a discovery which he believes he has made, by which a convenient, inexpensive, and highly-effective motive power can be obtained from xyloidine, or gun cotton. He says:—"I have been engaged in constructing an engine and locomotive, to be worked on common roads by xyloidine, on the following plan:—Small quantities of xyloidine are exploded successively into a copper recipient of a spheroidal form, of 13 inches diameter, and ¼-inch strong in metal. Each separate explosion is adequate to produce, by means of double cylinders, a complete revolution of the crank. The object of the copper recipient is merely to allow the intense gases thrown into it room enough to expand, and thus to change their percussive intensity into a more gentle dynamic power, without in any way losing any of the quantity of that power. I can, therefore, let out from that copper recipient as much of the gases, through a stop-cock, as would produce a pressure of from 30 to 60, or 120 lb. upon the square inch of the piston; moreover, by the very heat accumulated in the metal of the recipient, the gases are kept up to their original strength, so that, the longer the engine continues to work, the greater the comparative economy of xyloidine, on account of the heat of the recipient and of the machinery, which serve to keep up great expansion, and consequently great power in the gases. My experiments with a steam engine of about 2½ horse-power, on the above principle, answered admirably; but while these experiments were going on, I made a further discovery, and this last one is verging almost on a miracle. The most prominent features of my last discovery are—that the propulsion of carriages on railways, and on common roads, will be now effected without engines, steam, fire, water, magnetism, air, or animal power, and propelling of ships without either of the above means, sails, or paddles, or any propellers whatever."

The Spanish War-Steamer 'Colon.'—A very fine steam-frigate, built by Messrs. Wigram, for the Spanish government, and fitted with engines of 350-horse power, by Messrs. Penn, of Greenwich, was tried down the river on the 25th ult., to ascertain her speed, and the working of her engines. She left Blackwall at 12 o'clock noon, having on board Gen. Viogdet, of the Spanish army, Messrs. de Zulueta, Capt. Halstead, of Her Britannic Majesty's Royal Navy, Mr. Wigram, and the Messrs. Penn, and proceeded down the river to Long Reach, where the measured mile was tried once down and once up the river, and the speed against the tide found to be 8·238, and 13·438 with the tide, making an average of 10·835 knots per hour, a very excellent result considering the size of the vessel and the power of her engines, which made from 23 to 23½ revolutions per minute with a five feet stroke, and the common paddle-wheels, which were preferred, as a serviceable description of works not liable to become deranged during service. The length of the vessel is 190 feet, with a breadth of beam of 31 ft. 11 in., and a fine sweeping deck, admirably constructed for the facility of working her guns. Her depth of hold is 20 feet, with ample room for the engines; the whole space around them is very clear, and every person connected with them and with the boilers is under the immediate superintendence of the engineer in charge of the working of the engines. The engines work remarkably steadily, and during the trial gave the greatest satisfaction, as there was not the least appearance of a hot bearing, or delay on any account whatever. The armament of the "Colon" is to consist of two 68-pounder guns on traversing platforms, and four 32-pounders. She will carry 16 days' fuel at full speed, or 400 tons of coal, with three months' provisions, and shot and shells for service. Her principal cabins are neatly fitted up, and the whole arrangements are highly creditable to Messrs. Wigram, who have produced a war-steamer of a really serviceable description.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM MARCH 20, TO APRIL 19. 1849.

Six Months allowed for Enrolment, unless otherwise expressed.

William Henry Balmain, and Edward Andrew Parnell, both of St. Helen's, Lancaster, manufacturing chemists, for improvements in the manufacture of glass, and in the preparation of certain materials to be used therein, parts of which improvements are also applicable to the manufacture of alkalies.—March 5. [This patent was accidentally omitted in last month's list.]

John Macintosh, of Bedford-square, for improvements in furnaces and machinery for obtaining motive power, and in regulating, measuring, and registering the flow of fluids and liquids.—Sealed March 24.

David Henderson, of the London Works, Scotland, engineer, for improvements in the manufacture of metal castings.—March 26.

Alexander Parkes, of Harborne, Stafford, chemist, for improvements in the deposition and manufacture of certain metals, and alloys of metals, and improved modes of treating and working certain metals, and alloys of metals, and in the application of the same to various useful purposes.—March 26.

Stephen White, of Victoria-place, Bury New-road, Manchester, gas engineer, for improvements in the manufacture of gases, and in the application thereof to the purposes of heating and consuming smoke; also improvements in furnaces for economising heat, and in apparatus for the consumption of gases.—March 26.

John Mason, of Rochdale, Lancaster, machine-maker, and George Collier of Barnsley, York, manager, for certain improvements in machinery or apparatus for preparing and spinning cotton and other fibrous materials, and also improvements in the preparation of yarns or threads, and in the machinery or apparatus for weaving the same.—March 26.

George Thomson, of Camden-road, cabinet-maker, and James Elms, of the New-road, gentleman, for improvements in the machinery for cutting and tying-up firewood.—March 28.

William Buckwell, of the Artificial Granite Works, Battersea, Surrey, civil engineer, for improvements in compressing or solidifying fuel and other materials.—March 28.

Richard Satchell, of Rockingham, Northampton, for improvements in machinery for depositing seeds, and hoeing and working land.—March 28.

Pierre René Guerin, of Havre, for improvements in steering ships and other vessels.—March 28.

Charles Green, of Birmingham, patent brass tube manufacturer, and James Newman, of Birmingham, manufacturer, for improvements in the manufacture of railway wheels.—March 28.

George Henry Manton, of Dover-street, Piccadilly, gunmaker, and Josiah Harrington, of Regent's-circus, gunmaker, for improvements in priming, and in apparatus for discharging fire-arms.—March 28.

Francis Voullion, of Princes-street, Hanover-square, manufacturer, for improvements in making hats, caps, and bonnets.—March 28.

William Hartley, of Bury, Lancaster, engineer, for certain improvements in steam-engines.—March 28.

Frederick William Norton, of Lascelles Hall, York, fancy cloth manufacturer, for certain improvements in the production of figured fabrics.—March 28.

Osborne Reynolds, of Dedham, Essex, clerk, for certain improvements in railways.—March 28.

Thomas Harrison, of Liverpool, merchant, for certain improvements in the construction of baking ovens, and also in certain machinery for working or using the same.—March 28.

James Thomson Wilson, of Glasgow, for improvements in the manufacture of sulphuric acid and alum.—March 28.

James Fletcher, of Salford, Lancaster, manager, and Thomas Fuller, of the same place, machinist and toolmaker, for certain improvements in machinery, tools, or apparatus for turning, boring, planing, and cutting metal and other materials.—March 28.

James Lawrence, the elder, of Colnbrook, Middlesex, brewer, for an improvement or improvements in brewing worts for ale, porter, and other liquors, and in storing ale, porter, and other liquors.—March 28.

John Britten, of Birmingham, manufacturer, for certain improvements in the means, apparatus, and appliances for cooking, preserving, preparing, and storing drinks and articles of food, and in preparing materials for constructing the same; also in constructing vertical roasting jacks and chains for the same, applicable to other chains, parts of which improvements are applicable to other similar purposes.—March 28.

William Beckett, of Northwich, Cheshire, draper, and Samuel Powell, of Witton, Northwich, Cheshire, foreman, for certain improvements in the manufacture, making, or construction, of certain articles of wearing apparel.—March 28.

Henry Howard, of Railway-place, Fenchurch-street, for certain improvements in the manufacture of glass; also in the construction of furnaces for melting and fining the same.—March 28.

William M'Bride, jun., of Sligo, Ireland, but now of Havre, France, merchant, for improvements in the apparatus and process for converting salt water into fresh water, and in oxygenating water.—April 2.

Alfred Vincent Newton, of Chancery-lane, mechanical draughtsman, for improvements in separating and assorting solid materials or substances of different specific gravities. (A communication.)—April 2.

Samuel Alfred Carpenter, of Birmingham, Warwick, manufacturer, for a certain improvement in, or substitute for buckles.—April 3.

Alfred Woollett, of Liverpool, artist, for certain improvements in gun carriages.—April 3.

William Parry, of Plymouth, Devon, gentleman, for certain improvements in shoeing horses, and in horse-shoes.—April 3.

Henry Dunington, of Nottingham, manufacturer, for improvements in the manufacture of looped fabrics, and in the making of gloves and hat-bands.—April 3.

James Godfrey Wilson, of Chelsea, engineer, and William Pidding, of Elizabeth-street, Pimlico, for improvements in obtaining perfect combustion, and in apparatus relating thereto, the same being applicable to every description of furnace and fireplace, as also to other purposes where inflammable matter or material is made use of.—April 3.

A grant of an extension of an invention for the term of four years from the 4th day of April, for a certain improvement or certain improvements in the making and manufacturing of axletrees, for carriages and other cylindrical and conical shafts. To Charles Geach and Thomas Walker, assignees of James Hardy, the original inventor.

Gaspard Brandt, of Little Gray's-inn-lane, Middlesex, machinist, for improvements in the construction of the bearings of railway engines, and railway and other carriages now in use.—April 13.

James Childs, of Earl's-court, Old Brompton, Middlesex, wax bleacher, for improvements in the manufacture of candles, night lights, and candle lamps.—April 16.

Thomas Cocksey, of Little Bolton, Lancaster, millwright, and James Nightingale, of Brightines, Lancaster, bleacher, for certain machinery to facilitate the washing and cleaning of cotton and other fabrics, which machinery is applicable to certain operations in bleaching, dyeing, printing, and sizeing warps and piece goods.—April 16.

Louis Prosper Nicolas Duval Piron, engineer, of Paris, for certain improvements in tubes, pipes, flags, and kerbs for pavement and tram-roads.—April 16.

Charles Shepherd, of Leadenhall-street, city of London, chronometer maker, for certain improvements in working clocks and other time-keepers, telegraphs, and machinery, by electricity.—April 16.

Robert Clegg, Joseph Henderson, and James Calvert, of Blackburn, Lancaster, manufacturers, for certain improvements in looms for weaving.—April 16.

John Ruthven, of Edinburgh, engineer, for improvements in preserving lives and property from water and fire, and in producing pressure for various useful purposes.—April 16.

William Henry Phillips, of York-terrace, Camberwell New-road, Surrey, engineer, for improvements in extinguishing fire, in the preparation of materials to be used for that purpose, and improvements to assist in saving life and property.—April 16.

William Little, of the Strand, Middlesex, for improvements in the manufacture of materials for lubricating machinery. (A communication.)—April 16.

William Edward Newton, of Chancery-lane, civil engineer, for improvements in machinery for the manufacture of net lace or other similar fabrics. (A communication.)—April 16.

William Hyde Knapp, of Long-lane, Southwark, chemist, for improvements in preparing wood for the purposes of matches and firewood.—April 17.

Thomas Nicholas Greening, of the firm of Messrs. Burdekins and Greening, of Sheffield, cutlery manufacturers, for improvements in knives and forks.—April 17.

Alexander Alliott, of Lenton Works, Nottingham, bleacher, for improvements in apparatus for ascertaining and for marking or registering the force or pressure of wind, of water, and of steam; the weight of goods or substances; and the velocity of carriages; also in apparatus for ascertaining, under certain circumstances, the length of time elapsed after carriages have passed any given place; and for enabling the place or direction of floating bodies to be ascertained.

George Remington, of Warkworth, Northumberland, civil engineer, for certain improvements in locomotive, marine, and stationary steam-engines, and in hydraulic and pneumatic engines.—April 17.

William Edward Newton, of Chancery-lane, civil engineer, for improvements in boilers or steam generators. (A communication.)—April 17.

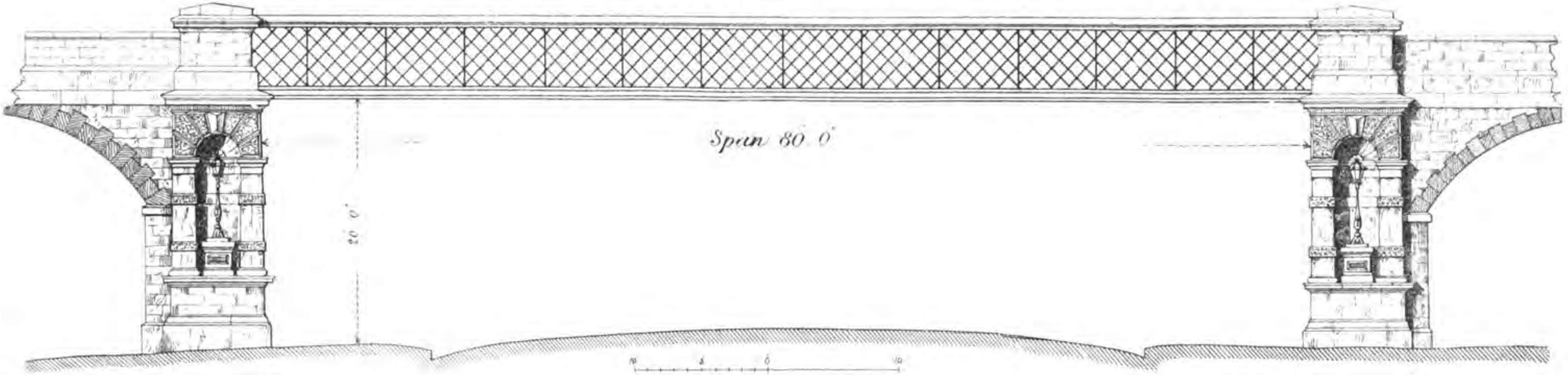
Henry Bessemer, of Baxter-house, Middlesex, for improvements in the methods of extracting saccharine juices from the sugar-cane, and in the manufacture of sugar, as also in the machinery or apparatus employed therein.—April 17.

John Ormerod, of Holt Holme Mill, near Newchurch, Lancaster, spinner, for certain improvements in carding cotton and other fibrous substances.—April 19.

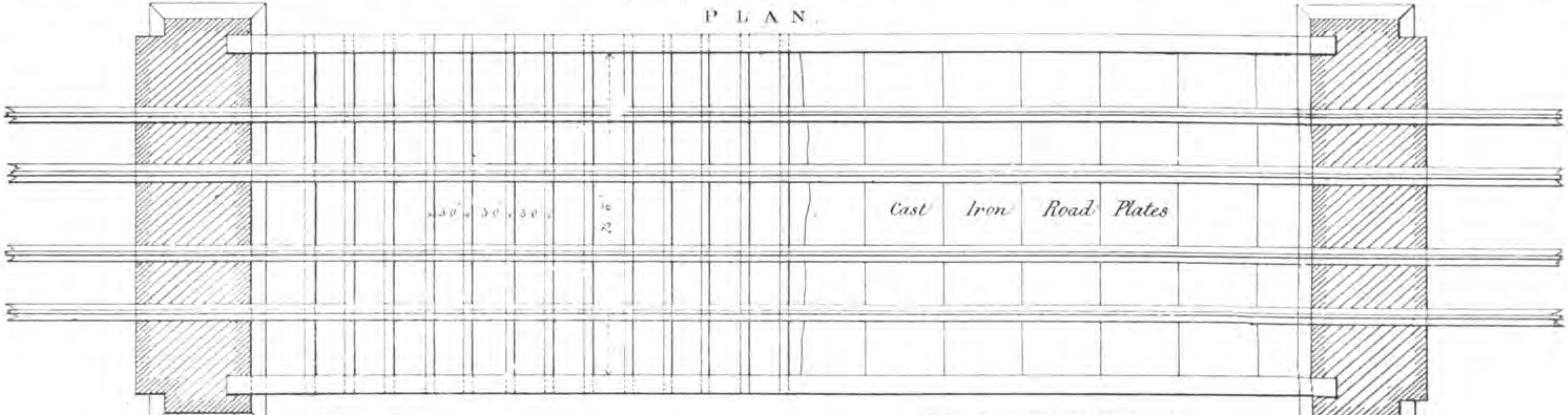
Robert Gordon, of Heaton Norris, Lancaster, engineer, for certain improvements in the ventilation of mines.—April 19. [This patent was not sealed till the 19th, but bears date the 4th day of April, per order of the Lord Chancellor, being opposed at the Great Seal.]

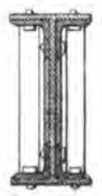
MALLEABLE IRON LATTICE BRIDGE.

ELEVATION.

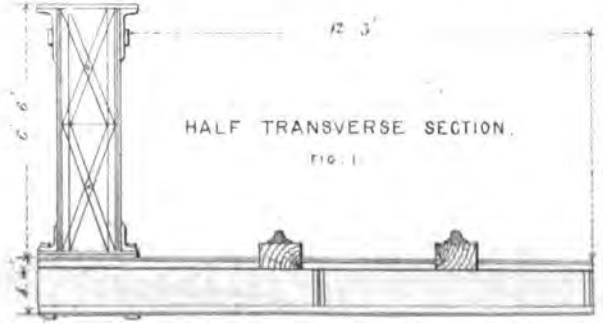


PLAN.





— SECTION OF TRANSVERSE BEAM.



HALF TRANSVERSE SECTION.

FIG. 1.

FIG. 2. – PLAN OF BOTTOM PLATES.

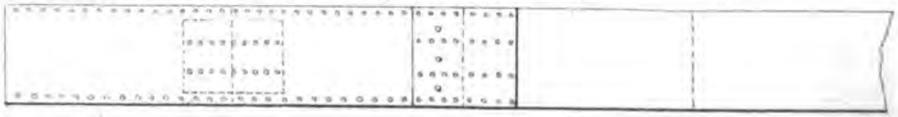
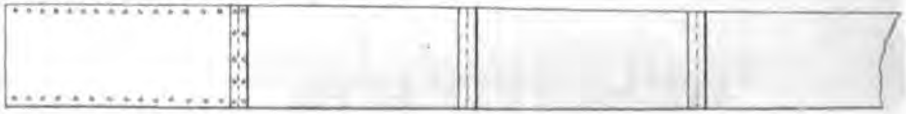


FIG. 3. PLAN OF TOP PLATES.



SCALE TO FIGS 1 2 & 3.

C. F. A. Bloor del. & litho.

MALLEABLE IRON LATTICE BRIDGE.

By C. E. A. Blair.

(*With an Engraving, Plate* IX.)

The bridge is proposed to be constructed of malleable iron throughout. The top and bottom of the main girders are composed of plates rivetted together, with covering plates at the joints. The sides are formed of strip iron, 3½ inch by ½-inch, with a single rivet at each intersection. The advantages of this principle of construction are that the largest spans may be crossed with the minimum headway, the distance from underside of girder to level of rails being reduced to 2 ft. 2 in. The saving of expense in cuttings and embankments would necessarily be greatly lessened, inasmuch as the greatest height required from surface of ground to rail level would be about 21 feet.

The sectional area of the bottom flanche is to the sectional area of the top as 6 to 7, and the breaking weight in the centre is taken at 6 tons per foot of the span.

Bridges on this principle of construction (not exceeding 80 feet span) may be erected at 40*l.* per yard forward, or about 19*l.* per ton, including all details.

For extensions of existing railways this plan is very advantageous, as the works can be executed with great rapidity and with perfect success. Bridges on this principle have been erected by Mr. Hawkshaw on the Lancashire and York Railway.

Manchester, March 21, 1849.

CANDIDUS'S NOTE-BOOK,
FASCICULUS XCIV.

"I must have liberty
Withal, as large a charter as the winds,
To blow on whom I please."

I. How far the "Seven Lamps" are likely to enlighten the public on the subject of architecture may be better judged by-and-by. It is not every one whom they will enable to see his way much better than at present; nor is it every one who will thank the Lamplighter,—so far from it that some of his opinions and utterings will seriously offend many. Pugin and his party will say that his book truly resembles a lamp in one respect—namely, in being a *wick*-ed thing, for it denounces the Romanist Church in unqualified terms of abhorrence as being "in the fullest sense anti-christian." "Our detestable Perpendicular" is an expression that will not be at all relished by Mr. Barry, and the commissioners for rebuilding the Palace of Westminster. Mr. Pickett will feel sadly agrieved by what is urged against the employment of Iron as "a constructive material," and against cast-iron ornaments. The protest against Machine-Carving, as being not only bad but "dishonest also," will be equally unpleasant to others. "Do not let us talk of Restoration," will scandalise not a few among us. And, "we shall not manufacture Art out of Pottery and Printed Stuffs," will scandalise quite as many of a different class. In another quarter, our Lamplighter's aversion to Railroads and Railway travelling, and his advice that no more money should be expended on Stations and other railway buildings, will not obtain him friends. His condemnation of Heraldic decorations, "its similitudes and arrangements being so professedly and pointedly unnatural that it would be difficult to invent anything uglier," will cause some to make such wry faces that they themselves will look as ugly as the ugliest heraldic images. Similar workings of the human countenance will again be produced by his deprecating and depreciating "rigid imitations of mediæval statuary," which he affirms to be "mere insults to common sense, and only unfit us for feeling the nobility of their prototypes." His severe reprehension of *cheap* churches, and *cheap* architecture generally, and of the present "that-'ll-do" system, will not at all ingratiate him with jobbers and "speculative" builders. Putting all this and a great deal more besides together, it will be well if his "Seven Lamps" do not prove to be seven mischievous Firebrands, that will singe and scorch numbers of folks, both those in the profession and out of it.

II. There is, indeed, one in the profession who, so far from being at all singed or scorched, is on the contrary absolutely irradiated,—at any rate, one of his buildings is set in a most luminous light; for the Oxford Graduate scruples not to express his "sincere admiration of the very noble entrance and general architecture of—" of what will hardly be guessed even when the reader is informed that it is one of our metropolitan structures—the British Museum. However sincere Mr. Ruskin's admiration may be, it is by far too laconic to be of any particular value, or to amount to more than a bare opinion unsupported by a single remark in evidence of its justness. Yet, some special remarks were certainly required, since the praise accorded to that edifice seems to be in flat contradiction to much that he elsewhere says. Besides that, the general bareness of the façade and its utter destitution of ornament would seem to do anything but recommend it to one who shows that he has a taste for even the most profuse decoration; the façade itself is but a mask, and one so awkwardly put on that it does not even conceal the meanness of the general structure behind it. Among other remarks of the same tendency, "it is not well," he says, "that ornament should cease in the parts concealed; credit is given for it, and it should not be deceptively withdrawn; as, for instance, in the backs of the statues in a temple pediment." *Risum teneatis?*—here is a gentlemen so over-scrupulous on the score of honesty and probity of work and workmanship, that he would have parts that can never, while the building remains in an entire state, be seen at all, be carefully finished up, yet can conveniently shut his eyes to the gross inconsistency and palpable wholesale deformity occasioned by its being seen that the stone Ionic façade is merely "a show-front" stuck on to a brick building of very homely and warehouse-like character, to say nothing of the paltry bits between the main building and the official houses. Mr. Ruskin surely reminds us of the giant who could swallow mill-stones with ease, yet was at last choked by a pound of butter.

III. It is not generally known, perhaps, that the Oxford Graduate is the same person as the *Kata Phusin* of Loudon's "Architectural Magazine," a clever but fanciful, and frequently so mystical a writer, that if he does not actually lose himself in his darkly-expressed sayings, his meaning is both mist to and missed by the generality of readers. An *eighth* lamp is required to throw light on some of his enigmatical expressions and phrases—such, for instance, as "*Parasitical Sublimity*," which, by the rule of *obscurum per obscurius*, he gives as the definition or explanation of the term "Picturesque." And he afterwards goes on to say, "*The picturesque is developed distinctively exactly in proportion to the distance from the centre of thought of those points of character in which the sublimity is found;*"—to make out the meaning of which far exceeds my comprehension.

IV. Passing from Mr. Ruskin's ambitious sublimities and eccentricities of language, and following him where he is more intelligible, even there we occasionally find him startlingly eccentric in some of his critical opinions. And after his profession of sincere admiration for the British Museum—which, by the by, might have been referred to by him as a notable instance of that "formalised deformity, shrivelled precision, and *starved accuracy*" with which he reproaches his own countrymen—startling it is to hear him descant with enthusiastic rapture on the Doge's Palace, the Campanile, and front of St. Mark's, at Venice, as "models of perfection." Of the last-mentioned he says, that "although in many respects imperfect, it is in its proportions, and as a piece of rich and fantastic colour, as lovely a dream as ever filled human imagination"! What will the Parthenonites,—or what will the devotees of our own mediæval styles, say to that flourish? Certain it is that the "*Lamps*" here afford us some entirely new light, for never before, as far as I am aware, have any of those three structures been spoken of otherwise than as architectural singularities and grotesques,—as such, curious and interesting enough, but devoid of any element of beauty. Mr. Ruskin himself does not attempt to conceal from his readers that the general opinion hitherto entertained of them has been the reverse of favourable. Like myself, he is not one of those who speak by book, and merely re-echo or repeat drowsily by rote stereotyped praise or censure. On the contrary, with a manly candour which is much more rare than it ought to be, he quotes the summary condemnation passed by a professional critic on those three works of architecture. Woods says of them: "The strange-looking church, and the great ugly campanile, could not be mistaken. The exterior of this church surprises you by its extreme ugliness more than by anything else. The Ducal Palace is even more ugly than anything I have previously mentioned;"—whereas he of the "Lamps" speaks of the last as "the model of all perfection,"—an opinion as marvellous as any of the wonders wrought by Aladdin's lamp. Pity that we did not get it before, because then, perhaps, we should have had a copy of the Doge's Palace for the Army and Navy Clubhouse. However, we may still have it for something else, now that we are enlightened as to its extraordinary merits.

V. Of Sansovino's works, and the later school of Venetian architecture, Mr. Ruskin says nothing, although they would afford studies of a more practical nature than do the edifices which he so greatly extols. On the other hand he says, but merely in general terms, that Venice affords "a model"—that is, I suppose, models—"of domestic Gothic, so grand, so complete, so nobly systematised, that, to my mind, there never existed an architecture with so stern a claim to our reverence." Such then being the case, it would have been no more than proper to have specified some examples of that particular and less-known class; pointing out at the same time, with some degree of distinctness, the peculiar merits which would seem to justify his very high, and now apparently very extravagant, encomium. Some such explanatory comment and critical description is all the more needed, because we have hitherto had none at all with regard to what he speaks of, or rather merely hints at, we being left entirely at a loss to know whether he alludes to examples that are to be met with in Cicognara's work, or other publications, or to some that have been neither described nor delineated. If it be only to the former, few will agree with him as to the excellence of Venetian Domestic Gothic, for it certainly is anything but a model to be at all followed at the present day,—assuredly not by us, who have far better models here at home.

VI. Though he could charitably throw a mite, or rather lump, of admiration to the British Museum—and that building certainly stands in need of such charity—Mr. Ruskin has very little admiration for English architecture generally, and none at all for one structure which we have hitherto been deservedly proud of. King's College Chapel, Cambridge, finds no favour at all in his enlightened eyes, for he scruples not to stigmatise it as "a piece of architectural juggling"! Again, elsewhere, he says: "What a host of ugly church towers have we in England, with pinnacles at the corners, and none in the middle! How many buildings like King's College Chapel, looking like tables upside down, with their four legs in the air!"—a kind of criticism on a par with that which likens spires to extinguishers, and window pediments to cocked-hats. "Knock down," he adds, "a couple of pinnacles"—perhaps he means the turrets—"at either end in King's College Chapel, and you will have a kind of proportion instantly." After this, our "Oxford" man would do well not to visit Cambridge, lest some Cambridge man should knock a couple of his teeth down his throat, not only in return for the compliment, but to give his mouth "a kind of proportion instantly."—Well, perhaps the modern King's College, in Somerset-place, satisfies him much better than the other. Indeed, any one who admires the British Museum can very reasonably afford to admire that building also, and discover in it—at least, by the aid of a *lamp*—the desirable quality of nobleness.

VII. Or perhaps the British Museum is something quite unparalleled in this kingdom, in comparison with which St. George's Hall, at Liverpool, is a mere puny and common-place piece of architecture; for Mr. Ruskin, strutting in tragic buskin, assures us that "all we do is small and mean, if not worse,—thin and wasted and unsubstantial. It is not modern work only; we have built like frogs and mice since the thirteenth century (except only in our castles)"! Like frogs and mice! what their architecture may be I know not, but no doubt, if it exist at all, it must be very ancient and very *Homeric*. One thing, however, is very certain—that our "Lamplighter" has neither seen nor otherwise knows anything of such modern English works as Blenheim and Castle Howard, or Greenwich Hospital; or, unless his face is of brass—of the same metal as his lamps—he could never had the effrontery to taunt us with having done nothing but what is mean and small—thin, wasted, and unsubstantial. The idea of Blenheim being *unsubstantial*, would be considered a very substantial qualification for Bedlam.

VIII. Among many other crotchets, of which the title of his book may stand for one, Mr. Ruskin lays it down as a law that "all the most lovely forms are directly taken from natural objects," and further assumes "the converse of this—namely, that forms which are *not* taken from natural objects *must* be ugly;"—which surely amounts to another qualification for Bedlam. Were such the fact, Mr. Ruskin, who, notwithstanding all his lamplight, must here have been groping quite in the dark, might have spared himself the trouble of saying anything at all about beauty, since the very law which he would establish would at once convict architecture of being necessarily ugly in the main, its forms being altogether conventional, and it admitting of the imitation of natural forms, vegetable or animal, only in sculptural accessories or details. Even in those details, too, which are borrowed from plants and foliage, an abstract and *formalised* imitation, instead of a direct and mimic one, ought to be adopted. Nature may very properly be looked to for fresh hints and *motifs*, but it is a great error to attempt, as some seem now inclined to do, to engraft botany upon architecture. So far from contributing to or enhancing beauty, all direct imitation of the kind is likely to be attended with a contrary effect. You may, if you like—supposing such decoration suitable to the particular occasion, represent foliage twined round the shaft of a column; but it must be uniform and regulated, for to show it *naturally* as that of a real climbing plant which had so grown accidentally, would be a mere conceit,—at variance with the nature of architecture itself, and, although in a different way, as unnatural as trees clipped into artificial forms.

IX. "There are many forms of so-called decoration in architecture," continues Mr. Ruskin, "habitual, and received therefore with approval, or at all events without any venture at expression of dislike, which I have no hesitation in asserting to be not ornament at all, but to be ugly things, the expense of which ought in truth to be set down in the architect's contract as '*For Monstrification*.' I believe we regard these customary deformities with a savage complacency [complacency of a savage would be less of a bull], as an Indian does his flesh patterns and paint. I believe that I can prove them to be monstrous, and I hope hereafter to do so conclusively."—What a cruelly tantalising *hereafter!* And so in the meanwhile we are to remain in a state of darkness and *savage complacency*, without so much as a single gleam of lamplight to enable us to guess what those terrible deformities are, and whether they belong to all the styles we practice, or only to certain of them. It will be well if we do not, when duly enlightened by Mr. Ruskin, discover that a great deal has been and will be expended on the new Palace of Westminster for mere *Monstrification.*

X. In speaking of the Greek "egg-and-dart" moulding, our man of lamps and light babbles somewhat lack-a-daisily about birds'-nests and rounded pebbles;—whereas birds'-nests and pebbles have just as much to do with the matter as ladies' ringlets have with Ionic volutes. Unless there existed direct evidence to the contrary, plain common-sense would infer that such pattern was adopted for the carving of the *echinus*, as being well adapted to the contour of that member, and producing, together with beauty of design, much effect of light and shade. Speaking of the Portcullis, he is obliged to admit that "there is no family resemblance between it and cobwebs and beetles'-wings." Into what strange extravagancies a man who is sensible enough in some things, may be led by such crazy crotchets as is that of referring or endeavouring to refer almost everything connected with architecture to some prototype in nature, as its express model. Cobwebs are, I will venture to assert, the very last things that would have been thought of by those who invented the portcullis. Rhinoceros hides for themselves would have been infinitely more to the purpose.

XI. Wrapped-up and perhaps mystified by his own recondite fancies, Mr. Ruskin has quite overlooked one very awkward consequence resulting from his own doctrine, for if it be, as he would have us believe, that forms *not* taken from natural objects *must* be ugly, how prodigiously ugly must all furniture be. Yet, considering his ingenuity and liveliness of imagination in detecting analogies and resemblances that never occurred to any other mortal, he may be able perhaps to find out some natural objects that served as models for tables and chairs. As to *beds*, they of course come from—the bottoms of rivers.

XII. Mr. Ruskin frequently speaks very unguardedly, uttering whatever comes uppermost without giving it a second thought or any after consideration. Although they have ever been considered equally legitimate and beautiful architectural decorations, he will not tolerate either festoons or wreaths. "Do not," he says, "carve the images of garlands looking as if they had been used in the last procession, and hung up to dry [!] and serve next time withered. Why not also carve pegs and hats upon them?" The interrogation is no doubt meant to be smart, and nothing less than a clincher, nevertheless it seems to me to show merely downright silliness; for if that be valid argument, it would serve just as well if turned quite differently, and directed against what Mr. Ruskin himself certainly would be very loth to have hit,—since, just as well might it be said, for instance, do not carve leaves or flowers upon the top of a column, where they cannot possibly grow, therefore look as if they had been merely stuck up to dry in the sun, before being used for culinary or medicinal purposes. Why not, as columns are said to have heads, give them either wigs or hats to keep their heads warm, especially those which are obliged to stand in the open air? Hats, however, would suit only the gentlemen or Dorics; the two *lady* orders would be distinguished by caps and bonnets.

XIII. In his next section or paragraph—for Mr. Ruskin's book is divided into numbered paragraphs just like this Note-Book of mine,—he falls foul of what he calls "one of the worst enemies of modern Gothic architecture—the dripstone, in the shape of the handle of a frying-pan"—no, not frying-pan—"of a pair of drawers"—pshaw! wrong again!—"the handle of a chest of drawers, which is used over the square-headed windows of what we call Elizabethan buildings." Really that is *handling* Elizabethan architecture very unceremoniously! That form he assures us is the ugliest possibly, and to convince us that it is so, exclaims: "Look abroad into the landscape, and see if you can discover any one [form] so bent and fragmentary as that of this strange windlass-looking dripstone. You cannot. It is a monster." And so Mr. Ruskin goes on abusing the poor dripstone, till the foam nearly drips from his own mouth.

XIV. The Ionic capital fares very little better than the Elizabethan dripstone; for our great enlightener says that in his opinion it is, "as an architectural invention, exceedingly base." Yet, if so, there must be a great deal of baseness and bad taste in the British Museum, which he nevertheless professes to admire: although, except the Ionic columns and their capitals, there is nothing to admire—at least, not in the façade. Probably, however, he does not extend his admiration to the front, although he does not say so.—Reserving for some other occasion my remarks as to his injurious opinion of the Ionic capital, I now pass on at once to another strange antipathy, accompanied with inconsistency also. His dislike of Heraldry as embellishment in architecture has been already noticed, and for such dislike there is certainly some reason, the forms and combinations employed for it being for the most part very monstrous and tasteless. He goes, however, very much further in his dislikes, and would proscribe mottoes, legends, and inscriptions; and that for the oddest reason—if reason it may be called—conceiveable, namely, because "of all things unlike nature, the forms of letters are perhaps the most so"!! Nevertheless, he afterwards either conquers or quite forgets that unfortunate antipathy to letters, when he lauds "that good custom, which was of old universal" of inscribing mottoes and sentences even on the walls of ordinary dwelling-houses. It is an awkward thing for a writer to have such a terribly short memory as to contradict himself point-blank at different places in the same book. Here I take my leave of Mr. Ruskin for the present. Having shown up some of his crotchets and absurdities, in my next Fasciculus I will bring forward some of the really instructive and valuable points in his work. And one of them is truly luminous, throwing so much light upon an important matter which nearly all other writers have helped to obscure, that it ought to be written on the walls of every architect's office.

ARCHITECTURE,—ROYAL ACADEMY.

In not better encouraging the Exhibition got up by the Architectural Association, the profession showed as little policy as they did liberality of feeling, for most assuredly an opposition shop is very much needed to render them independent of the Academy; since even did that body show itself more disposed towards architecture than it now does, the accommodation which it can afford it is so inadequate to that of the architectural subjects which are actually hung up and catalogued, that not above half, if so many, can be so seen as to be intelligible; and that inconvenience is still farther increased by the preposterous system of hanging, which is to occupy the *line* and thereabouts by some of the larger drawings, no matter what they are, while smaller ones, which, if they are worth looking at at all, ought to be immediately upon the line, are hung either much too high or much too low. Surely it would be better were the Academy to admit fewer drawings of the kind than they do, and to be more scrupulous in the selection of them; whereas, they not only take in very inferior designs, together with what are mere views of buildings—and those generally very stale in subject, —but they actually hang up some of the paltriest and most uninteresting productions of all, upon the very line. More than one design is so placed this season, that would have been favoured by being put into an obscure situation;—whether those which are so put are treated exactly as they deserve, we cannot undertake to say; but what we do see, do not, upon the whole, impress us very favourably. We perceive more of falling-off than of any advance;—no accession of fresh talent, no fresh subjects, and no freshness of ideas; on the contrary, much affectation of antiquated fashions in building, to a degree withal that in some instances amounts to masquerading, and is as preposterous as would be the adoption of the phraseology of our elder dramatists in modern conversation. Thus, because they are unable to extract its better qualities from its defects, architects give us Elizabethan with all its wonted dross and coarseness—*pure* only because it is unpurified; wherefore, so far from being any merit, its *purity* becomes a positive fault; and of such purity the present Exhibition affords too many instances.

Even were the show of architectural designs more satisfactory in all other respects, it is sadly deficient in variety, the subjects being too nearly of the same cast as regards the class of buildings shown, and also style and treatment. Gothic and Old English or Elizabethan predominate almost to the exclusion of any other style; and what few others there are, are not at all remarkable. There is, indeed, a large drawing (No. 1090) of "The South Façade of the Assize Courts at Liverpool"—but besides that, it is a very poor and flat performance as a drawing, which is the only share the exhibitor can claim in it: the design itself shows merely the talent we have lost, instead of any that we have gained to replace it. Architects do not now-a-days care, it seems, to let us see more than what is actually done or likely to be done. They have no notion of putting forth ideas gratuitously; or if any such productions are offered, they are stifled by the *veto* of those who exclude or admit as to them seems proper. For aught we know, it may be the Academy's *Chaplain!* who holds the St. Peter's keys of the Architectural Room. Although such office appears more properly to belong to the Professor of Architecture, we feel assured —at any rate would fain persuade ourselves, that he does not even participate in it, or else matters would be managed differently, and very much better than they now are. What kind of designs are admitted any one can see: what are rejected is not so easily ascertained, they being known only to the authors of them, and their immediate friends. We ourselves can speak confidently as to one instance of rejection last year—namely, that of the design for improving the façade of the National Gallery, which, as will be remembered, was afterwards shown at the Architectural Association's Exhibition. What could have occasioned the exclusion of a subject likely to excite some attention and interest, when so many dull and humdrum designs obtain admission, is rather to be guessed at than said; for though if uttered our suspicions might be deemed chimerical, we fancy that could the truth be proved, they would be found to come very near it. We are all the more confirmed in them, because we this year find a design (No. 1091) for a building for the Vernon Gallery, which seems to have been received solely on account of its insignificance and harmlessness, for it is certainly not at all calculated to lead to any stir or agitation. Instances of very unfair rejection this season have been rumoured; and if the designs turned away were at all above mediocrity, it was nothing less than scandalous and treacherous on the part of the Academy to serve them so, and at the same time to accept so many infra-mediocrity things as they have done. Fortunately, there is now a means of exposing the tyrannical conduct and injustice of the Academy towards architecture, because those who have been unjustly treated by that body, can now appeal to the public through the Architectural Association; which society, if it mind what it is about, may easily turn the conduct of the Academy in regard to architecture, to excellent account.

Although we do not know what architectural drawings have been turned away, we do know that they have turned away models altogether, which is an innovation quite the reverse of improvement. At first we thought that the absence of works of that class was purely accidental and owing to none having been sent in; whereas, we learn from a contemporary that a model by Mr. Dighton, of a large building now erecting under a government department, was actually turned away. It being a large building says nothing for its interest as an architectural subject and its fitness for exhibition, but its being by Mr. Dighton is of itself sufficient guarantee for the excellence of the model. The banishing models is certainly quite a new freak on the part of the Academy. Had models been turned away or refused admittance in order that a screen for drawings might be fixed along the middle of the room, there would have been sufficient reason for doing so, although even in that case models might have been allowed to find a place in the hall. The least that could have been done was to give notice in their advertisements that models had been put under ban. The Academy allow it to be seen that they are no friends to architecture, and seem also to think that it has none in any other quarter; at least, not any who either can or dare to remonstrate with them for their treatment of it. We almost begin to think with the editor of the *Art-Journal* that architects have no business in the Academy, although for a somewhat different reason from his—namely, because, with one exception, they show themselves to be drones in it, and do not make it their business to do anything in behalf of architecture, or to defend its interests. Were they to do so, we should soon see a very great change for the better in the Architectural Room, and in the general quality of the things there admitted.

As to the Professor of Architecture, it is no great wonder that he suffers things to take their own course, for he is asleep and dreaming. Nor is "The Professor's Dream" (No. 1102) of the most lively and imaginative kind, it being marked by none of those bold flights and exuberances of fancy which dreams, at least "remarkable dreams," usually consist of. On the contrary, he seems merely to have fallen asleep over Durand's "Parallèle," and dreamt that he was employed to make a collection of "elegant extracts" out of it. Really the Professor seems exceedingly loth let us behold anything or any ideas of his own, for when he does exhibit, which is but very rarely, it is only nominally, and in the capacity of draughtsman rather than of architect or designer. First of all, he gave us a mere hotch-potch of Wren's buildings; next, merely a composition of sculpture for filling up a pediment; and now this "synopsis," which after all is no more than "a development of that first published in the Useful Knowledge Society's Life of Sir Christopher Wren." When Professor Cockerell wakes up, he will perhaps show us something less borrowed and stale,—something in which he is more immediately concerned; for instance, some of the best parts of the interior of the Taylor Institute at Oxford, and of the Fitzwilliam Museum at Cambridge. As he now manages, he finds that though he takes care to ward off criticism, he cannot exactly shield himself from animadversion and very disagreeable remarks.

Mr. Barry, as usual, exhibits nothing, but is content to be himself exhibited this season, both in a portrait and a bust,—the former of which is so far from being at all satisfactory as a likeness, that we at first thought we must have mistaken the number in the catalogue. Of Professor Donaldson, too, all that we see here is a bust of him. On the other hand, we do behold Professor Pugin,—not in effigy of his person, but in several *full-length* designs, which are more remarkable for the oddity of the mode of representation and execution adopted, than for anything particularly praiseworthy in them as designs. It has been said of Mr. Pugin that he patronises bad drawing, and we now perceive that he patronises very queer perspective, and very bad colouring also; for nothing can be more flat and crude than the latter. As if determined to run quite counter to everybody else, while others are solicitous to set off their designs by every artifice of colouring, and to make them as much like pictures as possible, he goes to the opposite extreme, and is studiously unpictorial in every respect. Yet, we will not be certain that even in this apparent rejection of all artifice, there is not a good deal of artifice at the bottom—affectation there certainly is. The *monstrari digito* has such charms for some people, that they will not stick at sheer absurdity in order to gratify their passion for it, as has been shown of late years by Turner in his pictures, and now by Welby Pugin in his drawings. Could we fancy that the mode of representation adopted by the latter were so with the intention of scarecrowing people away from those drawings, there might be some policy in it; for assuredly neither No. 1085, which shows us Mr. Pugin's own residence at Ramsgate, with a church tacked to it, nor No. 1117, "Bilton Grange, Rugby, the seat of Washington Hibbert," is not, on being looked into and considered as a design, found to display any of that superior *forte* he has obtained credit for. He is by far too blind a venerator of mediævalism in all its rustiness, to be at all to our taste; for the way in which he employs Gothic, makes evident how unfit it is for domestic architecture at the present day. In one respect, indeed, Nos. 1085, and 1117, are more than usually satisfactory, since the small interior views and plans placed upon their borders serve to convey a tolerably complete idea of the respective buildings. We have also in No. 1013, "The new Dining Hall at Alton Towers," another work of Mr. Pugin's, although the drawing itself is evidently by a different hand, and both on account of its subject and execution is one that deserved to be placed exactly on the line; as did also No. 1074, "Interior of part of the new buildings at East Sutton Place," C. J. Richardson. Were the line entirely occupied by the best subjects and drawings, some of the best must perhaps be hung less advantageously; but it appears to us nothing less than stultification to place on the line several things that ought not to have been admitted at all, while others that both require to be and are deserving of being looked at attentively, are put more or less out of sight. Surely the architectural drawings must in the first instance be chosen by drawing lots to decide which are to be admitted; after which, those who are appointed to hang them are blindfolded. In this room the hanging is so wretchedly—or else, maliciously managed, that besides injustice towards good things, uncalled-for cruelty is shown towards some of the worst. Although it may look like unaccountable favouritism, it was surely nothing less than the refinement of cruelty to put, with *malice prepense*, just where they are, the two interiors of Ormond Quay Church (in the Pecksniff-Gothic style), as if on purpose to disgust us by letting us plainly see that they are the "perfect abominations" they have been called. Nor are they the only things which would have been favoured by being either turned away or thrust into the ranks of the Indistinguishables. It will be thought that we keep harping very wearisomely, again and again, on the mere matter of bad hanging. True, we do so, and it is in order that our obstinate importunity may force attention to it, to some purpose. Were there no Professor of Architecture, nor a single architect, we could only be surprised that any body of artists with the title of a Royal Academy should take in so many things not fit to be seen, so many more than can be properly seen, and as the climax of absurdity, to hang up some of the very worst and poorest of all in the very best situations. As painters, the general body of the Academy may know no more of, and care as little about architecture as their own porters. Not only may they be incapable of judging between good and bad designs, but not even so much as know what are designs, and what are mere views. They may have no suspicion that the front of Wells Cathedral (1045) was not designed by Mr. Dolby, nor that of York Minster (1109) by Mr. Bedford; but then, why do they not leave architecture to the architects? To suppose that the latter are now even so much as consulted, would be to suppose that they are what we do not care to say; but it is certain that they show themselves to be very remiss in not properly remonstrating in behalf of their own art.—May there never be occasion for our making any such unpleasant remarks again!

There are very few designs this season which show us any buildings either lately executed or now in progress, that are in any other style than Gothic or Elizabethan. The only subject which shows us an edifice of any importance in a different style is No. 1090, "The South Façade of the New Assize Courts, Liverpool," W. H. Campbell; in which rather large drawing Mr. C's own share is merely that of draughtsman, and even in such character he is by no means an extraordinary one. What is extraordinary, however, is that any one should be at the pains of merely letting us see another person's ideas, if he could not at the same time show some talent himself. Had the design been his own, we might have praised his abstinence from any of the usual allurements employed upon paper, and his trusting entirely to its intrinsic merits as an architectural composition. As such is not the case, the absence of all aim at pictorial quality and effect is rather unaccountable, it being so contrary to *exhibition practice;* for while many things which we here see have an adventitious interest imparted to them by dexterity of colouring, and by background and figures, which does not at all belong to them as designs, Mr. Campbell has not rendered Mr. Elmes's building by any means his debtor by his mode of showing it. Not only is the colouring flat, but light and shade are so feebly expressed—in fact, merely indicated instead of expressed, that the drawing looks more like a vision than the view of a real building. Besides which, the perspective is somewhat faulty, and the point of view injudiciously chosen; for had it been taken a little more obliquely, while the south portico itself would have been in a more picturesque attitude, we should have distinctly seen the square pillars and low screen walls between them in the other façade, which are by far the most original ideas in the design, and which would have contrasted admirably with the round columns and open intercolumns of the south portico; which latter, although certainly a noble and classical piece of architecture, gives us little more than a correct copy or restoration of the front of a Corinthian temple. The only touch of originality there, is the lofty stylobate on which the portico is raised, and the steps leading up to it, both which together, add the picturesque to the classical,—or would have done so, but for the three windows in the stylobate, which mar the whole façade so shockingly that it ought even now to be seriously considered whether they cannot by some contrivance or other be got rid of; and got rid of they certainly ought to be, were it even by some sacrifice of internal convenience.—Here we will take the liberty of adjourning till our next Number.

IMPROVED PUMPING ENGINE.

The great economy of fuel that was first attained by the Cornish engineers in their single-acting engines for pumping water from mines, some years ago attracted much attention among engineers generally. The fact of the alleged economy having been really attained, was first denied or doubted; then the subject was investigated, and the fact found not only to be true but easily accounted for. It was nothing more than might have been expected from the great degree of expansion effected in the steam-cylinder, efficient covering of all radiating surfaces, and generally great care on the part of the engine workers. These were admitted by all to be the great sources of economy; but many supposed that they were in some way necessarily connected with single-acting engines working on the Cornish plan. This led to the erection of several Cornish engines for waterworks' purposes in various parts of the country, and the saving of fuel has in all cases been found to be very great, when compared with the former Boulton and Watt engines.

So slow, however, is frequently the progress of correct ideas on mechanical subjects, that it is only now that those interested in such works are becoming gradually convinced that the desired economy of fuel may be attained without the cumbrous and expensive machinery of a Cornish engine.

The peculiarities essential to the Cornish engine are, that it is single acting, and that it should not directly lift the water it is intended to raise by its means, but that it should lift a ponderous weight, which is then let fall, and in falling raises the water. The faults connected with such engines are, that they are double the necessary size, and do their work in an indirect manner; and the only reason given for adopting this description of engine is, that no other engine could work with the same amount of expansion. But in the calculations of saving, all consideration of the loss of interest arising from the greater first cost of the Cornish engines has been omitted. This greater first cost arises not only from the much larger size of engine required to do the same work on the Cornish system, but also from the necessary concomitants—huge balance-weights on the pump-rods, engine-houses and foundations double the necessary size, and stand-pipes that have not unfrequently cost nearly as much as the engines themselves. The interest on this large expenditure has frequently gone far to swallow up the saving on the fuel.

We have been led to make these preliminary remarks in consequence of inspecting a small engine, of 20-horse power, made for the Richmond Waterworks Company by Messrs. Simpson, of Pimlico, which is a double-acting engine, and cuts off the steam at one-fourth of the length of the stroke, so as to expand the steam into four times its original bulk; and all the radiating surfaces are neatly and efficiently clothed with non-conducting substances. From several trials, it has been ascertained that the consumption of fuel is only $2\frac{3}{4}$ lb. per horse-power per hour, and that even this economy, it is expected, will be considerably exceeded when the company have fixed a second boiler, the present one being only one-half the size that the makers intended the engine to work with. This result, we think, clearly proves the practicability of emulating the Cornish economy of fuel with double-acting engines judiciously constructed.

This engine has another advantage not very common with pumping engines, in being capable of working at the same speed as an ordinary mill-engine. This is accomplished, partly by the construction of the pump-valves and partly by the use of a new kind of pump lately registered by Mr. Thomson, Messrs. Simpson's manager.

The annexed engravings, figs. 1 and 2, show a section and external view of this pump, from which its action will be very easily understood. It is, as will be seen, in many respects the same as the old bucket-pump; but there is added to it the plunger *p p*, the sectional area of which is half that of the pump-barrel *b b*. This simple addition makes the pump double-acting, and suitable for being wrought by a double-acting engine; for, when the bucket is ascending, one-half of the water that it raises, instead of going out at the delivery-pipe *d*, occupies the place previously occupied by the plunger, and when the bucket descends, this part of the water is then expelled by the plunger. Equal quantities of water are thus delivered at each stroke, and the pump is double-acting, while at the same time it has only two valves, and is nearly as simple in its construction, and occupies as little space, as a single-acting pump. In all pumps it is of the first importance that easy access should be afforded to all the valves, and when this condition is adhered to, and the valves made large and of the best modern construction, those who have made double-acting pumps on the present system with four valves, know that they are both expensive in their construction and unwieldy in their dimensions. These objections are very much obviated by the plan we have now described, and much advantage is also derived from the water having

Fig. 1.—External View

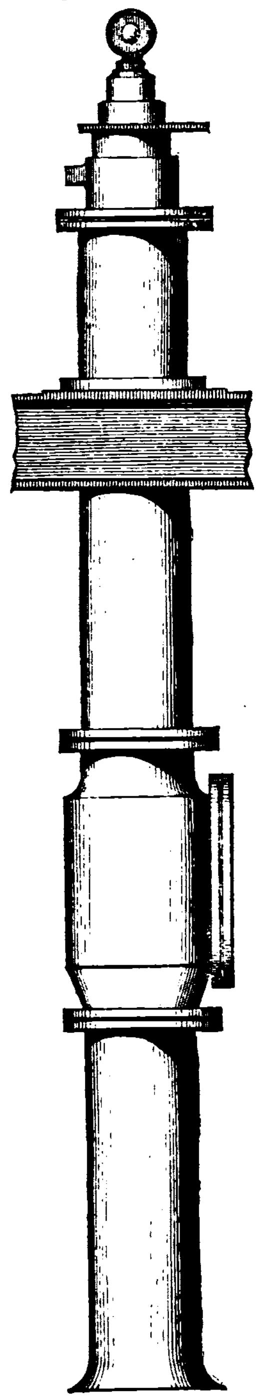
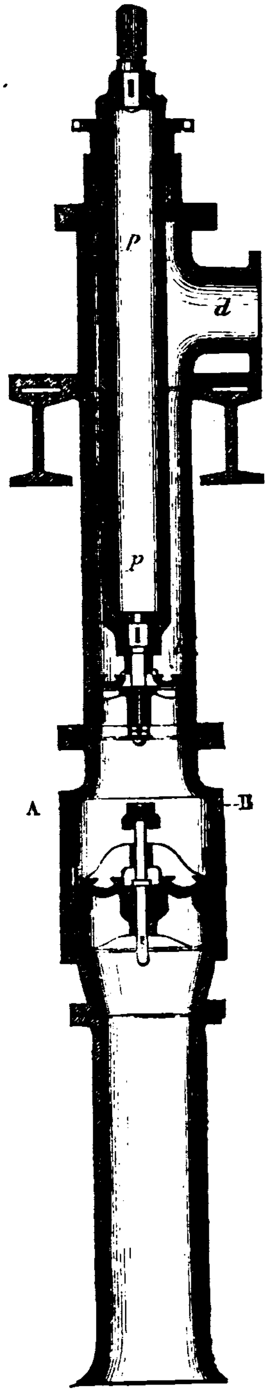
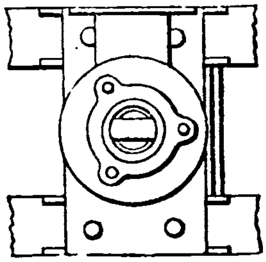
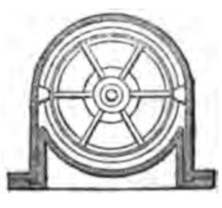


Fig. 2.—Internal View.





View of Top.



View of Valve.

no turns to make in passing through the pump. This prevents the concussion that is so objectionable in many pumps, and enables this pump to be worked much quicker than one of the old construction. We consider this, therefore, as a decided improvement in the application of double-acting engines to the pumping of water, and we hope that so obvious an improvement will speedily secure for itself an extensive adoption among the parties interested in this department of engineering.

The following particulars give some of the dimensions of the engine:—

Diameter of cylinder, 20 inches.

Length of stroke, 3 feet.

Length of beam from cylinder centre to connecting-rod centre, 9 feet 6 inches.

The boiler is cylindrical, with an internal tube, the diameter of the boiler being 4 feet, and of the tube 2 feet; the length 15 feet.

The engine works two pumps, both being connected directly to the crank-end of the beam; one of them 8 inches nearer the cylinder, and the other 8 inches farther from the cylinder, than the connecting-rod centre. With this arrangement, one pump has a stroke of 31 inches, and the other a stroke of 41 inches. The object of having two pumps is that one may be wrought when the water is being pumped to the higher part of the town, and both used when the water is being delivered in the lower district. The diameter of the plungers in both pumps is the same, viz. 8 inches, and the diameter of the buckets is 11¼ inches.

It is to be observed that the design is ultimately to work the engine with *two* boilers of the above dimensions; but the second one has not yet been fixed.

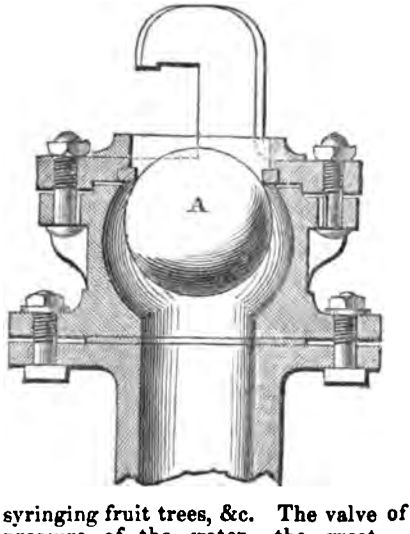
In estimating the performance of the engine, the horse-power is taken at 33.000 lb. raised one foot per minute, and the number of horses'-power is determined by an indicator fixed on the delivery-pipe of the pump, which, combined with the speed of the engine, gives the *effective* power, exclusive of the friction of both the engine and pump.

The steam-valve is two short slides connected together and wrought by cams, so as to dispense with the use of a separate expansion valve.

It will be observed that the distance from the centre of one pump to the centre of the other is only 16 inches, and both are fixed in a well of 5 feet square, which shows the great compactness of this kind of double-acting pump. With no other kind would it have been possible to put two pumps of this size in so small a space, and at the same time leave sufficient room for examination, repairs, &c.

BATEMAN AND MOORE'S PATENT HYDRANTS.

The Patent Fire-Cocks are introduced as substitutes for the inefficient wood plug, at present in general use. Under constant high pressure, they supersede the necessity for fire-engines, as in cases of fire they can be brought into almost instant operation, with the most perfect ease and efficiency, and without any waste of water. They can be also expeditiously, cheaply, and most effectively applied to the watering and thorough cleansing of streets, alleys, courts, public buildings, windows, &c.; in railway stations for supplying engine tenders, cleansing carriages, &c.; and placed within mills, warehouses, and public buildings, they would afford the most important protection against fire. They are also adapted for watering gardens and pleasure grounds, and by the application of suitable spreaders or jets, for syringing fruit trees, &c. The valve of the cock is closed by the pressure of the water,—the great therefore such pressure becomes, the more is the tightness of the valve secured, and effectual safety from leakage ensured.



The fire-cock consists of a cast-iron box or casing, containing a self-acting valve, A, closed by the pressure of the water. For street purposes, this casing is attached to a vertical branch from the water main, and when not in use the outlet of the valve is closed by a loose cover or stopper, and the whole protected from injury by a cast-iron case, similar to the ordinary cases or covers for protecting street cocks or fire-plugs. The valve, A, consists of a ball of less specific gravity than water, covered with india-rubber or other elastic substance, and closed by the pressure of the water against a properly prepared seating.

THE SOCIETY OF PAINTERS IN WATER COLOURS.

The Exhibition is on the whole superior to last year's. The President, Mr. Copley Fielding, exhibits forty-two works, the best of which are, *View near the head of Loch Tay* (23),—an effect after rain; *View of Snowdon* (126),—the effect of Snowdon in the distance is well sustained; and *Scarborough* (130),—the stormy character is very good: they all show the artistic powers of Mr. Fielding. The atmospheric effects he produces with great freedom.—Mr. Cattermole, the delineator of scenes of the Middle Ages, has two excellent studies:—*The Chapel* (242), representing a number of persons at prayers,—it is both picturesque and solemn; and *The Call at the Monastery* (253), which is free, graceful, and forcible.—Mr. F. Tayler's *Morning* (28), and *Evening* (39), are two masterly productions. The first represents five dogs waiting for the entrance of their keeper,—their faces are full of expression; the latter, when they are tired and weary, and shut up for the night: they are two of the best paintings of this artist. *The Chase in the time of Charles* II. (144) is equally good; as also is *The Stag Hunt in the Last Century* (154).—Mr. De Wint's *Wilsford, Lincolnshire* (294), and *a Hay-Field*, are good, particularly the latter; but in a *View of Lincoln* (139), the water and trees are not at all good,—it appears an unfinished picture.—Mr. George Fripp exhibits some excellent subjects, which all show great finish and effect, particularly *The Valley of the Thames near Reading* (54); in *The Allée Blanche, Mount Blanc* (111), the mountainous scenery is well shown,—this is the best; and *The Weir at Pangbourne* (121). —The architectural drawings of Mr. Samuel Prout are, as usual, all deserving of notice, particularly the Gothic ones: *The Porch of Ratisbonne Cathedral* (9), and *St. Etienne Beauvais* (229), especially.—*The High Altar Cathedral of Toledo, Spain* (82), by Mr. Lake Price, is an admirable drawing, and one of the best we have seen of his; the ornamentation is elaborately worked out.—Mr. Glennie has a classic example—*View of the Temple of Neptune at Pæstum;* the background is subdued in order to give more effect to the buiding, which is carefully drawn.—Mr. Palmer strains too much after effect in *Sun and Shade* (149), and *Sheltering from the Storm* (175): the contrasts are violent.—Mr. Topham has an effective composition in *Making Nets* (247): all his paintings have the merit of originality.—Mr. Frederick Nash, in No. 62, *Interior of Exeter Cathedral*, is deserving of great praise.—Mr. Wright shows a good composition in *The Mouse, or the Disappointed Epicures*, (174): it has much expression.

NEW SOCIETY OF PAINTERS IN WATER COLOURS.

This is the fifteenth Exhibition; the Drawings number 402.—Mr. Warren, the President, has a large painting—*Joseph's Coat brought to Jacob* (276), illustrating the Scripture history, where the brothers bring the blood-stained garments of Benjamin to their father, who is weeping at the supposed loss of his son. There is great feeling in this picture, and shows the power of the artist.—Mr. Haghe, the Vice-President, exhibits two pictures—*The Veteran's Story* (262) is the best. It is representing an old cavalier listening to the deeds of prowess done at Edge-Hill; the countenances and situations show Mr. Haghe's great skill and expressive touch.—Mr. Vacher has a good architectural subject—*The Piazza of St. Peters during the Benediction* (221); the buildings are well drawn in this.—Mr. Aaron Penley has an effective picture in *Serenity* (357); it is a scene on Windermere Lake in the evening: the picture well expresses the title.—Mr. Laporte sustains his reputation in *Cantabs* (324); the horse is well drawn, and is represented pawing the ground, anxious to start.—One of the best in the Gallery is *The Murderers of Thomas Chase, of Amersham, drawing up the Letter to the Clergy* (160), by Mr. Edward Corbould, who has attempted a great deal, and has been well rewarded for his trouble. The figures are well drawn and striking, and the faces of the murderers are full of thought and expression; the armour is excellently done, and the colouring rigorous, and does great credit to this persevering artist.—Mr. J. Chase has a good architectural picture—*The Return from Matins* (35).—We cannot compliment Mr. Wehnert on his figure as *Peace* (185): it does not come up to his former efforts.—Mr. Absolon has a harvesting scene, *Plenty* (55); there are a great many figures in this which are well executed, the positions are good, and all express the pursuit in which they are engaged.—There are fifteen views taken in Australia, by Mr. J. S. Prout, painted on the spot: they are all good, and show the peculiarities of the country. The best landscape is by Mr. T. L. Rowbotham, jun., *Rouen* (191), the quays and bridges of which are shown in a remarkably clever manner—Mr. James Fahey has an animated picture, *The Hop Garden* (135): it represents a number of persons employed picking the hops.—Mr. F. Richard's *Julia* (175) has a pretty face.—Mr. Robins's picture of *Portsmouth* (77); Mr. Davidson's *Bolton Park, Yorkshire* (103), a good study of trees; and Mr. H. Maplestone's *Romney Marshes* (82), a view of Rye in the distance and the ruins of Winchelsea Castle, are worthy of notice.

REVIEWS.

Weale's Quarterly Papers on Engineering, Part XII. London: Weale, 1849.

This is the last number of a very useful series, the conclusion of which we very much regret. It was a very laudable undertaking of Mr. Weale to provide the means of publication for those professional papers too short for a volume, and too long for our pages, and which did not come within the scope of the Institution of Civil Engineers. We only wish that the zeal of the profession and the condition of commercial affairs had afforded Mr. Weale a better return for his labours, and sufficient inducement to persevere in his undertaking. As it is, the Quarterly Papers constitute a valuable accession to the library of the engineer, and include many practical subjects, illustrated by numerous engravings.

Architectural Publication Society. Illustrations, Parts I. and II. of Volume for 1848-9.

The Architectural Publication Society is an institution which the architects ought to support; for most branches of learning have such a society, and it argues want of zeal to be behindhand. Architecture is, however, now redeemed from this slur.

The numbers now before us contain the illustrations to what will, we hope, be the Great National Dictionary of Architecture, which the members of the Society have undertaken to compile. Twelve plates in each number give numerous examples illustrative of the articles Campanile, Ceiling, Chimney, Corbel, Cornice, Cortile, Diaper, Doorway, Façade, Loggia, Metal-work, Pavement, Stained Glass, Staircase, and Window Coronets. As the Society have access to the public and private collections of architectural drawings, it is naturally to be expected that many curious and original examples will be included in the series.

The undertaking is, we think, particularly well deserving of the support of the members of the architectural profession, as it will place before them a copious and valuable library for reference.

It may be very usefully taken into consideration by the engineers, whether they should not have an Engineering Publication Society, to reproduce the numerous reports on Harbours, Canals, Railways, and other public works, which abound with useful information, and are inaccessible to the profession.

Buildings and Monuments, Modern and Mediæval. Edited by George Godwin, F.R.S. Part I. London, 1849.

This is a reprint, in a separate form, of some of the large wood engravings in the *Builder*, and being carefully worked-off on stiff paper, slightly tinted, they have an exceedingly good effect. Indeed, they do great credit to the art of wood engraving, and will form a cheap and handsome work, as well suited for the library of the architect as that of the amateur. Some modern buildings are included in the series, and the text is further illustrated by ground plans and details of the work. Many will prefer them in their present form to their original appearance in the columns of the newspaper.

The Mining Almanack for 1849. Compiled by Henry English, Mining Engineer, Editor of the *Mining Journal*. London: *Mining Journal Office*, 1849.

Mr. English has here produced a work which will be found of very great value to every engineer, and the more so as so few books are published on mining. The Almanack contains a great many original papers by well-known writers connected with the mining interest. Among them are those 'On the Jurisdiction and Practice of the Stannaries Courts,' by H. S. Stokes, Esq.; the 'Newcastle Coal-fields,' by Matthias Dunn; the 'Custom of Tin Bounds;' 'Records of Ancient Mining,' by J. Y. Watson; the 'Cornish Steam-Engine,' by James Sims; the 'Structure of Crystalline Rocks,' by Evan Hopkins; 'Assaying,' by P. N. Johnson; 'Fire Damp,' by Professor Ansted; 'Gold Deposits,' by Dr. Cliffe; the 'Cost-Book System'; 'Mineral Topography of Great Britain,' by A. W. Tooke; 'Mineralogy,' by G. Abbot; 'Lives of Trevithick and Stephenson,' by Hyde Clarke; and papers by E. Smirke, T. Clark, the Editor, and Dr. Albert. Copious tables of Statistics and Scientific Data make it a very practical work.

A Letter to Lord John Russell, on the Expediency of Promoting Railways in Ireland. By George Preston White, C.E. London: Weale, 1849.

This is a practical and interesting pamphlet on a most important subject, of which Mr. White has taken a very liberal view. We say, without any professional bias, that no measure is so necessary for Ireland as railways; and it is most discreditable to the ministry, that neither upon this nor any other reproductive undertakings has one single practical suggestion been adopted, nor any propounded by the cabinet itself. The Irish, therefore, suffer doubly—from their own idleness, and the idleness of the government.

Mr. White's remarks on the Standing Orders do no injustice to their oppressive character. He says—

> "The Standing Orders were framed with a view of protecting private interests; the slightest consideration will show that this object has been more than realised. The sums of money which landowners have received for supposed injuries caused by the passing of a railway through their property, are almost incredible. The Manchester and Birmingham Company paid upwards of 16,000*l.* per mile for their land, and the Eastern Counties paid nearly as much. Now, supposing that the railway occupied ten acres to the mile, which is a fair average allowance, it would appear that these two companies have paid for their land at the rate of 1600*l.* per acre.
>
> The clause in the Standing Orders, which still exists, requiring the assents and dissents of landowners and occupiers, can be attended with but little advantage, and is liable to great abuse. It is impossible to conceive, taking into consideration the benefit conferred on property by railroads, and the amount of compensation given by railway companies, that landowners can be serious in their opposition. In nine cases out of ten they oppose a line of railway in order to make the company pay exorbitantly for the land required. It is certainly a useless clause, affording no proof of the desirableness of the project.
>
> Many of the clauses of the Standing Orders which apply to the plans and sections are quite inconsistent. At the same time that you are allowed to make a deviation in the line, you are compelled to adhere to the original gradients, an alteration of only a few feet being allowed. Now it is evident that, in a sideling country, deviation is impracticable under the requirement as to gradients. The clause requiring the landowner to be furnished with a statement of the greatest depth of cutting or height of embankment through his estate, is equally useless; for should the line be deviated from, which is frequently the case, there may ultimately be an embankment instead of a cutting, or *vice versâ*.
>
> Another objectionable clause in the Standing Orders is that requiring a deposit of ten per cent. in the Court of Chancery, which has so signally failed to produce the object for which it was framed, namely, making a *bonâ fide* company; whilst it has had the ill effect of locking up a large amount of capital, on which no interest has been paid, and has often been the means of discouraging really useful projects. This object of the legislature might, I think, be more effectually obtained by rendering it illegal to dispose of shares until a large amount of the capital was paid up. This was done in the case of the Dublin and Kingstown Railway, and was in that instance attended with the happiest results. It would possess the further advantage of preventing over-speculation in railway shares."

We do not, however, concur in this last suggestion, for we do not see either the good or the necessity of preventing speculation in railway shares. Trade, under all circumstances, to be efficient must be free.

FRICTION CURVE

A well-known defect in revolving valves is their want of tightness after some use, or their great friction when tightened by force. In a stop-cock with a conical plug, for instance, the amount of wear in the bigger part differs from that in the smaller part, because every point in the former has a longer way for friction than any point in the latter. To lessen this defect, it is necessary to make the plug nearly cylindrical. The consequences thereof are—

1. A comparatively trifling pressure causes the plug to stick in its socket like a wedge.
2. The bore, instead of being made round, as it ought to be for giving the fluid a free passage, must be made flat.
3. Very little wear causes the plug to sink considerably in its socket; from which again results
4. The necessity of making cocks comparatively long and heavy.

Fig. 1. Fig. 2.

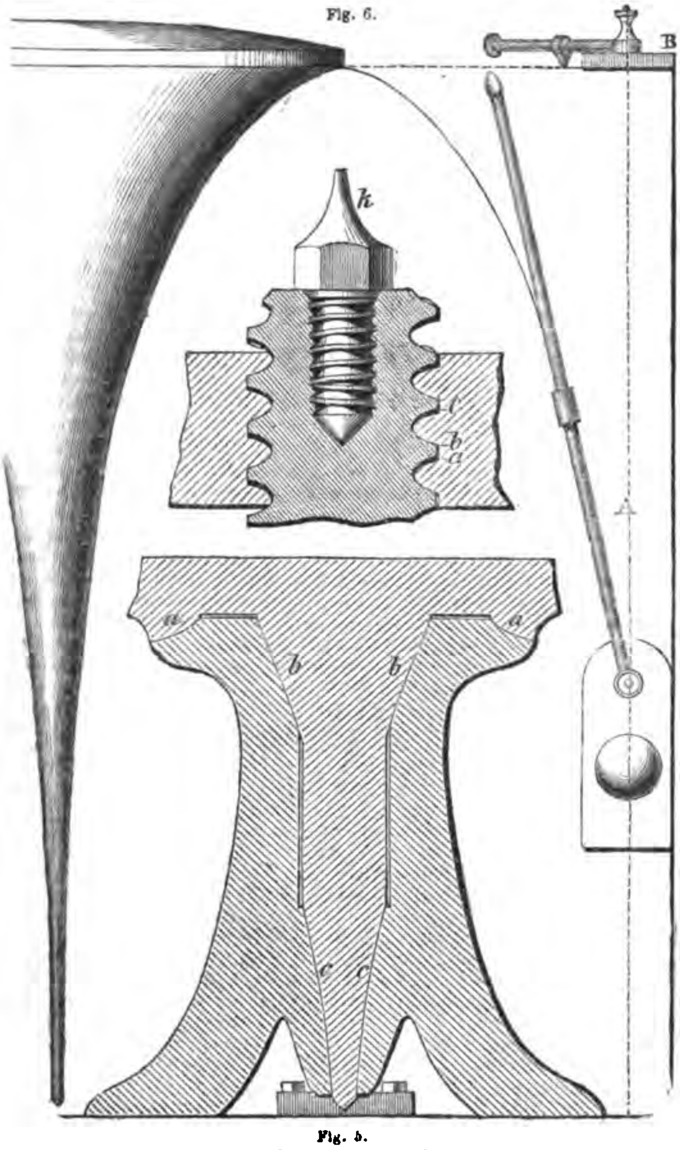


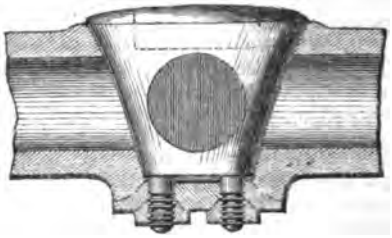
Fig. 5.

The friction between a plug and its socket divides itself so that the products of the pressure multiplied with the length of way are the same for any point in the rubbing surfaces. The length of way being different in different parts, the pressure must differ also: it is greatest on the smaller end. Now, as the bigger end must be tight as well as any other part, the destructive wear [abrasion] of smaller parts is apparent. Therefore, considering such a truncated cone to be divided into infinitely narrow ones, I propose to take a more obtuse cone for each bigger part; and in such progression, that it would require equal pressure for every point in the surface to cause an uniform sinking of the plug in its socket by wear The shape thus obtained is one with a curved surface, as shown in fig. 1.

The main feature of the generating curve for such a surface is the equality of all tangents drawn to the axis. Hence the use of an instrument I constructed as shown in fig. 2, A, and B, where the curve is described by a little drawing-pen moving on a horizontal plane.

Figs. 3 to 6 show some examples for the application of the described principle.

Fig. 3.—A.



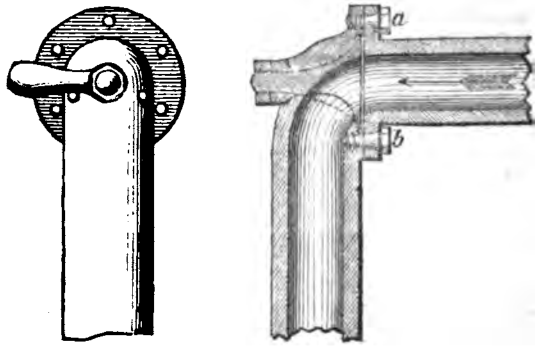


Fig. 3.—B.

Fig. 3, A and B, represent two stop-cocks, which from their shape may be called *bell*-cocks. They have none of the imperfections of those now in use, while they possess the natural tendency of insuring tightness by wear.

Fig. 4 represents part of a regulator for a locomotive engine, for transmitting the angular motion from the handle to the inside of a boiler; here the amount of friction varies with the pressure of steam which acts against the journal.

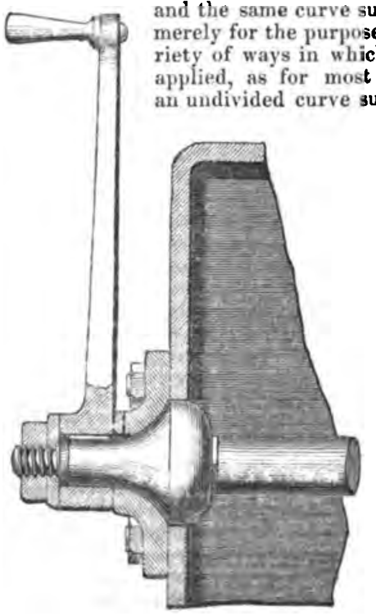


Fig. 4.

Fig. 5 represents an axle for astronomical or surveying instruments, &c. *aa*, *bb*, *cc*, are annular parts of one and the same curve surface, and are so chosen merely for the purpose of exemplifying the variety of ways in which this principle may be applied, as for most purposes an axle with an undivided curve surface (as in fig. 1) will serve as well, or better.

Fig. 6 shows how to construct the threads of screws according to this principle. The proportions I prefer are—

a b one-fourth of *a c*;
a c one-fourth, sixth, eighth, tenth, or twelfth of the diameter.

As a further illustration of the variety of contrivances to the construction of which the described principle may be usefully applied, I will name the following:—Curve-shaped revolving valves (instead of flat ones) for regulating the quantity of steam let into the cylinders of locomotive engines.--Similar valves (instead of slide valves) for steam-engines, which applied to either end of the cylinder, would cause a considerable saving of steam,—as in many engines (for instance, those on railways) a great deal of steam in the canals is now lost.—A revolving motion, varying in speed, would be better than the motion given by an eccentric.—

Safety valves.—Turning joints in pipes.—The different centres (fig. 6, *k*) and journals in turning-lathes.—Spindles.—Axles of railway turn-tables.—Footsteps for upright shafts.—Couplings for shafts.—Collars of screws (fig. 3, B, *a* and *b*)—Glass stoppers;—in short, all those contrivances which present similar rubbing surfaces.

The friction is a minimum and equal to $\frac{8\,G\,L\,N\,P}{C\,(D^2 - d^2)}$, where

P = the whole pressure which the rubbing surfaces have to bear in the direction of their axis.
D = the diameter of the larger part.
d = the diameter of the smaller part.
L = the length of the generating curve.
G = distance of the point of gravity of the curve from the axis.
C = co-efficient of friction. And,
N = number of revolutions.

Measures to be taken of equal units.

William Fairbairn, Esq. having kindly assisted me in bringing out my scheme, I have great pleasure in publicly acknowledging my obligations to him. This gentleman gave me his favourable opinion about the principle described above, and allowed me to make some trials on one of his locomotive engines.

I beg to offer my services as patentee, and as manufacturer of most of the articles mentioned above, as well as of instruments for drawing the curves.

CHRISTIAN SCHIELE, *Mechanician.*

Manchester, May, 1849.

STEAM AND VACUUM GAUGE.

(*From the Journal of the Franklin Institute.*)

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the Promotion of the Mechanic Arts, to whom was referred for examination and report, an "Engine Register and Manometer Steam and Vacuum Gauge," invented by Mr. PAUL STILLMAN, of the City of New York, *Report*:—

That the instrument referred to is designed for application to marine steam-engines, and that it is, in outward appearance, similar to the marginal sketch.

It is threefold in its purposes—consisting, 1st, of a circular cast-iron box, faced with a dial, in which are cut side by side, six (or more as may be required) slots, through which may be seen the numbers representing the revolutions of the engine; this is denominated the "counter" or "register;" 2nd and 3rd, of two gauges, one for steam, the other for vacuum, connected by suitable pipes with the boiler and condenser. Both these latter consist of vertical glass tubes, hermetically sealed at their upper ends and having their lower ends immersed in small chambers (the joints being insured perfect by tinning the brass glands surrounding the tubes.) These chambers communicate with the reservoirs for the mercury only by the lower end of the small chamber, into which is screwed a plug; so that it is only by the minute leakage around this screw, that the same pressure is maintained on the mercury in the tube and that in the reservoir. The object of this arrangement is to prevent the too rapid agitation of mercury consequent on differences of pressure, and also to enable the tubes to be filled and then inverted in their reservoir, without loss to the contents,—in fact, supplying the place of the bulb in common gauges.

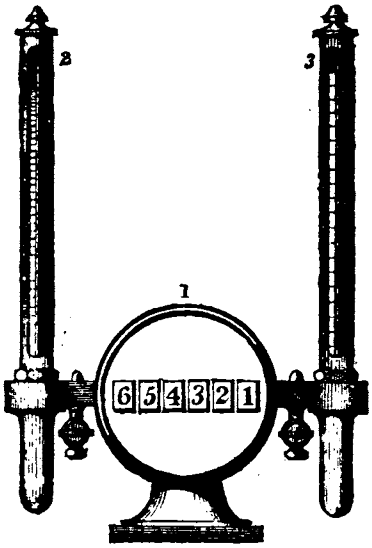
The steam gauge then, having been partially filled, indicates by the compression of air, caused by the forced ascent of the mercury; and the vacuum gauge, being at first entirely filled, indicates by the descent of the mercury, as in common gauges. To prevent, in the steam gauge, the soiling of the tube, caused by the oxidation of the mercury, a small quantity of naphtha is introduced on its surface. These gauges are thus presented in a compact form, and in a manner not very liable to derangement. But as it would require a practical experience to test their supposed advantages over those in common use, the committee, at present, will confine themselves to a consideration of the "Register," of which the following is a description.

By an attachment to any suitable part of the engine, a vibratory motion is communicated to an arm attached to a central horizontal shaft, placed parallel to the dial, and within the cast-iron box—to the ends of which is also fixed a frame carrying a small shaft parallel to the former, on which six palls or arms are attached, side by side, and at a certain distance apart, in such a way that the right hand pall may fall without the others, but cannot rise without carrying the rest.

This frame-work, with the pall-shaft, &c., is made, by the motion of the arm attached to the engine, to describe an arc of 36°, or to move through one-tenth of a circle.

The ends of the palls respectively rest on, and slide over, six cylinders placed side by side on the central shaft, all of which are free to move in the same direction and independently of each other, and are arranged in the following manner:—

For the sake of clearness, we shall number them 1, 2, 3, 4, &c., beginning with the right-hand one.



On the right-hand edge of each cylinder are cut 10 slots, and on the left-hand, which overlaps the edge of the next, only one slot; these slots being of such a size as will admit the end of one of the palls; then on the back motion of the frame-work, &c., the pall is carried back till it drops in, when the forward motion carries with it the cylinder so locked.

In the central spaces (between the laps) in each cylinder, and opposite to one of the slots in the dial face, the numbers 1, 2, 3, &c., to 0, are engraved at equal distances round the circumference.

The palls are placed one over each of the slots, so that the pall can fall into the inner cylinder only when the slot in the outer one comes directly under it; and as this occurs only once in a whole revolution, and as the motion of the palls is only through one-tenth of a circle, it follows that cylinder No. 2 can only be moved through one-tenth of its circumference, after cylinder No. 1 has moved a whole revolution, or ten times that space, and so on. Thus, if the figures on No. 1 represent units, those on No. 2 will be tens, on No. 3, hundreds, &c.; and extending the same principle, No. 1 must move round one hundred thousand times to produce one revolution of No. 6. It will be observed that every revolution of the engine must insure one-tenth of cylinder No. 1 to move round, inasmuch as the ten slots in its right-hand edge are not covered by any other cylinder, as is the case with the rest.

The cylinders being free to move in the direction of their motion, or *forward*, they may be adjusted at any time to their starting point, without deranging any of the palls, or even opening the case.

The committee judge the following to be the advantages of this arrangement:—

1. The compactness and symmetry.
2. The ease with which the result may be read. And,
3. The facility of adjustment.

The two latter being important considerations in an apparatus of this kind.

The arrangement is also probably of less expense than the old form of counter.

In view of all which points, the committee are of opinion that Mr. Stillman is entitled to the First Premium awarded at the Exhibition, where it was placed by him in October last.

By order of the Committee.

WILLIAM HAMILTON, *Actuary.*

Philadelphia, February 8, 1849.

LIFE OF GEORGE STEPHENSON.

(Continued from page 107.)

XIV. LIVERPOOL AND MANCHESTER FIRST BILL.

In 1823 and 1824, the minds of the traders of Liverpool were kept alive to the need of a railway, as well by the writings of Mr. Sandars as by the great want of means for carrying goods. A declaration was signed by 150 of the leading merchants of Liverpool, setting forth "that a new line of conveyance has become absolutely necessary to conduct the increasing trade of the country with speed, certainty, and economy."[1]

To set at rest the doubts of those who did not know whether a railway between Liverpool and Manchester would do well, some gentlemen went to Northumberland, to see the railways there at work. These gentlemen were Mr. Sandars, Mr. Lister Ellis, Mr. John Kennedy, of Manchester, and Mr. Henry Booth. They met George Stephenson at Darlington, and went with him over the Stockton and Darlington Railway, then being made; and afterwards over several rail or tramways near Sunderland and Newcastle, and which were at work either with locomotives or fixed engines.[2] As the great end of the Northumbrian railways was to haul coal, so that of the Liverpool and Manchester railway was then thought to be to haul cotton and other goods. On the 20th May 1824, these gentlemen made their report to a committee sitting at Liverpool, of which Mr. John Moss was chairman; and it was settled to make a company for a double railway between Liverpool and Manchester. A list was opened for shares, and was soon filled with names from Liverpool and Manchester. A board was likewise named, of which the then Mayor of Liverpool, Mr. Charles Lawrence, was made chairman, and George Stephenson, of Newcastle, was named engineer.[3]

Stephenson set to work forthwith to lay out the line, and drew up a plan, which was sent into the committee. It was not, however, till the 29th of October that the prospectus was sent forth. The chairman was, as already said, Mr. Charles Lawrence; among the deputy chairmen were Mr. John Moss and Mr. Joseph Sandars; and among the directors Mr. Robert Benson, Mr. Henry Booth, Mr. James Cropper, Messrs. John and Peter Ewart, Mr. William Garnett, Messrs. Adam and Isaac Hodgson, Mr. Joseph Hornby, Mr. William Potter, Mr. William Rathbone, and Mr. William Rotherham. Of these, many are now directors of the London and North-Western Railway, and had a great share in making the Grand Junction, North Union, and other railways. The solicitors were Messrs. Pritt and Clay, a member of which firm is still one of the leaders of the railway interest.

The estimate was 400,000*l.*, taking in the cost of locomotive engines and everything else; and it must be remembered this was for a rough goods line. The stock was four thousand shares of one hundred pounds each. The goods going between Liverpool and Manchester were taken at one thousand tons daily. The prospectus seems to have been drawn up by Mr. Sandars, its groundwork being the letter of that gentleman on railways. It takes a bold and wide view of the question, and is a document well worthy of the great purpose for which it was intended.

By this able writing the canal-owners were roused, and in answer to it the Leeds and Liverpool, the Birmingham, the Grand Trunk, and other canal companies, sent forth circulars, calling upon "every canal and navigation company in the kingdom, to oppose *in limine* and by a united effort the establishment of railways wherever contemplated." The Liverpool and Manchester Railway therefore sent their prospectus, with a letter dated 25th November 1824, to leading men, begging them to uphold the railway company.[4]

In the next year, the ever-to-be-remembered 1825, a bill for a Liverpool and Manchester Railway was brought before parliament, and some of the parliamentary committee went to London to watch the bill.[5] Of this committee we believe Mr. Booth was one. To beat the railway, the owners of three canals, the Duke of Bridgewater's, the Mersey and Irwell, and the Leeds and Liverpool, banded together. With these were two land-owners, the Earls of Derby and Sefton, who set up the common tale about the holiness of their domains being broken in upon, and the privacy of their dwellings destroyed by bringing into their neighbourhood a great highway. Now, it seems the company and their engineer had been careful on this head, for their road was not to go within a mile and a half of the dwelling of the Earl of Sefton, and was to cross the Earl of Derby's lands over the barren mosses of Kirby and Knowsley, about two miles from the hall.[6]

On the 8th February 1825, the petition for the bill was laid before the House of Commons, and on the 9th, the Committee on Standing Orders resolved the orders had been complied with.[7] At that time they had not found out the way of wasting the money of shareholders, by having standing orders such as no engineer could follow, nor which could not be got through if any one opposed.

On the 18th February, the bill was read a first time; and on the 2nd March, a second time, after a debate of about an hour and a half. Sir John Newport, Mr. Huskisson, Mr. William Yates Peel, Mr. Doherty, Mr. Calcraft, and Mr. Henry Brougham, spoke for the bill; Mr. Greene, and Mr. George Phillips against it. There was no division.[8] Since then, we have found Lord Brougham the greatest foe of railways, and wishing to go back to turnpike roads and stage-coaches at ten miles an hour.

Nemo unquam fuit tam impar sibi.

Committees were then named otherwise than now; and General Gascoyne, member for Liverpool, was asked to be the chairman, which it is said he kindly undertook. The movers of the bill then named committee men of their own, and got as many friends as they could to come forward. On the 21st March, Mr. Adam made his opening speech for the bill, being followed on the same side by Mr. Serjeant Spankie, Mr. Joy, and Mr. William Brougham. The witnesses spoke strongly on behalf of the railway. On the 2nd of May, Mr. Spankie summed up for the railway.

The canal-owners began their case on the 3rd May, having Mr. Harrison, Mr. Alderson, Mr. Parke, Mr. M'Donald, Mr. Earle, and Mr. Cullen. Mr. Harrison acknowledged that there was great loss of time in carrying goods by water, and that the railway was shorter, being 30 miles instead of 50; but he held that the canals and river could carry all the trade of the harbour; that the levels and sections were wrong; that the locomotive was an unsightly-looking thing; and that the cost of the railway would be three or four times as much as the estimate. In behalf of this, Mr. Booth says[9] Mr. Francis Giles was brought forward to give his opinion that it would cost upwards of 200,000*l.* to carry the railway across Chat Moss alone. From the official copy, Mr. Booth takes the following evidence of Giles:—*Q.* Be so good as to tell us whether in your judgment a railroad of this description can be safely made over Chat Moss, without going to the bottom of the Moss? *A.* I say certainly not; (and again) undoubtedly not.—*Q.* Will that make it necessary to cut down the 33 or 34 feet of which you have been speaking; (and again) and afterwards to fill it up with other soil? This Giles likewise answered in the affirmative, and said it was quite impossible to get a railway through the Moss at any cost.

Mr. Stephenson seems to have remembered this man's conduct; for Mr. Herapath tells us,[10] "at the time the Southampton Railway was in committee, this Giles, who had just descended from the witness-box, after giving some extraordinary evidence of the cost of construction, which turned out to be much too low, was accosted by Mr. Stephenson in the committee-room, thus: 'Giles, you are the best fellow to tell a lie and stick to it afterwards I ever heard in my life.' At another time, having made some sharp observation on Giles, the latter replied: 'If you had not said that, Mr. Stephenson, so good humouredly, I'd have knocked you down.' 'You knock me down,' rejoined Mr. Stephenson, taking this Giles by the shoulders, 'why, I'd put such a fellow as you in my pocket.'"

The opposition were able to prove errors in the surveys and sections, which were acknowledged in committee, and set right; but an unfavourable turn was given to the committee. On the 30th of May, Mr. Harrison ended his case; and on the 31st, Mr. Adam answered him. The committee then divided on the preamble, which was carried by one, there being 37 members for the bill, and 36 against it.[11] These numbers will show how large the committees then were. They consisted of the parties named by the friends of the bill, and a list of local members, which would in this case be the Lancashire list. Only a few members attended daily, but on every division numbers would be brought up, most of whom had not heard even one word of the evidence. The committee of five gets rid of this evil, but without lessening the cost to the shareholders, or the fees of the lawyers. Indeed, it will be found, whatever is done, that the oppression of the lawyers never becomes less, but too commonly their means of extortion are strengthened.

So far had the railway company got after a three months' war in parliament, and thirty-seven working days spent before the committee. All that had been done was to prove the preamble, and the clauses of the bill had to be gone through, when the outlying members might be brought up to vote. Accordingly, on the 1st of

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[1] Sandars's Letter, p. 29.——Booth's Account, p. 8.

[2] Booth's Account, p. 9.

[3] Booth's Account, p. 10.

[4] Volume of Prospectuses belonging to H. Booth, Esq.

[5] Booth's Account, p. 14.

[6] Prospectus.——Booth's Account, p. 10.

[7] Booth's Account, p. 15.

[8] Booth's Account, p. 16.

[9] Booth's Account, p. 17.

[10] Railway Journal, 4to series, Vol. X., p. 867.

[11] Booth's Account, p. 18.

June, the first clause of the bill, empowering the company to make a railway, was lost on a division by 19 to 13; the clause to take land was next put and likewise lost; whereupon Mr. Adam, on behalf of the railway company, withdrew the bill.[12] In the committee, Stephenson was examined; and in his speech at Newcastle, he said, "I tried to keep the engine down to 10 miles an hour. I had to place myself in that most unpleasant of all positions—the witness-box of a parliamentary committee. I was not long in it, I assure you, before I began to wish for a hole to creep out at. I could not find words to satisfy either the committee or myself. Some one inquired if I were a foreigner, and another hinted I was mad. But I put up with every rebuff."

Such was the end of the first trial to get a bill for a railway between Liverpool and Manchester; but the board forthwith set to work to try again for the next year.

The backers of the railway felt sure, says Mr. Booth, that their failure was not to be set down to any lack of public opinion in favour of the great work which they had undertaken; and understanding many members of parliament strongly felt the great worth of the proposed railway, it was thought right a meeting should be held between the railway committee and such of the members as were able to come, so as to give some expression of opinion on the then state of matters.

This meeting was held on the 4th June 1825, when seventy-one members were present; and among them, General Gascoyne, Sir Robert Wilson, Mr. Huskisson, Mr. Spring Rice, Mr. William Yates Peel, and Mr. Richard Hart Davies. Mr. Spring Rice, now Lord Monteagle, has almost throughout been a great mischief to railways. As Chancellor of the Exchequer, he raised the deposit on railways to ten per cent.; in the Lords he has been intriguing for a government audit on railways. The meeting passed resolutions in favour of a railway, and a renewed application to parliament.

XV. LIVERPOOL AND MANCHESTER SECOND BILL.

On getting back to Liverpool, the railway committee advertised their intention to go again before parliament. As George Stephenson was not known in London, and it was thought his knowledge of the locomotive was not enough to give him weight before the House of Commons, it was determined to set him aside, and have engineers better known to the public. On the 1st of July, therefore, it was resolved that Mr., now Sir John Rennie, should be asked to become the engineer of the company. After some writing, it was settled that Messrs. George and John Rennie should be asked to become the engineers. George Rennie undertook a new survey of the country between Liverpool and Manchester.[13]

On the 12th of August, the committee, moved thereto by the engineers, determined to take a new line of way, going much to the south of the former; and Mr. Charles Vignoles, on behalf of Messrs. Rennie, was named to make the sections and plans for this undertaking. As these went on, it was seen the new line would cost more than the old, which had been set down at 400,000*l*. The committee had, therefore, to think how they should raise the further money which would be needful.

Mr. R. H. Bradshaw, M.P., was trustee for the Duke of Bridgewater's canal, and the manager of it. In the beginning of the undertaking he had been asked to have shares, but refused. It was now thought a more fitting time to settle with the Duke of Bridgewater's interests, and it was at length agreed the Duke of Sutherland should become a shareholder for one thousand shares.[14]

On the 26th December 1825, a new prospectus was sent forth, and in which the committee give their support to the locomotive system.

In February 1826, the committee again went to London. On the 7th, the petition for the bill was sent in; on the 9th, the standing orders were passed; on the 10th, the bill was read a first time, and on the 20th a second time, without a debate. The committee-room was then the fighting ground, for it was always much easier to knock down a bill there than in the House. On the 16th of March, the preamble was voted by 43 to 18; and on the 6th of April the bill read a third time. In debate, General Gascoyne, Mr. William Yates Peel, Mr. Huskisson, and Sir John Newport, spoke for the bill; and the Hon. Edward Stanley, now Lord Stanley, Sir Isaac Coffin, Mr. Philips, and Captain John Bradshaw, against it. The numbers were 88 for the bill and 41 against it.

On the 7th of April, the bill was read a first time in the Lords, and on the 10th, a second time. On the 13th, the bill went into committee, there being thirty-three peers present; Lord Kenyon in the chair, and the Earl of Derby to support his own interests. Evidence was given against the use of the locomotive; but so poor a case was made, the Lords did not think it needful to hear any witnesses for it.[15] Mr. Jessop gave evidence in favour of the estimates.

On the 27th of April the committee divided, 30 for the bill and 2 against it; these two being the Earl of Derby and the Earl of Wilton. The bill was on the 3rd of May read a third time and passed; and on the 7th May 1826, received the Royal assent.

On the 22nd of May, the committee sent forth a circular, calling the first meeting of shareholders, and in which they say: "They have already received a proposal from an engineer of eminence, to furnish an engine that shall comply with the clause in the act, compelling the consumption of smoke,—the engine proposed not to be paid for, if it do not answer the objects of the company."[16]

The first meeting was on the 29th May 1826, when twelve directors were chosen by the shareholders, and three by the Duke of Sutherland; and on the 30th of May, Mr. Lawrence was named chairman, and Mr. Moss deputy-chairman. At this meeting, the question of a principal engineer came under discussion. It was the wish of Mr. Sandars and his friends to have an engineer resident in the north, but others wished to keep the Messrs. Rennie; and the Board wrote to ask them to undertake the professional superintendence of the works. Mr. Booth says, that on the 17th of June, George Rennie saw the board, and proposed to superintend the execution of the works, making six visits yearly, and remaining on the ground seven or ten days at each visit, but asking that the resident engineer should be named by him.[17]

Nothing will show more strongly the slow communication between the great towns of London and Liverpool, five-and-twenty years ago, than this proposal of George Rennie. To make these six visits, which were two months apart, he would have to travel each year fourteen or fifteen days, night and day, boxed up in what Lord Brougham calls a comfortable stage-coach, travelling on the turnpike road at some ten miles an hour;—but which we know was most uncomfortable, and which made a man so tired at the end of the journey between London and Liverpool, that he wanted a long time to refresh himself. An absence of ten days or a fortnight at Liverpool, away from home, was aggravated by the slowness of the post; neither was the control of the engineer over the lower officers during his absence made any whit more efficient in Lord Brougham's Saturnian time.

For no class have railways done more than for professional men, and among these perhaps most of all for engineers. They can now undertake works at a great distance, and exercise an efficient control over them; the more efficient because it can be brought into play at any moment, instead of the resident engineer having it in his power to do as he liked at all times than the visits few and far between of his principal. The readiness of commmunication and cheapness of postage enables daily reports to be made; and professional men are able to travel, without being kept away for protracted periods from the comforts of home.

On the 19th of June the board met, and at length declined George Rennie's proposition, and named George Stephenson engineer-in-chief.[18] We believe it had been left to Mr. Sandars to choose between Stephenson and Mr. Rastrick, and that he named the former.

XVI. LIVERPOOL AND MANCHESTER WORKS.

The works began on Chat Moss in June, and the first shaft of the Liverpool Tunnel was opened in September of the same year; but very little way was made with either. In January 1827, the earthworks were begun.[19]

At this time, public works were on a scale so much smaller that it was hard to find contractors with wagons, tools, and plants enough for such an undertaking as the Liverpool and Manchester Railway; and great works instead of being done cheaper, were sometimes more costly,—being the monopoly of the great contractors, or done by the companies themselves. For a long time, in the beginning of railways, works were carried on by the companies under the superintendence of the engineers. In the end, a class of capitalists has been made in England, who are ready to undertake the greatest works, many of whom can hold a contract for a million, and who have been able to carry on works abroad to the great profit of this country. This class of capitalists has much helped the growth of railways, not only by making great works cheap and easy, but by making the cost certain. All great works, however well carried on, are open to risk; but formerly this risk fell on the companies, whereby the estimates were exceeded. Now

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[12] Booth's Account, p. 19.

[13] Booth's Account, p. 23.

[14] Booth's Account, p. 24.

[15] Booth's Account, p. 33.

[16] Mr. Booth's volume of Prospectuses.

[17] Booth's Account, p. 37.

[18] Booth's Account, p. 37.——Ritchie on Railways, p. 239.——Volume of Prospectuses.

[19] Booth's Account, p. 37.

this risk is undertaken by the contractors, and it is much more common for the cost to be below the estimates than formerly it was for the estimates to be below the cost.

Dock and harbour works, however great, are very unlike railway contracts, reaching over fifty or a hundred miles; neither are canal works on a like scale, for the latter by means of locks can be made without heavy embankments; nor are the cuttings so deep, nor the tunnels so many or so long. On a railway, the need of a smooth way leads to high mounds, deep cuttings through rock or shifting sands, and long tunnels coming near to the ground-line or reached by heavy slopes. To master these works, railway contractors were brought forward,—an operation which Stephenson helped to bring about, though without the knowledge or the intention of the great results which flowed from it.

The great contracts have brought up a host of navigators, one of the not least striking among the social wonders of this day. Here we have brought together men picked from the best of our workmen in the two islands, of the strongest thews, of the smallest teaching, of brutal passions, and skilled in the display of their strength and in the disregard of danger. These men are hundreds of thousands in number, liable to be thrown out of work whenever quacks in parliament choose to stay public undertakings, and who will in a time of strait form an army ready for any mischief which mob-leaders can prompt and madness can carry out.

The great want of workmen and plant threw on Stephenson great labour, and he had to organise his staff under difficulties now little understood. As he brought some men from Northumberland, he was set upon by the papers for favoritism, and for letting loose these wild men of the east to corrupt the manners of the Lancashire men, and an explanation was published in his defence.

In 1826, the directors tried to get a loan of 100,000*l.* from the Exchequer Bill Loan Commissioners, which was after some correspondence granted,[20] and it lightened the call upon the shareholders in the lowering times of the great panic. The loan was given mostly on the ground that it was desirable to afford employment to working-men in those times of distress.

The great work of 1827 was the tunnel under Liverpool, and here Stephenson's mining knowledge was of very great worth to him, and was of no less weight with the directors and the working men. Night and day were the mining and digging carried on, and many difficulties had to be overcome. The ground was in some places a soft blue shale, with much water; in others was a wet sand, to go through which much care and skill was needed, as it had to be pinned and propped with timber.[21] Work like this, though now common, was then so new, the engineer was more tasked and had a greater burthen on him. In passing under Crown-street, near the Botanic Garden, for want of enough props the ground fell in, being a depth of 30 feet of loose moss earth and sand. At this time Stephenson was away from Liverpool.

Sometimes the miners would not work at all, and the presence, superintendence, and encouragement of Stephenson were often needed to keep them at their posts,[22] to give confidence to them by sharing their dangers—a call to which, as already seen, he was never deaf. Practice now gives hardihood: there are thousands of tunnel miners who cheer each other on to the rashest attempts; but at the time we are naming they were little used to the work, and they had to bore their way almost in the dark, with the water streaming around them, and uncertain whether the props and stays would bear the pressure from above till the archwork was made good. Happily a great part of the tunnel was hewn through a fine red sandstone, clean and dry, and needing no masonry.[23]

The tunnel was under the care of Mr. Locke, as assistant-engineer; being one of his first great works, and was carried through to the satisfaction of the shareholders.[24]

By March 1827, there was a working railway on Chat Moss, and the directors in their report speak strongly in favour of Stephenson's operations. They say:[25] "The roadway over the Moss will be effected with much less difficulty than was apprehended by those whose ignorance on the subject of mosses, or whose professional bias, altogether prevented any rational judgment of the matter."

In an amended bill that year brought before parliament, the directors got power to pay interest on calls during the progress of the works,—a measure of great importance, and although strongly opposed at all times, unquestionably conducing to the ready raising of money for railway purposes.

In 1828, it was found that notwithstanding 212,000*l.* had been spent, the work was not going on as fast as could be wished, and the directors were therefore earnest for greater speed, so as to get an earlier opening. The workmen had been partly kept back by a wet winter, and partly by want of money, but by no want of zeal on the part of George Stephenson. In this year a bill was got for a new line laid down by Stephenson between Rainhill and Bury-lane, whereby the railway was shortened and the cost lessened. In the report to the yearly meeting on the 27th March 1828, all these points were noticed, and likewise the state of the estimates, which were shown to be likely to be exceeded on some heads of engineering outlay, besides land; but although 39,574*l.* had been left by the engineer for contingencies, this was swallowed up by one head of outlay—parliamentary expenses.

At this time the directors say they had, after due consideration, authorised the engineer "to prepare a locomotive engine, which, from the nature of its construction and from the experiments already made, he is of opinion will be effective for the purposes of the company, without proving an annoyance to the public. In the course of the ensuing summer it is intended to make trials on a large scale, so as to ascertain the sufficiency in all respects of this important machine." They likewise express their confidence in Mr. Stephenson, their principal engineer, whose ability and unwearied activity they are glad of this opportunity to acknowledge.[26]

In 1829, a fourth act of parliament was got, which provided for a Manchester station, and also to raise 127,500*l.* for providing stations, engines, wagons, and carriages,[27] which had not been asked for in the first act of parliament. Indeed, it was for some time not uncommon to make no provision in estimates for stations or carrying stock, such being considered of small importance.

About this time, the board were embarrassed with the Exchequer Bill Loan Commissioners. In making the loan of 100,000*l.*, the latter had kept a hold on the last 30 per cent. of the calls, as a further security for repayment in case the works should not be of sufficient value. The board being wishful to use these calls for the works, asked the commissioners for the leave to raise them, when the commissioners sent down Telford to report on the value of the works. This he did in the end of November, spending one day on the line, and leaving his assistant to take detailed measurements of the work.[28]

Telford's report was carefully worded to throw the greatest doubt on the undertaking, whether as to the amount of work to be done, the cost of it, the time needed, or the certainty of it. This report was given in on the 4th February 1829, and the commissioners resolved not to release any part of the calls. Some of the Liverpool directors then went to London, and having shown the unfairness of Telford's report, succeeded in obtaining the powers required.

Telford, speaking of the power to be employed, said that the use of horses had been done away with by introducing two sets of inclined planes, and he considered this an evil, while the planes must be worked either by locomotive or fixed engines; "but which of the two latter modes shall be adopted, I understand has not yet been finally determined; and both being recent projects, in which I have had no experience, I cannot take upon me to say whether either will fully answer in practice."[29]

This is far from satisfactory in Telford, after the locomotive engine had been before the world five-and-twenty years, and he had himself laid out railways,[30] in which it was his business to inquire as to the most advantageous mode of propulsion. He ought to have known about the locomotive, and indeed must have known,—but there was a great deal of jealousy in the very highest quarters, which had it been given way to would have utterly stopped the growth of railways. In aftertime, Stephenson himself was inoculated with the same feeling, and showed it with no less warmth. It behoves the public, however, always to be on their guard against swallowing any statements on authority, and particularly when they bear on any new undertaking. The locomotive, gas, high-pressure steam, steamboats, and electric telegraphs, would all have been swamped if authority had had full sway.

In the spring of 1829, the directors, earnest for greater speed, ordered the contractors to employ two gangs of men on all the cuttings, one by night and one by day. After this time, night-work and Sunday-work became too common to be thought wonderful. Notwithstanding the wishes of the directors, a wet summer and autumn threw the works back; indeed, the heavy and lasting rains lodged much water in the cuttings, which had to be pumped dry.[31] More rain fell in this year than for fourteen years before.[32]

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[20] Booth's Account, p. 38. [21] Booth's Account, p. 39. [22] Booth's Account, p. 39.
[23] Booth's Account, p. 39. [24] Booth's Account, p. 40. [25] Vol. of Prospectuses.

[26] Volume of Prospectuses. [27] Booth's Account, p. 43.——Vol. of Prospectuses.
[28] Volume of Prospectuses. [29] Telford's Report, Liverpool 1829, p. 15.
[30] See Report of Telford on the Knaresborough Railway, in the Library of the Institution of Civil Engineers.
[31] Booth's Account, p. 44. [32] Volume of Prospectuses.

In 1829, a skew-bridge was opened at Rainhill. This, too, is another work common at this time, but thought worthy of being set down by the historian of the railway. More books have been written since 1829 on skew-bridges, than there were then skew-bridges in the island.

In this year two locomotive engines were used for the first time for loading marl at the two great cuttings.[33] Stephenson, by doing this, opened a new field for the locomotive. Now, a good stock of locomotives is held by contractors, besides ballast-wagons, and thus a great means of economy in earthworks was brought about. The plant of a great contractor now always includes a locomotive engine and rails. This is another example of the unintentional benefit derived from the progress of a great improvement: indeed, in taking up an improvement, no one can foretell to what it will lead, nor in what indirect manner it may benefit the community. The doctor who took up the lump of gutta percha at Singapore so few years ago, did not know that he was giving his fellow-countrymen a material, which though of little use in the East, should be of so many uses here. What was there made up into the handle of an axe, was here to take the several shapes of a child's toy, a surgical bandage, a steam-engine band, a speaking-pipe, a shoe-sole, or a medallion, and set to work the mind of every mechanic and man of learning, to find new applications.

On 31st July 1829, the great tunnel being finished, and lighted with gas, which made it more of a novelty, was opened as a show to the townsmen of Liverpool, and was seen by several thousands. A shilling was paid by each person, and the money was set aside to be shared between the Liverpool and Manchester Infirmaries and the families of the workmen who had met with hurts upon the line. From this fund a very fair sum was raised.

The locomotive contest in 1829 will need to be spoken of by itself, and therefore we may go on with the works. These were still going on in the beginning of 1830, and the board found that more money was wanted, though the line was ready to be opened throughout. The more that was seen of the undertaking, the more needful was it known to be to get station and warehouse room, and greater accommodation for the traffic. At this time, a cattle station was first thought of, and a coach manufactory was set up. The whole outlay was then reckoned at 820,000*l*.[34]

In 1829, the coal traffic was begun, and on the 16th September, 1830, the line was partially opened for carrying passengers. The lamentable death of Mr. Huskisson at the state opening, is an event too well known to be dwelt upon.

There was a controversy, as usual, whether the rails should be of cast or of wrought iron, but the board, on Stephenson's advice, adopted Birkinshaw's wrought-iron rail, as on the Stockton and Darlington Railway; Stephenson, however, raised the weight from 28 lb. per yard on the latter to 35 lb. per yard on the Liverpool and Manchester,[35] so needful had it already become to get a stronger rail.[36] The cost of the rails was, on the whole, 12*l*. 10*s*. per ton, and the whole weight 3487 tons; the cost of the chairs was 10*l*. 10*s*. per ton, and the weight 1,428 tons.[37] In 1834, the directors reported that these rails were found too weak, and ordered stronger and heavier rails.[38] From 35 lb. the weight rose to 50 lb., 65 lb., and 75 lb.[39]

Of thirty-one miles, eighteen were laid with stone blocks, and thirteen with sleepers of oak or larch, the sleepers being laid on the embankments and mosses.[40] The two mosses crossed were Par Moss and Chat Moss. The former was small, and about 20 ft. deep, and by June 1830 was already beginning to be brought under the plough. Chat Moss was much greater, being then a barren waste of about twelve square miles, and in depth from 10 to 35 feet; the whole being so spongy and soft, that cattle could not walk over it. The bottom is clay and sand, on which is the mass of peat.[41] This has likewise been brought under the hands of the husbandman.

To the 31st May 1830, the whole outlay for surveying and engineering, from the beginning of the undertaking, was 19,829*l*.,[42] so that the reward of Stephenson could not have been very exorbitant.

In 1831, a new tunnel was found needful at Liverpool, to extend the line, and next year the works were begun by Stephenson.

In 1831, the outlay for cranes became greater, and the want of them on railways has led to many valuable inventions. In the same year, in consequence of a passenger train having run over an embankment, Stephenson set about a self-acting break, which has employed so many since. A guard-rail was thought of at that time for the side of the lines, but was given up.

In 1832, the timber traffic was begun, and reached 5,000 tons yearly.

Besides Mr. Locke, other now well-known engineers were employed under Stephenson. Mr. John Dixon was for a long time resident engineer, and Mr. Allcard superintendent of locomotives.

(To be continued)

PUBLIC ENTERPRISE, PATENT LAW, AND NATIONAL PROGRESS.

(*Continued from page* 103.)

If the engineers, and therefore other enterprising classes, are trammelled by the patent laws, so are they by every act of legislation. If, indeed, the engineer were a quack, hurtful to the commonwealth, he could not be kept within closer bounds; and it says little for the practical bearing of our system of government, that, with the greatest want of public works, the civil engineers have for the last two or three years been starving. Engineers are so far from receiving encouragement, that they are in every way kept back. They have latterly forced the government to make a sanitary movement, but although many classes of public works are necessary for the proper development of a healthy condition of the people, there is every impediment to their construction. A company for making waterworks, a bath, a slaughter-house, a market, or a sanatorium, must expose itself to the risks and costs of a parliamentary contest. In a case of our own, a bill for setting up waterworks in a town of from six to seven thousand people, was thrown out, by local influence, in its last stage in the Lords; and a great part of the capital, which might have been laid out in works, was wasted in fees. Thus capitalists are hindered from putting their money in undertakings, which may become an utter loss, for they have not that safeguard that come what may, still there will be something for their money.

Every class of public work is exposed to the same evils, and the engineer and the patentee are ever thwarted by the legislative hindrances to their getting capital for their undertakings. However useful may be the undertaking, or however worthless, there is the same system applied to both; and the hardships are such that they work, as many of them are meant to work, as clogs on the growth of public enterprise. However praiseworthy it may be to stop jobbing, it cannot be praiseworthy to stop useful works, and that system must be bad which looks rather to hindering rogues than to fostering honest industry. As matters now stand, there is every reason why a man should not embark in any useful undertaking, to however small an amount, for he puts his whole wealth in peril by becoming what the lawyers are pleased to call a partner.

This is one of the great evils of English law-craft, beginning no one knows how—that they have taken a false view of the relations of partnership, so that in the eyes of our lawyers a fellowship of two or three men and a fellowship of two or three thousand are held to be on the same footing; though any one might tell beforehand, if he did not know it by seeing it, that such associations are as unlike as may be. It is quite true, that they are both associations or partnerships of single men, but they are thereby no more under the same laws of government than the hamlet of Gandersheim and the whole Germanic empire. No tradesman deals with such associations under the same circumstances, no man embarks in them under the same conditions, and the common-sense of society has drawn the distinction between small partnerships and joint-stock companies—one acknowledged in all systems of law but that of England; and here the more wilfully denied because partially acted upon.

If a patentee, having gone through the plucking process of getting a patent, then wants a thousand or two thousand pounds to enable him to work it, the wisdom of the government places him at the mercy of those few persons who may be willing to incur the risks of partnership at his expense. George Stephenson, for instance, must pay a forced contribution for the assistance of Messrs. Losh, and has to wait for years before he can obtain an engine-factory of his own—a factory, it is true, which made a great reputation, and brought great wealth to this country by sending hundreds of locomotives abroad, but which in the chapter of accidents might never have existed.

Some persons think it an advantage that a patentee should be laid at the mercy of capitalists for the working of his invention, but on what real or moral ground cannot be stated. It must rest on the hankering after money-grubbing and the furtherance of

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[33] Volume of Prospectuses.

[34] Volume of Prospectuses.

[35] Ritchie on Railways, p. 42.

[36] Booth's Account, p. 61.

[37] Booth's Account, p. 101.

[38] Volume of Prospectuses.

[39] Ritchie on Railways, p. 54——Whishaw on Railways.

[40] Booth's Account, p. 102

[41] Booth's Account, p. 54 and p. 56.

[42] Booth's Account, p. 97.

the money-grubbing school, which no sound thinker has ever considered to want extraneous help in this country; and it must go on the assumption, that a patentee being poor is thereby a worthless and hurtful member of the commonwealth, who ought to be kept down by confiscation. The fair remuneration for capital is one thing—the oppression of a patentee is another, which has no necessary connection with it; and we do not therefore feel called upon to uphold on any fanciful grounds the claim to plunder the patentee.

As matters now stand, the patentee must give up the working of his patent altogether to another, or he must give up a large share of it, if he is able to get it worked at all. This is overlooking the very great difficulty the inventor of a new process has in bringing it into use, from the inveterate prejudices or vested interests of those engaged in old processes. Thus, as said by the *Edinburgh Review*, although a watch is a very imperfect piece of mechanism, the perfection of the economical processes of its manufacture are such that an improved watch could scarcely be made to sell against it, for above a hundred different trades would be called upon to change their tools and acquire new processes. These circumstances always act more or less against the inventor, and to our minds they constitute quite hindrance enough in the way of any useful invention, without the necessity of having those other shackles which are clung to so strongly by the upholders of the present system of evil. Some might think, if they were laying down laws for Atlantis or Utopia, that the inventor should be helped to stem the tide of prejudice. We dare not say anything about that.

So long as the inventor is restricted to a few persons for obtaining capital, his chances are less, and the price he must pay is greater, for a virtual monopoly is created. At the same time, he is hindered in the help he might get from the great capitalist or the small capitalist; and therefore these two latter classes are injured, by being prevented from investing their money. It is, indeed, the necessary result of evil laws, that while they give a worthless monopoly to a few, they do a great injury to the many.

A great capitalist who is willing to encourage a useful invention, and who as he has the greater means has likewise the greater inclination, is frightened from doing so,—for if he lays down only one hundred or one thousand pounds for a new locomotive factory or a new spinning-jenny factory, he thereby perils his hundreds of thousands or his million. The statement of this peril is answer enough to all applicants, and the fact itself works so effectually that our merchant princes are, under a heavy penalty, prevented from encouraging any useful invention which has not the immunity of an act of parliament, shielding against individual responsibility. Thus, instead of the English mechanic thinking it a blessing that he lives in a country where there is capital to overflowing, and where there is the energy and enterprise of Lord Ashburton, Baron Rothschild, Baron Goldsmid, or Mr. Morrison, he can only grieve at their prosperity, for the advancement of any man renders him less able to promote useful undertakings.

If anything could help the inventor, it is the munificence of men such as we have named, who uphold largely our public institutions, who engage in our great public undertakings, and who want not the will, if they had but the option, of encouraging what their own intelligence points out to them as useful and praiseworthy.

The small capitalist is equally injured, for instead of being allowed to put his few pounds in a joint-stock company, he is driven to the savings-bank.

All this results from the unlimited liability attaching to partnerships, and the want of efficient means of establishing companies free from such liability.

Some persons may think this works well, and if we look only at home we may bless ourselves that we are no worse off; but we have already shown that we are so much dependent on the progress of other rivals, we dare not nurse ourselves with any such delusions. Wherever we look abroad, whether on our side of the Atlantic or the other, we are struck by the progress of manufactures, mining, and material wealth, by means of joint-stock associations, whereby such poor countries as Saxony, Flanders, and New England, are able not only to enter the field against our manufacturers, but to drive them out. It has therefore ceased to be optional with us, whether we shall uphold a vicious and oppressive system, or whether we shall do justice.

In all those countries where the Code Napoleon prevails, there are the greatest facilities for establishing not only ordinary partnerships, but *societés en commandite*, and *societés anonymes*. The *societé en commandite* consists of sleeping partners who are not liable, and managing partners who are so; the *societé anonyme* is a joint-stock company with limited liability.

Here, perhaps, may be the fitting place to answer the objections of those who, relying upon their imaginations, and not on the evidence of facts, choose to consider limited liability and joint-stock undertakings as injurious to private enterprise and the public.

It is a very favourite objection, that joint-stock companies would drive out private enterprise in any branch of business in which they embarked. The answer is simply this, that they can only do so when the business is one unsuitable for private enterprise. The trader, looking after his own affairs, has such immense advantages over any joint-stock company, that it is he who would beat the joint-stock company, and not the company which would beat him, in any fair career. This has been too long established to be gainsaid, even if we knew that joint-stock glass companies, joint-stock copper companies, or joint-stock ironworks had driven single traders out of the field. The truth is, private enterprise wants no such protection as is tendered to it,—it can do well enough without.

Another objection is, that great frauds would be practised on creditors. Perhaps there might be such,—but creditors are best able to protect themselves, and are perfectly cognisant how they give credit. Here, again, is the opening for the competition of private enterprise, for a creditor considers whether it is better to trust a company, which is not personally liable, or a firm, which is personally liable. Perhaps the best answer is, that there are numerous corporations and companies in this country with limited liability, that transactions to the yearly extent of one hundred millions are carried on with them, and that persons are found to transact business with them.

Indeed, no valid reason can be brought forward against the introduction of the *societé anonyme* and the *societé en commandite* into this country, while there are the most urgent reasons why they should be introduced forthwith. The Manchester cotton-spinner, the Derbyshire silk-weaver, and the Nottingham framework-knitter have now to compete with joint-stock establishments abroad, and they want every resource that can be got. Indeed, nothing is more striking than the progress of the joint-stock system abroad. Even in the bleak regions of Vermont or Maine, the newly-born towns are crowded with buildings and works, erected by the joint-stock contributions of the traders and workmen. Thus is enterprise stimulated, industry rewarded, and frugality upheld; and thus are our own kindred preparing for a rivalry in which we seem doomed to be beaten.

If we look at home we find many reasons, even among ourselves, for a reform of our system. The copper and tin mining interests of this country, the value of which has never been under-rated, are wholly upheld by a joint-stock system. Either the cost-book system, which is that of a *societé anonyme*, or a scrip system, which is that of a *societé en commandite*, for the directors are responsible on the bills they draw, constitutes the machinery by which the administration of our mines is carried on. Indeed, were it not for the companies our mines would have been closed. We might refer to many other instances in support, but the greatest is this—that a sufficient case of evil cannot be made out from our experience against joint-stock companies.

To say that speculation and jobbing would be extended by an extension of joint-stock companies, is about as wise as to say—and there may be found people in the House of Commons to say this—that cheating and lying are extended by the extension of our home trade.

We can see no reason at all why we should not enjoy all the advantages of the United States or of France; but we should be contented in the first instance, if any lingering doubts remain, to take what may be considered a safe instalment. Among undertakings to which we would at once give the advantages of joint-stock companies with limited liability, by simple registration of the deed with the clerk of the peace and the Registrar of Joint-Stock Companies, are the following:—Waterworks, gasworks, baths, bridges, docks, marine-slips, warehouses, granaries, halls of commerce, markets, slaughter-houses, manufactories for agricultural implements, works of irrigation and drainage, canals, railways, mining, smelting, schools, libraries, sanatoriums, deaf-and-dumb asylums, blind asylums, lunatic asylums, museums, observatories, botanic gardens, zoological gardens, galleries and exhibitions of arts and manufactures, telegraph companies, manure companies, mining, fishing, fish-curing, salt-works, and river improvements. Such companies might be allowed for any new processes, as gutta percha, gun cotton, electric light, &c., and for any establishment where none of the kind exists in the neighbourhood. The Privy

Council might likewise have the discretion of giving the privilege on special application.

Cases for non-liability of sleeping partners would be steamboat companies, common road and canal conveyance companies, pawnbroking, theatres, brickworks, limekilns, and coke ovens.

A very significant illustration of the working of our system, and one very humiliating to our pride, may be found in the electric telegraph. Here we have one company, badly worked, overcharging, and badly paid: the United States are already covered with telegraph wires. Why? They have neither more money nor more business than ourselves, but they have better legislation. The state of New York, with a population of some three millions, has passed a general law for electric telegraphs, under which companies can at once be established with a limited liability.

If we look beyond these islands, we shall find our miserable system equally blighting elsewhere. We have so lately spoken upon railway and steamboat enterprise in India, that it is needless to say more than that this subject affords a memorable instance of the way in which the national interests are trifled with. A good law would give facilities for steam navigation to Australia, for whaling companies, for cotton cultivation in Hindostan, and sugar making in the West Indies.

Some curious information is given in the Report for 1848 of the Registrar of Joint-Stock Companies. One hundred and twenty-three companies were provisionally registered, and of these no less than ninety-six companies proceeded no further. Among these were the following:—Patent Galvanised Iron Company, Morley Gasworks, Wolverhampton Market, Wolverhampton Railways Approaches and Town Improvement Company, London Marine Electrical Telegraph Company, British Fishing Company, Lichfield Market Hall, Caldwall's Patent National Windlass, Farmers' Estate Society of Ireland, Hydraulic Telegraph, Bungay Navigation Tontine, Arley Coal, Iron, Brick, Lime, and Coke Works, South Hams Flour Mill, Bangor and Coytmoor Slate Works, Camborn Consols Mining Company, Henley and London Waterworks, Belper Gasworks, Coggeshall Patent Plush Manufacturing Company, Walsingham Gasworks, West Hartlepool Shipping Company, Royal Slate and Slab Company, Banbury Carrying Company, Cornwall New Mining Company, Wimshurst Patent Submerged Propeller Company, Bury St. Edmund's Gasworks, British Smelting Association, Aberdare Gasworks, Kirrage's Patent Sewer Block, Alnwick Gasworks, Tynemouth Gasworks, Salcombe Market, Great Western Fisheries, Cardiff Steam Towing Company, Dawley Gasworks, British Southern Whale Fisheries, Leeds Stock Exchange, Sanitary Baths, Edinbridge Corn Exchange, Mossley Gasworks, South Hayling Building and Ferry Association, Brierly-hill Gasworks, Surrey Consumers' Gasworks, South Tyne Colliery, Ampthill Gasworks, Kent Indurated Stone Company, Torquay Market, Patent Electric Light Company, Hartlepool Baths, New Steam-Tug Company, Combined Vapour Engine Company, Kingsbridge Public Rooms Company, Wareham Docks.

In this list are no less than thirteen companies being for new or small towns, and the utility of which may be considered as little liable to question,—but of which the prospects are very doubtful, as most of the undertakings fall through from the legal and parliamentary difficulties in their way. If this be the case in those classes of enterprise which are well established, matters are much worse as affecting the prospects of getting capital for working patents and new processes.

A very great evil in this country, which should not be left unnoticed, is the want of proper courts for deciding matters affecting trade. By the invasion of the lawyers these have all come into their hands, to their very great emolument, and to the very great loss and hindrance of all men of business. Formerly in this country the jurisdiction as to trading cases was in the hands of men of business. The several merchant guilds had full powers to settle all cases affecting their members, and the several trades guilds of the City of London still hold the power by charter, though ousted of it by the lawyers. All cases between masters, working-men, and apprentices, or between masters and the others, ought rightly speaking to be settled by the guild of the respective mystery; but this is all done away with, and great evil has arisen therefrom. Elder brethren of the Trinity House are still called in in running-down cases, but commonly the lawyers sit alone. Abroad, we have the name of a nation of shopkeepers, and it would be supposed we can manage our own mercantile matters; but who is there abroad who would believe that even in arbitration they are referred to lawyers, and not to men of business? Whoever heard of a judge recommending a patent case to be referred to an engineer? No one; for the recommendation always is to a member of the bar,—and the consequence is, that awards are not unfrequently given which are wholly incapable of being carried out, and the parties have to come to an arrangement irrespective of the arbitrators.

The only tendency in the right direction was by the appointment of men of business as official referees; but otherwise, the tendency is to exclude men of business. Thus, even those cases of trade disputes, and differences upon the registration of designs, of which the jurisdiction was given to the justices of peace, as being many of them men of business, have come under the cognizance of police magistrates, who are only lawyers. In the Court of Chancery, where the references are constantly of matters of business, as of accounts, and framing schemes for managing estates and trading transactions, those references are made to the Masters in Chancery, not one of whom is a lawyer; and if he knows anything of business, it is in despite of his legal education, which utterly unfits him for anything of the kind. Indeed, lawyers are kept so closely to the tether of law by the solicitors that they are debarred even from literary exertion, or the pursuit of the higher studies, without which a right exercise of the reasoning powers cannot be acquired.

In France they have been wiser than we are: every small town has its Tribunal of Commerce, the judges of which are men of business, and are chosen by the men of business; and most trades have a *conseil de prud'hommes*, while scientific and practical evidence, or that of *experts*, is imperative in all cases of a nature to call for it.

It has been very well advised in a pamphlet lately published, under the initials "A. P. P.," that our commercial legislation should be in the hands of the trading classes, as well as the administration of the law. As it is, we are a law-ridden people.

If a stranger looks at the institutions of England, in the matters now under our consideration, and looks likewise at those of other countries, he may come to the conclusion that the working of those institutions has placed us in a condition of decided inequality. That it has not done so, constitutes one of the difficulties in the way of reform, for persons are blinded to the immediate consequences of our commercial legislation, because these are happily counteracted in some degree by other circumstances.

As there is much misapprehension on this subject, we think we cannot do better than devote to it a few words. In England we have the resources of a great accumulation of mechanical power, of large capital, and great natural enterprise. These have a powerful influence, and are wholly wanting in France and Belgium, and partially so in the United States.

When the Fleming has made a sum of money in trade, instead of applying it in the extension of his business, in joint-stock enterprise, or even government stocks, he lays it out in land. Everything favours the small purchaser of land in Flanders, as much as everything here hinders him. He has a simple registered title, and pays only *ad valorem* duties. He can therefore go on buying field after field, while here the cost of stamps and long deeds of conveyance often comes to more than the purchase money; and the result is, that here the small capitalist is quite shut out of the land market, to the great injury of the latter, no doubt, and he is therefore restricted in the application of his capital to purposes of trade. Here the capitalist never becomes a land-owner until he has realised a large sum; and commonly, only a small part of his capital is so applied. It is the next generation from the money-maker which buys land. In Flanders, the resources of trade are always being drained off by the land market; and although theoretically this should find its level, it has not yet done so, but the price of land is enhanced, so that sometimes sixty years' purchase is given. Under such circumstances, nothing but the Code Napoleon keeps the great establishments of Ghent and Liege at work. Where a large factory is established by private enterprise, it is commonly by foreigners, Hollanders and English. Indeed, most of these were established and upheld by the King of Holland, William I.; and on his withdrawal, it was necessary to make them joint-stock undertakings.

In France, the ambition of the tradesman is likewise limited. When he has got together 2,000*l.* or 4,000*l.*, enough to keep him quietly, and provide for the conventional family of one son and one daughter, he gives up trade, retires to the *faubourg* or *banlieu*, and becomes a *rentier* or *proprietaire*, a fund-holder or a holder of house property. Few are those who stop to double their stakes or to engage in larger undertakings. The son becomes an employee of the government, or, what is the same thing, a professional man; his friends are employed in buying a *charge* or lodged in the Caisse des Consignations. Everything beyond this career is exceptional, and all tends to keep the trader within it. The laws of bankruptcy are most severe; the unfortunate are treated there as the criminal, and not as here, the criminal as the unfortunate. The settlement of property on women is most strict, and the disposal of the wife's property greatly hampers both parties. Here, again, is enterprise deprived of its resources; though, during the peaceful reign of Louis Philippe, the country very much improved. The funds, however, absorbed a large sum in new loans, and the French have been employed for some time in buying back from the English the *rentes* and railway shares. If, therefore, the French do not press us more strongly in foreign markets, it is because we have greater material and personal resources.

In the United States there is no want of enterprise,—there is a spirit of enterprise beyond us; but the country is thinly-peopled, and is wanting in those buildings and roads, the accumulated stock of ages, the working plant of society, which so much abounds here. The New Englanders are, however, doing their best to make up for their wants, and with freer laws, greater enterprise, and the power of accumulating capital in joint-stock undertakings, they will prove more formidable rivals to us than they have yet shown themselves.

Now is the time to be stirring—not when we are beaten, but while we have still the time to make headway. We have got a warning, and we must take it. We are losing several branches of trade already, and unless we bestir ourselves we shall lose more. To beat our rivals, we must take advantage of the same means that they do, and we must have the same freedom for our industry and enterprise.

(To be continued.)

REGISTER OF NEW PATENTS.

LOCOMOTIVE ENGINES.

Samuel Thornton, of Birmingham, Warwickshire, merchant, and James Edward Mc Connell, of Wolverton, Buckinghamshire, engineer, for "*improvements in steam-engines, and in the means of retarding engines and carriages on railways, and in connecting railway carriages or wagons together; also improvements in effecting a communication between one part of a railway train and another, by signals or otherwise.*"—Granted August 7, 1848; Enrolled February 7, 1849. [Reported in Newton's *London Journal.*]

This invention, so far as it relates to improvements in steam-engines, consists, firstly, in an improved construction of piston; secondly, in certain alterations in the chimney and blast-pipe; and thirdly, in certain arrrangements and alterations of the eduction-passages and valves, for the purpose of diminishing the back pressure, or the resistance of the steam in the eduction-passages to the motion of the piston.

The improvement in the piston consists in a certain arrangement and combination of parts, for the purpose of ensuring uniformity of pressure on the rubbing surface of the piston.

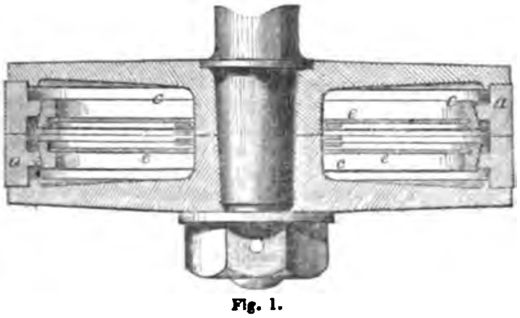


Fig. 1.

The improved piston is shown in cross section at fig 1. The novelty consists in the adoption of one or two packing-rings *a*, *a*, which are of a form to allow of a projection towards the interior of the piston, having the surface conical at *b*, *b*; on which conical surfaces two inner rings *c*, *c*, are accurately fitted, in such a manner as to act easily to and fro;—the expansion of the outer or packing-rings being allowed for by their being cut asunder in the usual manner. The inner rings are not cut; but, being concentric with the outer rings, they are made to fit closely against the conical surfaces *b*, by the elastic pressure of a spiral spring *f*, which allows of their taking a position suitable to the varying diameter of the rings *a*. On each of the inner rings *c*, there is fitted one of two thin elastic discs *e*, *e*, of tempered cast-steel, for the purpose of receiving the pressure of the spring *f*, which causes the inner rings, *c c*, to act on the outer or packing-rings, as before-mentioned, and thus render the rubbing surface steam, water, or air-tight. Instead of the two discs being pressed from each other by means of the spiral spring *f*, a spring of india-rubber or other elastic substance, placed in the centre of the rings round the piston-rod, may be employed for that purpose. In this arrangement of the piston, the rings may, by means of pins or holders, at relative distances in the piston, be shifted round, so as to wear equally, and prevent the formation of ridges and marks in the cylinder or packing. The piston may be also made of wrought-iron or steel, in one piece with the piston-rod, and with the adoption of one breadth of packing, so that the piston may be as light as possible. Under this division of their invention, the patentees claim the construction of pistons above described, in which the packing-rings are adjusted by means of two conical surfaces, acted on by a spring and elastic discs.

Fig. 2.

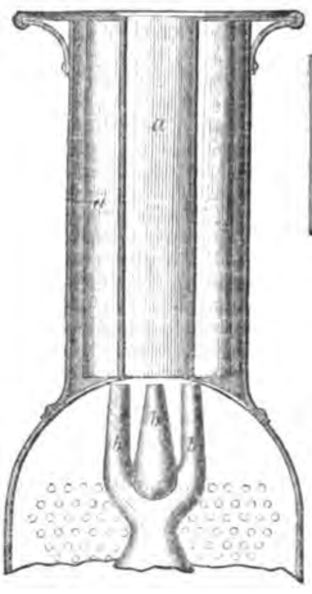
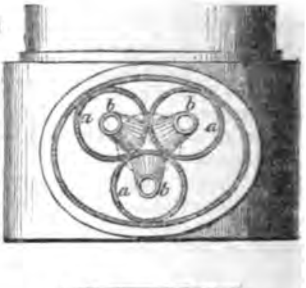


Fig. 3.



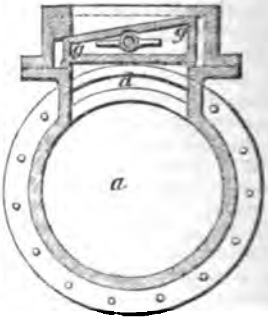


Fig. 5.

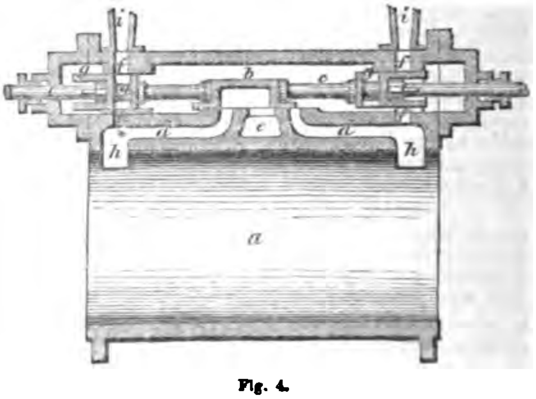


Fig. 4.

The second improvement, relating to steam-engines, consists in certain alterations in the chimney and blast-pipe of locomotive engines, and is intended to obtain, from the escaping steam, an effectual means of accelerating the ingress of atmospheric air to the furnace, and at the same time increase the effective force of the steam acting upon the pistons. It is generally known that the quantity of steam which escapes, at the usual pressure, from the smallest cylinders of any engine used on railways, is sufficient to eject the air from the chimney; and it has been the usual practice to vary the diameter of the chimney in a certain proportion to the diameter of the cylinders of an engine, and to preserve a nearly uniform height for the chimney: namely, the greatest which the bridges over any particular railway would admit. Now, the object of this part of the invention is to obtain the advantage of a chimney of a height incompatible with the ordinary working of a railway, limited as such height is by the head-way of the bridges;

and this is effected by adopting two or more shafts, instead of one, as the chimney, into which shafts the steam is discharged simultaneously from a corresponding number of blast-pipes. Fig. 2 is a vertical section, and fig. 3 a plan of a chimney, having three shafts *a, a, a*, say five feet long each. Into these shafts three blast-pipes *b, b, b*, convey exhaust steam simultaneously; which, being discharged at the top of the chimney, will cause a rapid in-draft of air to the furnace.

The patentees do not confine themselves to the particular arrangement shown in the drawing; but they intend to use two, three, four, or more shafts for the chimney, with a corresponding number of blast-pipes, and of dimensions according to the quantity of steam to be discharged. They claim the division of the chimney into several shafts, into which a like number of blast-pipes exhaust simultaneously, as above described.

The third improvement in steam-engines, which consists of an improved arrangement of the eduction-passages and steam-valves in high-pressure engines, for the purpose of increasing the effective power of the steam, is shown in longitudinal section at fig. 4, and in cross section at fig. 5. To all persons acquainted with the working of steam-engines, it will be evident that a great saving of power and consequent economy will result from diminishing the back pressure of eduction steam on the piston; or, in other words, much of the power now expended in expelling the steam from the cylinder, after it has performed the operation of pressing the piston to the end of the stroke, will be saved, if the passage for this eduction steam is rendered more direct and capacious than according to the arrangements at present adopted. In order to accomplish this, the patentees have arranged the eduction-passages and valves as shown at figs. 4, and 5. *a*, represents the present cylinder, as in use on a locomotive engine; *b*, the slide-valves of the engine; *c, c*, the valve-spindles; *d*, the steam-passages; and *e*, the eduction-passage. In addition to this (the ordinary arrangement), another eduction-passage from the cylinder to the atmosphere is provided at each end of the cylinder, as shown at *f, f, f*; and this passage may be placed as found convenient, either exactly opposite the opening from the interior of the cylinder, or at any intermediate distance between that and the passage which admits the steam. The valves are also somewhat differently arranged, as one valve *g*, at each end, is used for the purpose of regulating the emission of the steam from the cylinder. These valves *g, g*, are attached to the same spindle *c, c*, as the ordinary steam-valve, and are moved simultaneously with it. In order to explain the operation of the above, it is proper to state that the valve *g*, at either end, is so placed that it is open to the atmosphere from the cylinder at the same instant that the eduction steam, from the same end of the cylinder at which the said valve is placed, is escaping by the ordinary passages to the atmosphere. The size of the passage for steam, next to the interior surface of the cylinder, as shown at *h, h*, should be increased, in order to allow for the increased area of the eduction-pipes, caused by the additional passages through the valves *g, g*. *i, i*, represent the two blast-pipes for taking the eduction steam to the chimney; and the arrangement of these pipes, and also the plans of packing the back of the valves, may be varied according to the circumstances and particular construction of the engine to which they may be applied. It will be obvious that a similar arrangement of valves and eduction-passages, for increasing the area for the passage of eduction steam, may be adapted to any of the various kinds of engines in which high-pressure steam is employed, as well as in locomotive engines. It will be understood that, by the arrangement of passages and valves as described, the pressure in the blast-pipe and eduction-passages will be diminished, so as to admit of a diminution of the back pressure or resistance to the motion of the piston. The patentees claim the constructing and arranging of the eduction-passages and valves in the manner above described and represented.

The second head of this invention relates to improvements in connecting railway carriages or wagons together; and consists, firstly, in an improved method of coupling; and, secondly, in improved arrangements of the buffers.

And first, as to the improved method of coupling the carriages and wagons together.—The object of the improved method of coupling is to obviate the present dangerous mode of coupling railway carriages and wagons, whereby the men employed to do that work are constantly liable to be crushed to death, or to receive serious injury, particularly when in the act of coupling merchandise or mineral wagons together. This is effected by preventing the necessity of a man going under, or standing between, the carriages or wagons, when in the performance of the duty of coupling them together or uncoupling them.

Fig. 6 shows, in elevation, a carriage with the improved coupling apparatus applied thereto; and fig. 7 is a plan of the framing of the carriage, showing also the arrangement of the coupling. *a, a, a*, are brackets, for supporting the rods which carry the hook-links; *b, b*, are the hooks; *c, c*, the coupling-links, placed in their coupled position. At *e*, (see fig. 6,) the right-hand link is shown as turned up uncoupled. *f, f*, are handles for working the coupling-links: they may be applied to the outside of the carriage or wagon as well as to the inside of the framing. *h, h*, are mitre or bevel wheels, for working the screws which draw the buffers of the carriages together.

Fig. 9.

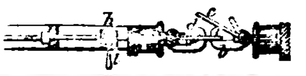
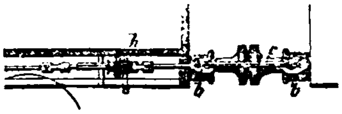


Fig. 6.



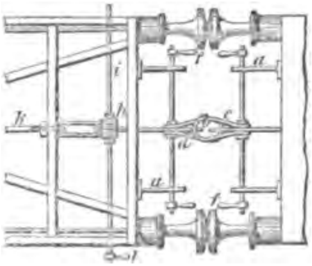


Fig. 8.

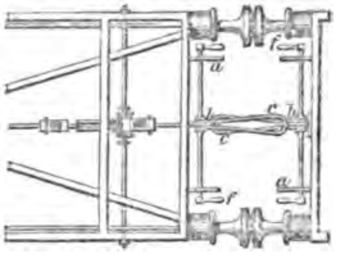


Fig. 7.

Figs. 8, and 9, show, in plan and side views, a modification of the above-described arrangements. *a, a*, are the brackets; *b, b*, the hooks; and *c*, and *d*, the links. The right-hand link *d*, is shown as coupled; and the left-hand link *c*, falling down over the link *d*, to be coupled. *f*, are the handles for working the coupling-links; *h*, is a worm-wheel, for drawing the buffers of the wagon together; *i*, is a shaft, with an endless screw, for working the worm-wheel; *k*, is a rod, for connecting the coupling-hooks to the springs under the carriages; and *l, l*, show the handles for giving motion to the shaft *i*, which carries the endless screw for working on the worm-wheel and drawing up the carriages. They give also a plan for tightening the carriages from their centres, by making use of one worm-wheel and one shaft passing through from one side of the carriages to the other: and they claim the connecting of railway carriages and wagons together by the arrangement above described, whereby carriages may be coupled together or uncoupled from the outside, without the necessity of any person being between them.

The second improvement, under this head of the invention, consists in connecting railway carriages and wagons by means of an improved system of buffers, so as to ensure uniformity in height of the same, whereby, whatever may be the position of the carriages or wagons, in respect of deflection of springs from load or other circumstances, the buffers will always be at the same distance from the rails, and in a line with each other both laterally and vertically: thus ensuring safety to the train in this particular, and also great economy in the wear, and ease in the travelling of the carriages or wagons. This improvement consists in attaching the buffers to, or connecting them with, the axles, or a frame affixed to the axles, instead of the bodies of the carriages; by which means the buffers, or the line of their action, will maintain one and the same height from the surface of the rails, to whatever amount the carriages may be loaded. It will be obvious that, provided the buffers are attached to a frame affixed to or connected with the axles instead of to the carriage (the height of which from the rails is liable to variation according to the load and other circumstances), the line of the action of the buffers will be maintained. The patentees recommend that the buffer-rods should be hollow, and of wrought or drawn-iron tubing; but this is not essential. They claim as an improvement in connecting railway carriages and wagons, the constructing and arranging the carriages and wagons so that they may be brought together by means of a system of buffers, framed to or connected with the axles, in such manner that the line of their action, when the carriages and wagons are coupled together, may be at one and the same height throughout the train, and independent of the loading of the carriages.

The third head of this invention relates to improvements in the means of retarding engines and carriages, and in effecting a communication between one part of a railway train and another by signal or otherwise; and consists, firstly, in certain arrangements for transmitting signals from one part of the train to another; and, secondly, in certain arrangements for bringing the breaks into action by or through the system of buffers. It is well known that various suggestions have, from time to time been made for effecting or facilitating a communication between different parts of a train with certainty; and, amongst others, it was suggested some time ago by James Edward McConnell (one of the present patentees) that the carriages should be constructed with a continuous platform, so arranged that a guard might travel from one carriage to another while the train was in motion. But it is desirable that some more expeditious means should exist of communicating from one part of a train to another, and of bringing into action all the breaks throughout the train.

The last-described part of the invention, viz., the arrangement whereby the buffers or their line of action are preserved at one and the same height, affords the means of attaining the object; for, by employing hollow buffers, and carrying a chain through them, every carriage throughout the train may be communicated with; and by the adoption of hollow or tubular buffers, breaks may be applied to any or all of the wheels of the carriages or wagons in the train; by means of levers, &c., a chain, rod, or rope, extending through the buffer-tubes, is connected to levers or wheels, which act on the breaks when the chain is drawn tight. *j, j, j,* represent the levers, which are acted on by the chain by means of a toothed quadrant, working in the tube; and which levers are fixed to the breaks *k, k, k.*

One or more chains, lines, wires, or other mediums of communication, may be introduced, as considered desirable, for signals, breaks, &c.; and when the carriages have been coupled up, the ends of the chains, rods, or other medium of communication, may be connected together through a slot or openings at each end of the hollow buffer-rods. The various modifications of which this part of the invention is susceptible will be obvious.

The patentees claim, as their improvements in effecting a communication between one part of a railway train and another, the giving signals by means of a chain, line, wire, or other medium of communication, passing through hollow or tubular buffer-rods, and connected with different parts of a train, as above described; they also claim the means of retarding engines and carriages on railways by actuating the breaks by means of a chain or rope, passing through hollow or tubular buffer-rods, as above described.

STEAM-ENGINES AND HYDRAULIC MACHINERY

Alonzo Buonaparte Woodcock, of Manchester, for "*improvements in steam-engines, and in apparatus for raising, forcing, and conveying water and other fluids.*"—Granted August 22, 1848; Enrolled February 22, 1849.

The invention relates—Firstly, to the improvement of the piston of the steam cylinder, the stuffing-box of the piston-rod, and the bucket or piston of the air-pump.

Secondly, to the improvement of pumps or apparatus for raising or forcing water and other fluids in those parts known as the buckets or pistons of such pumps, blowing cylinders, and other similar apparatus.

Thirdly, to the improvement of the apparatus used in conveying water and other fluids in those parts of such apparatus known as valves, taps, and cocks.

Fourthly, to improvements in the cylinders or barrels of pneumatic and hydraulic machines. And in order that the invention may be fully understood, the patentee says in those parts of the machines above described, as the cylinders and pistons, it is usual for the circumference of such piston or bucket to fit accurately into and press hard against the internal circumference of such cylinder, so as to prevent the fluid that may be contained in one part of the cylinder from passing to another; in other words, that the piston shall be steam-tight, water-tight, or air-tight, as the case may be. When this tight fitting is obtained and the machine set to work, the piston or bucket slides against the circumference of the cylinder, thus causing great friction, loss of power, and wear of the rubbing surfaces.

The object of the first, second, and third parts of this invention is, the substitution of a rolling packing for pistons or buckets for those of the sliding character, herein described, and the application of such rolling packing generally to the purposes herein named, and others of a like nature.

The elastic rings are made of a cylindric or other suitable form, and of any suitable elastic material as india-rubber (caoutchouc), any variety thereof, or compounds; but rings of india-rubber, prepared by Messrs. Macintosh and Company, under a patent granted to Mr. Thomas Hancock, are preferred.

The internal diameter of the ring is made smaller than the piston for which it is intended, and the piston of so much less diameter than the cylinder in which it is to work as that when the ring is stretched on to the piston and the whole inserted into the cylinder, the ring, by reason of its elasticity, shall be compressed into an elliptical figure in its section; and as the permanent elasticity of the ring has a continued tendency to regain its original figure, it consequently presses firmly against the external circumference of the piston and the internal circumference of the cylinder, thus making a perfect air-tight or steam-tight joint. The piston being now put in motion the ring revolves upon its own axis, and at the same time rolls along the circumference of both piston and cylinder, thus preserving the tightness of joint without any contact or rubbing of the piston against the cylinder, so that there is no friction or wear, and no oil required for lubricating. The ring by reason of its elasticity adapts itself to any irregularity in the surfaces of cylinders or pistons, and where such rolling packings are used, the cylinders and pistons need not be bored and turned, but may be left rough from the casting, and consequently the first cost of such apparatus be very much diminished.

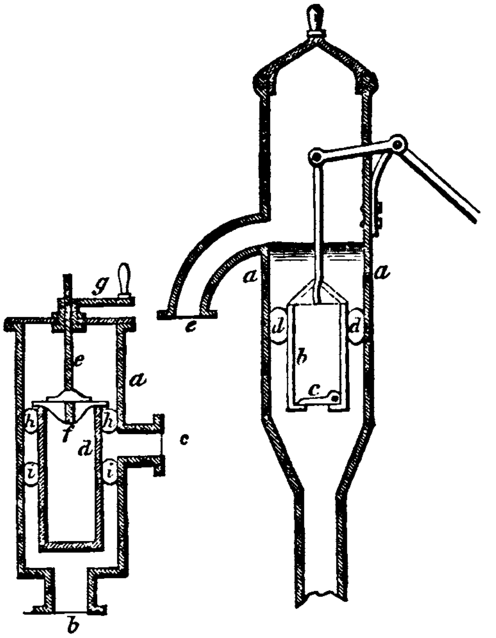


Fig. 2. Fig. 1.

Fig. 1 is a sectional drawing of so much of a lifting-pump with the rolling packing applied thereto. *a, a*, is the working barrel of a common lifting-pump. *b, b*, is a hollow bucket or piston. *c*, is a valve made to open upwards. *d, d*, is the elastic packing forced into an elliptical form by pressure against the circumference of the barrel *a, a*, and that of the bucket *b, b*, the result being the formation and continuance of an air-joint. The elastic packing being made to roll upwards by the motion of the piston, the air is withdrawn from the lower part of the pump; the water follows, and passing through the valve *c*, is delivered at the mouth *e*. These rings are applied to the pistons and cylinders of steam-engines in the same manner as for air-pumps.

The elasticity of the rolling packing permits the passing of mud or particles of coal, stones, sand, and other substances, consequently pumps made according to this invention are not liable to become choked or injured by the friction of granular particles, hence they are well adapted for excavations, mining purposes, and ships. For such purposes barrels or other portions are made of the usual materials as wood, lead, cast-iron, or other metal; but for purposes in which wood would be destroyed, and the presence of lead or other metal injurious, as in chemical operations, or where great cleanliness is required, as, for domestic purposes, the barrels and other portions of the pumps are made wholly or in part of glass, china, or earthenware.

Fig. 2 is a sectional drawing of the invention applied to such apparatus as is used in conveying water and other fluids as valves, taps or cocks. *a, a*, is the outer cylinder or casing which is furnished with two or more openings as the inlet *b*, and the outlet *c*.

d, *d*, is a metal piston made either solid or hollow according to the size of the valve; for small taps they may be solid, but where weight is objectionable, as in large valves for water or gas mains, the patentee prefers to make them hollow. *e*, is a screw firmly connected to the piston at *f*, and passing through the nut handle *g*. Now if this valve be connected with a water cistern or main by means of the flange at *b*, the water will flow into the casing of the valve as far as the rolling packing *i*, *i*, as shown, but no further. The handle being now turned and the piston raised, the packings *h*, *h*, and *i*, *i*, will roll along between the piston and casing beyond the outlet *c*, thus allowing the water to flow freely through. The act of turning the handle in the contrary direction will cause the packings to roll back to their former situation, and thus effectually cut off the passage of the water. The patentee does not confine himself to one outlet, but places any number of openings in the circumference of the casing, and thus obtains any number of jets that may be required. He prefers an oblong figure for the outlets at those parts of the casing where the elastic packing rolls over them in order that it may not press far into them in the act of rolling. Where great pressure of fluids is to be sustained, he prefers rolling packings to be made solid, as shown in section, fig. 2, but in the case of glass or earthenware valves, cocks, or pumps, or where very light pressures are used, he makes the rolling packings hollow, and wholly or in part fills them with air or other fluid, and thus renders them more soft and yielding than when made solid, but in either case causes them to be made of permanently elastic materials, as hereinbefore described.

The improvements in cylinders or barrels of pneumatic and hydraulic machines consist in rendering them elastic by forming them of, or lining them with, vulcanised india-rubber. These linings are made of any required thickness, taking care to have the interior surface as smooth and even as possible, and are attached to the barrels or cylinders of pumps or other machines, whether formed of wood, metal, pottery, glass, or other material, by any suitable cement or other means. The patentee forms these barrels entirely of vulcanised india-rubber. The pistons to be used in these barrels may be such as have been before described, but he prefers them to be made of some smooth and inelastic material, such as glass or metal (preferring tin), or hard wood, and of such a form as that the rubbing surface should present a curved or rounded figure to the barrel, the part impinging being only of such a breadth as may be necessary to prevent the passage of fluids. When the entire barrels are made of vulcanised india-rubber, he proportions the thickness to the diameter, the pressure of the atmosphere, and the duty the machine has to perform. By means of these elastic barrels and linings, the amount of friction is greatly diminished and the wearing parts rendered much more enduring than with ordinary barrels.

APPLICATION OF COAL TAR.

Robert Angus Smith, of Manchester, for "*improvements in the application and preparation of coal tar.*"—Granted October 19, 1848; Enrolled April 19, 1849.

This invention relates to coating the interior of water-pipes with coal tar.

The coal tar is reduced by distillation, or otherwise, to a thick pitch-like mass, which is kept melted at a temperature of 300° Fahrenheit (or such temperature as will keep the matter in a fluid state), in an open vessel. The interior of the water-pipes is first cleaned, to remove any oxide; and then the clean surface is coated with linseed oil, particularly when the pipes cannot be immediately coated with the coal tar. The pipes are heated to about 300° Fahrenheit in a stove; then they are immersed in the melted coal tar, in which they are allowed to remain for about an hour; and at the expiration of that time the coal tar will generally be found to have attached itself closely to the surfaces of the pipes, both inside and out: the chief object, however, is to obtain a good coating on the inside. The patentee states that, in removing the pipes from the melted coal tar, he has found it desirable to pour a quantity of linseed oil on the coated surfaces, which he finds to have the effect of removing any excess of the coal tar; and the oil, running into the coal tar, keeps it fluid, and prevents it from becoming unsuitable for the operation of coating the pipes. Instead of heating the pipes before immersion, a like effect may be produced by immersing the pipes in the melted coal tar after the interior surface has been cleaned, and allowing them to remain therein for some time after they have become as hot as the coal tar: this process will generally occupy about one hour and a half.

MANUFACTURE OF STEEL.

Alfred Vincent Newton, of Chancery-lane, Middlesex, mechanical draughtsman, for "*certain improvements in the manufacture of steel.*" (A communication.)—Granted November 2, 1848; Enrolled May 2, 1849.

This invention relates to the process of refining the metal, and forcing currents of atmospheric and gaseous air during the process, so as to convert it into steel; and also to preparing the metal previous to submitting it to the process of conversion into steel.

The apparatus consists of the converting furnace, to the tuyere whereof a blast-pipe is attached, formed into three passages, provided with valves for regulating the air currents. Two of the passages communicate with two iron receptacles in front of the converting furnace—the centre passage passing between them and to the front of the receptacles. These receptacles are provided with gratings and ash-pits beneath, and with covers for closing them.

The process of converting the metal into steel by this apparatus, consists in allowing the air to pass into the two passages of the blast-pipe communicating with the receptacles, such receptacles being filled with charcoal, which is then ignited, and the receptacles closed by means of the covers; the air thus passed through the receptacles is formed into carbonic oxide, and enters the tuyere of the converting furnace, where it is mixed with such a quantity of atmospheric air from the centre passage, as may be judged desirable, though the patentee states, that a large quantity should generally be avoided. By means of the valves, the quantity of gaseous or atmospheric air can be regulated by the operator. To prepare the metal for the process of conversion, the patentee states, that if it be pig-iron, it is to be melted sufficiently in a cupola furnace, to which is applied the apparatus above described; but if it be wrought-iron, a plumbago crucible is used, in which the metal is to be placed, being properly stratified with charcoal, or carbonaceous material.

OXIDES OF IRON.

William Longmaid, of Beaumont-square, Middlesex, gentleman, for "*improvements in treating the oxides of iron, and in obtaining products therefrom.*"—Granted October 26, 1848; Enrolled April 26, 1849.

The improvement relates to treating the oxides of iron for obtaining a black or dark coloured pigment, or a volatile oleaginous product, or an inflammable gas. The oxide of iron is finely pulverised and mixed with carbonaceous matters. The proportions vary considerably:—the addition of 10 per cent. of carbonaceous matter is generally sufficient; but the patentee prefers a little excess of carbonaceous matter, and mixes the oxide of iron with from 12 to 15 per cent. of carbonaceous matters, or such a quantity that, when the process is complete, a slight excess of carbonaceous matter will remain in the retort unemployed. Any kind of carbonaceous matters, which are not too volatile or expensive, and which can be mixed intimately with the oxide of iron, may be used; but when not in a fluid state, they must be pulverised. Those preferred are resin and tar. When resin is used, it must be pulverised, and the oxide of iron mixed therewith in a dry state. When tar is employed, the oxide of iron is mixed therewith in a moist state, for the purpose of facilitating the incorporation of the materials; and the mixture is dried at a temperature sufficiently high to deprive it of nearly the whole of its moisture, and reduce it to a state of powder.

The mixture is to be put into retorts or close vessels; and the patentee prefers to use cast-iron retorts, of the ordinary kind, five feet in length, and one foot in diameter, with a cover, to be fastened on the open end, and a ring at the opposite end, for the purpose of lifting it. A retort of this size may be charged with 1¼ cwt. of the mixture; and then (the cover being secured) it is lifted by a crane, and placed in a suitable furnace, in a vertical position, with the cover end downwards, in order that the volatile products evolved from the mixture may be consumed, and thus aid in heating the retort. The heat is to be gradually raised until the whole of the retort has arrived at a low red heat; at which temperature it must be kept until about two hours after the evolution of the combustible volatile products has ceased; and then, the process being complete, the retort is removed from the furnace, and allowed to become cold, or nearly so, before the charge is withdrawn—as it would be injured by contact with the air whilst hot. The material produced will be black, or dark coloured, and will form a good pigment for many purposes. Some carbonaceous matters, when used in the production of this material, will cause it to be sufficiently pulverulent; but, when this is not the case, it must be ground or pulverised: the pulverised matter is to be ground with oil, so as to form paint, in the usual way. When the combustible volatile products of the calcination are not burnt, the cover on the retort is luted, so as to make it air-tight, and a pipe inserted therein to convey the volatile products to a condenser. The calcination will cause a volatile oil to be evolved from the contents of the retort, and the oil will pass through the pipe into the condenser, where it will be condensed. The calcination will also cause the evolution of an inflammable gas, suitable for the purpose of illumination; which gas must be conveyed by a pipe from the condenser to a gasometer.

The claim is for treating oxides of iron by mixing them with carbonaceous matters and subjecting them to the action of heat in the manner above described, for the purpose of obtaining one or more of the several products before mentioned.

PAINTS FOR CLOTH.

Robert Thomson Pattison, of Glasgow, Scotland, for "*an improved preparation or material for fixing paint or pigment colours on cotton, linen, woollen, silk, and other woven fabrics.*"—Granted November 2, 1848; Enrolled March 2, 1849.

The improved preparation for fixing the colours is made or extracted from butter-milk in the following manner:—The butter-milk, as soon as possible after churning, is put into a boiler and heated to 160° Fahrenheit, which causes the curd to precipitate from the whey; it is then strained through a cloth, to separate the curd from the whey; after which, the curd is subjected to pressure in a cheese-press for a night; it is next broken and granulated, by being rubbed through a wire sieve; it is then spread upon cloth sieves, arranged on shelves in a room with a stove, for gradually drying it; and, when dry, it is ground to fine powder: it is now in a fit state to be used for fixing colours on fabrics. It is necessary, after the milk has been heated, to add to the boiler a quantity of acid sufficient to effect the precipitation of the curd: most acids will answer; but oxalic acid is recommended to be used. When the curd has been precipitated, it is treated in the same manner as that obtained from butter-milk. The fixing material is termed by the patentee "lactarine." The relative quantities of the lactarine and the colours to be applied to the fabrics will vary according to the result desired to be obtained with regard to the colour or shade. As an example, the following mode of fixing a medium shade of ultramarine blue is given:—Two gallons of water and three pounds of lactarine are mixed in a suitable vessel, and then four gills of *ammonia fort* are added, which will have the effect of dissolving the lactarine and converting the mixture into a thick gum or gummy substance. In another vessel one gallon of water and twelve pounds of ultramarine blue are mixed together, and the contents of the two vessels are thoroughly mixed; the combined mixture is then strained through a fine cloth, after which it is ready for printing. The operations of printing, straining, and finishing the fabrics, are successively performed in the manner usually adopted by calico printers.

BELL ROCK LIGHTHOUSE.

Sir—I have carefully read Mr. Alan Stevenson's letter of the 10th ult., in reply to mine of the 8th February last, the former contained in the May number (p. 136), and the latter in the March number (p. 77), of your valuable *Journal;* and as the main facts and statements in my letter remain undisturbed, upon which it appears to me, as I have no doubt it will to your readers also, that the whole case rests, I do not feel that any further answer is required, and I should be sorry to waste the valuable time of your readers by following Mr. Stevenson through a variety of minor details,—all of which are easily answered, although they have nothing to do with the main question at issue.

Mr. Alan Stevenson, by publishing in your *Journal* what he says was his father's original design for the Bell Rock Lighthouse, as well as the one actually executed, proves beyond all doubt that his father's design *was not adopted or executed;* and his father's book, together with the correspondence in your *Journal,* proves equally beyond doubt that *previous to any design for the lighthouse being adopted, or to any of the works being commenced, the late Mr. Rennie was appointed chief engineer, and furnished his own design,* and Mr. Robert Stevenson was appointed *assistant engineer under the late Mr. Rennie,* and carried Mr. Rennie's design into effect, under his directions, with such alterations as Mr. Rennie considered advisable during the progress of the work, which he (Mr. Rennie) superintended and directed, *from the commencement to its final completion.* It is quite superfluous, therefore, for me to pursue the subject further.

Mr. Alan Stevenson's doctrine, that the *assistant engineer, acting under the directions of the chief engineer,* should have the merit of the whole, *instead of the chief engineer,* is so contrary to common-sense, as well as to the *universally-acknowledged practice,* that I do not think he will find that any member of the profession or of the public will agree with him.

Giving Mr. Robert Stevenson, therefore, as I have done, every possible credit which is due to him for the very important services he rendered previous to the work being placed under the late Mr. Rennie, as well as for the able manner in which he discharged the duties of assistant engineer under the late Mr. Rennie whilst the work was being carried into effect, I still adhere to the statement contained in my work upon the Breakwater in Plymouth Sound, and in my Address to the Institution of Civil Engineers—viz., that the late Mr. Rennie designed and built the Bell Rock Lighthouse.

I am, Sir,
Your humble servant,
London, May 17, 1849. John Rennie.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF MECHANICAL ENGINEERS.

April 25.—Robert Stephenson, Esq., M.P., President, in the Chair.

The President opened the proceedings of the meeting by tendering to them his sincere thanks for the distinguished privilege they had conferred upon him, by electing him the President of the Institution of Mechanical Engineers. He assured them that he highly prized it, and would endeavour to prove himself worthy of it by attending with diligence and energy to the interests of the Institution. In undertaking that duty, it was not merely because he delighted in mechanical pursuits, but he was actuated also by the feeling that he should be doing honour to the departed. In undertaking it, however, it was necessary that he should express to them how apprehensive he was—at least, that he had apprehensions—of an Institution of that kind failing for want of energy on the part of its members. What had hitherto been the character of almost every Institution of the kind in this country?—almost universal failure. It was a remarkable circumstance, that in a country like Great Britain, whose wealth and power are so closely connected with the development of the Mechanical Arts and Sciences—it appeared to him, in fact, a complete anomaly—that Institutions of that kind should not appear to reach a higher standard than they now had. They saw Astronomers cultivate and maintain a society for extending their knowledge of the movements of the heavens. They saw Geologists maintaining and extending societies for investigating and developing the structure of the earth. They saw Physiologists and Botanists maintaining and extending their societies for investigating and developing the knowledge of the animal and vegetable productions of the earth: yet they had witnessed only languidness and inactivity in the pursuit of those arts and sciences on which the nation's wealth absolutely depended. That it should be the case was to him the more remarkable, because the nation stood pre-eminent for their mechanical abilities. It was not egotistical in him to say this in Britain, because all foreigners conceded to them an unmeasured pre-eminence in those particular arts. Without despairing therefore of the success of the Institution, he felt that in undertaking the task he was now doing, it was necessary that he should impress upon the members the absolute necessity of co-operating with him with energy in the further development of the Institution. With that strong conviction on his mind, he wished also strongly to impress it on them; for without energy and industry they must fail as heretofore. He would endeavour to do his part, and trusted and hoped most sincerely that the members would not fail in doing theirs, for without their assistance no efforts of his would sustain an Institution of that kind.

The following papers were read:—

ON THE CONSTRUCTION OF PERMANENT WAY.

"*On the Construction of Permanent Way.*" By Mr. Hoby, of Brighton.

The subject on which a few remarks are here offered for consideration, seems hardly to fall within the scope of this Institution; there exists, however, such an intimate connection between the construction and condition of the permanent way and the performances of the motive stock, as regards speed, economy, and safety, that little further apology need be made for the introduction of a few observations on the various kinds of permanent way now in existence.

The rapid deterioration of the permanent road on most of the leading lines of railway since the introduction into general use of a class of engines considerably more powerful, and by consequence larger and heavier, than those in use four or five years ago, has been such as to attract the notice of the public, and to call forth the anxious attention of those on whom more immediately devolve the duties of engineering and management. That there has been deterioration, more especially in the rails themselves, and that it has been lately manifesting itself far more rapidly than had been calculated upon, is evident from the additional strength now given by most engineers to the rails and other parts of the permanent way, in order that repairs may be less continuous, and renewals less frequent.

If the question be regarded in a general view as connected with economy, whether of first cost or annual maintenance, it will be manifest that these two points have an essential bearing on each other. A system of road may be expensive in its first construction, yet cost so little in maintenance, and last so long a time, as to be in the end far cheaper than a road less expensively formed, but requiring greater annual outlay, and more speedy replacement. Circumstances being equal, the annual cost of maintenance distributed over a period of years, and including both labour and materials, should form a very distinguishing test to apply in ascertaining the merits or defects of the different constructions of permanent way now in use; for it may fairly be argued that the road which costs least to repair will also last the longest, a state of efficiency and security being presumed.

Acting on this view, the writer has endeavoured to collect such facts in regard to mode of construction, and cost of maintenance, on different lines, as might suffice when collated, to determine the most advantageous, and ultimately economical, mode of construction, as well as to obtain some practical information as to the points wherein existing systems appeared weak or defective; and had intended simply to offer these facts, so far as they might be useful, for the consideration of the members of this Institution. But in pursuing this investigation, and attempting the proposed comparison, it became apparent that the cost of maintenance was controlled by elements not only not common to the different systems under consideration, but varying even on contiguous portions of the same line; these elements being, the nature of the substratum, or material of formation; the character of the ballast; and the extent and kind of the traffic;—circumstances which, whilst they render it difficult to arrive at any accurate average of the cost of maintenance on any particular line, make it impossible to deduce satisfactory results from a comparison of those averages.

It therefore becomes necessary to take up the question more at large, and to ascertain the conditions of stability and efficiency which are required in all permanent way, and the manner in which the various systems at present in use meet those conditions.

The principal of these conditions may be arranged as under:—

1. Sufficient platform or bearing surface on the ballast to prevent the whole road from being crushed down into the ballast.
2. Sufficient bearing surface of the various parts one on another to prevent their crushing into each other.
3. Sufficient cross-ties to secure uniformity of gauge between the two rails composing one line of rails.
4. Sufficient side stiffness in each rail.
5. Sufficient strength, quality, and shape of materials, to prevent their crushing in themselves.
6. Such general precautions as shall tend to the protection and preservation of the more perishable portions from atmospheric and other influences; on this last point, however, it will not be within our limits at present to enter.

These conditions satisfied, the questions of economy and simplicity of construction, remain for consideration.

The bearing surface of the permanent road on the ballast has been variously provided. Amongst the more prominent of the modes now in use we may notice roads laid upon,

1. Stone blocks.
2. Cross sleepers (of usual make).
3. Cross sleepers (of usual make) brought nearer together at the joints, with a larger sleeper under the joints.
4. Cross sleepers of triangular section.

All of the foregoing usually sustain and secure the rail by the intervention of chairs.

5. The longitudinal bearer used on the broad gauge lines.
6. The same as laid on the narrow gauge at London Bridge.
7. A combination of the cross sleeper with the longitudinal bearer now in use on the Midland Great Western Railway of Ireland, and formerly laid down on the Croydon line.

In these three plans, a flat-bottomed or a bridge rail is bedded on and secured directly to the longitudinal bearer.

8. And lastly, the system introduced on the South Coast lines, and on the Great Southern and Western of Ireland, in which a bridge rail is immediately fastened to cross sleepers. The cross sleepers in the case of the Southern and Western of Ireland vary considerably in size, and are placed at proportional distances, the great body of the support being under the joint.

Briefly to compare the amount of bearing surfaces respectively presented to the ballast under the several systems mentioned above, it will be found that, assuming a length of rail at 18 feet,

1. With stone blocks there are 1·33 ft. super per foot run of rail.
2. With cross sleepers (of usual make) equally distributed, 1·12 ft. super per foot run of rail.
3. With the same brought nearer together at the joint, 1·36 ft. super per foot run of rail at the joint, and for 4 ft. 1½ in. each side of joint; and 1·04 ft. super per foot run of rail, over the 9 ft. 9 in. remaining to make an 18 ft. length.
4. With sleepers of triangular section rather more surface is presented to the ballast.
5. With that used on the broad gauge lines, 1·25 ft. super per foot run of rail.
6. With the longitudinal bearer used at London Bridge, 1·17 ft. super per foot run of rail.
7. With the combination of the longitudinal and cross sleepers used on the Midland Great Western of Ireland, 1·43 ft. super per foot run of rail; and in cases where more sleepers are introduced on boggy or peaty ground on the above line, or in the road on the Croydon line, 1·75 ft. super per foot run of rail.
8. With the construction adopted on the Great Southern and Western Railway of Ireland, a general average of 1·50 ft. super per foot run of rail; the proportions varying from 2·50 ft. super per foot run of rail at joint, to 0·93 ft. super per foot run of rail in centre of rail.

The next point for attention is the amount of bearing surface of the several portions of the permanent way one on the other, necessary to prevent their crushing into each other.

On instituting a similar comparison to the previous one, it will be found that, assuming as before an 18 feet length of rail,

1 and 2.—With stone blocks and cross sleepers placed at equal distances apart, which may be regarded as the older forms of construction, when rather light chairs were used, there are 20 super inches per foot run of rail at the joint, and 17 super inches per foot on the remaining length.

3 and 4.—With cross sleepers brought nearer together at joint, of usual make, or of triangular section, with large chairs, 23¼ super inches per foot run of rail at joint, and 4 ft. 1½ in. on each side of joint; and 16⅛ super inches per foot run of rail for the 9 ft. 9 in. remaining to make up 18 ft.

5, 6, and 7.—With the longitudinal bearer used on the broad gauge lines and at London Bridge, and with the construction used on the Midland Great Western Railway of Ireland, and on the Croydon line, 60 super inches per foot run of rail.

8.—With the cross sleepers to which a bridge rail is immediately attached on the Great Southern and Western of Ireland, a general average of 16 in. super per foot run of rail, in proportions varying from 27 in. super per foot run of rail at joint, to 10¼ in. super per foot run of rail in centre of length.

It must be remarked that in these last four instances, whether with bridge rails or flat-bottomed rails, packing plates are placed under the joints, and in the road at London Bridge at intervals along the rail, to prevent it from burying itself in the timber, more particularly at the joints; and that on the broad gauge lines a packing of hard wood is introduced between the rail and the bearer, which presents to the longitudinal timber a surface of 108 superficial inches, or 0·75 superficial feet per foot run of rail, through which the fastenings for securing the rail pass.

The modes adopted for the preservation of the gauge next claim our attention. With stone blocks there is no provision for this beyond the stability of each individual block. With cross sleepers this essential object is very completely secured. With longitudinal bearers this point is secured by cross timbers with strap bolts; these bolts securing the longitudinal timbers hard up against the ends of the cross pieces. In the case of the Midland Great Western Railway of Ireland and the old Croydon line, as has been before mentioned, cross sleepers are used with the longitudinals.

The next point for consideration is the side stiffness in each individual line. With stone blocks and cross sleepers, whatever be the kind of rail used, the side stiffness depends entirely on the strength of the rail itself to resist lateral strain between the points of support. The rails used with longitudinal bearers are in themselves very stiff laterally, whether of the bridge or flat-bottomed section, and their immediate connection with the longitudinal bearers gives a further amount of side stiffness to this construction.

From the foregoing remarks we collect, that stone blocks as a means of support on the ballast, although presenting a large amount of bearing surface on the ballast, and being in themselves solid and stable, neither retain the road in gauge, nor secure the correct continuous elevation of the different points of support in the same line of rail; and as from this circumstance their use is chiefly confined to cuttings where the substratum is hard, and the ballast good, their hardness gives a peculiar harsh and grating feeling to the carriages passing over them.

The situations now are comparatively few in which stone blocks can be procured for cost to surpass the wooden sleepers, especially when the labour of jumping and plugging the holes for the chair pins are taken into account. It is however to be remarked, that in cases where horse power is used they have the advantage of leaving a clear way for the horses' feet.

Cross sleepers, which have, on the narrow-gauge lines, been so extensively adopted, whilst presenting a very sufficient bearing surface on the ballast, unite in themselves a cross tie to preserve at every point of support uniformity of gauge, and are readily packed and adjusted. Triangular-sectioned sleepers present theoretically a very large bearing surface to the ballast to resist downward pressure; it is however doubtful whether, except in ballast of a very firm and binding character, this effect is got from them, as in coarse and open ballast the sharp edge of the sleeper has a tendency to work downwards into the ballast with the motion of the trains, and to cant with the driving forward of the rails, a defect to which all cross sleepers are more or less liable. These last sleepers have the great advantage of being surface packed, so that repairs can be effected without the removal of a large quantity of ballast.

For side stiffness between the points of support both with stone blocks and the various kinds of cross sleepers the lateral strength of the rail is alone depended on; and in this respect the double T rails so extensively used seem open to some objection, for to their deflection sideways with an engine slack in gauge, or travelling at a high velocity, may be attributed much of the side oscillation so observable at times, which a variation of speed will often check.

The writer is aware that it has not been usual to attach much importance to this question; and in Professor Barlow's valuable work, in commenting on the small amount of side deflection as indicated by experiments in what were then considered most unfavourable circumstances, Professor Barlow says (p. 421):—

> "The whole of these experiments" (on the lateral deflection of railway bars) "have a tendency to show that the stress which the bars have to sustain in this direction is not such as to require to be more amply provided for than the increased thickness the bar must have to meet the greater vertical strain due to a longer bearing. In other words, the additional strength given to the bar for the purpose of resisting the vertical strain will be amply sufficient to meet and resist the lateral strain."

That is to say, the rails then experimented on were deemed strong enough laterally, and it was held that further increase of strength vertically, necessary for a longer bearing, or we may add, to support heavier loads, would suffice to impart the requisite lateral strength to the rails.

The weight of the engines since Professor Barlow conducted these experiments has been doubled and even trebled, the weight on the driving-wheels more than doubled, and the speed, no unimportant element in producing side oscillation, has been almost constantly doubled, and on special occasions quadrupled; the weight of the rails has crept up from 45 or 50 lb. per yard to 75, 80, 90, and even 100 lb. per yard, but the side stiffness has by no means proportionally increased. In cases where even 70 lb. rails have been tried with long bearings, the side oscillation has been found so constant and violent as to necessitate a recurrence to the shorter bearings most in use, from 3 feet to 3 ft. 6 in.

The longitudinal bearers have the advantage of presenting a continuous bearing surface to the ballast, and of giving with the rail great and uniform side stiffness to each line of rail, so that comparatively few cross ties are needed to keep the line in gauge, those on the broad-gauge lines being 15 feet apart. To these two main features, continuity of bearing on ballast, and continuity and amount of side stiffness, are to be attributed the great ease and evenness of the motion of the engines and trains on the Great Western Railway.

This system of construction is open to the following objections: —The expansion and contraction of the rails tends to loosen the fastenings, especially at the joints; and from this cause, with the comparatively complex nature of the cross ties, the maintenance is more expensive than on ordinary roads laid on cross sleepers, and it seems difficult to lift this road without great care and attention. When a cross sleeper is used under the longitudinal bearer, securing at the same time correctness of gauge and of the cant of the rail, this objection vanishes; and the cross sleeper being raised and packed, the longitudinal timber may be packed subsequently. This last construction, as used on the old Croydon line, stood a very large amount of traffic, although laid on substratum of a very inferior character.

Where a bridge rail is laid down directly on cross sleepers, the rail undoubtedly possesses in itself considerable side stiffness between the points of support; it does not however contain so much vertical strength to resist deflection as the ordinary double T rail, and the expansion and contraction of the rail is apt in cases to split the joint sleepers. The proportions in which, in the Great Southern and Western of Ireland, the bearing surface on the ballast is varied (from 2·50 feet to 0·93 feet super per foot run of rail), give so great a preponderance to the joint, that it may be doubted whether in practice it will not be found that constant packing is required in the centre of the rail lengthwise; and the amount of bearing surface of the rail on the sleepers is so small that there will be much crushing of the rail into the timber, especially on the curves.

Having made these general remarks on the various peculiarities of some of the leading modes of constructing permanent way, it remains for us to consider the shape, strength, and quality of the materials used, to prevent them from crushing in themselves. This more immediately applies to the rails, or wearing surface of the permanent way. It is in this respect that most of the systems have alike suffered since the introduction of heavy engines.

The rails most in use vary from 2¼ to 2½ inches in width on the upper table or wearing surface, and are for the most part made rounding at the top. Now if we look at the line of contact of a tyre on a rail, it will be found that a comparatively small portion of the width of the rail, in favourable cases not more than 1¼ inch, and in some instances less than ½ inch, is in actual contact. Now if it be assumed that on a 5 ft. 6 in. wheel of an engine in working order, a weight of 6 tons has to be carried, and if the strength of the iron in large railway bars to resist compression be taken at 8 tons per inch—(and it is doubtful whether more may be taken) —then the line of contact of the tyre on the rail in section being ¾ inch, it is obvious that such line of contact will have to be extended in the other direction into a surface of 1 inch, before the surface of the rail in contact with the tyre becomes sufficient to resist the weight superimposed, and the amount of compression in the rail will be represented by the versed sine of the chord of an arc 1 inch long with a radius of 2 ft. 9 in. The limit of compression of iron, such as is used in railway-bars being determined, it is evident that the amount of bearing surface between the rail and tyre will vary directly with the weight superimposed; that its extent in the length of the rail (or the length of the circumference of the wheel in contact), will vary with the length of the line of contact in section; and the extent of the compression or length of the versed sine, will vary with the radius of the wheel.

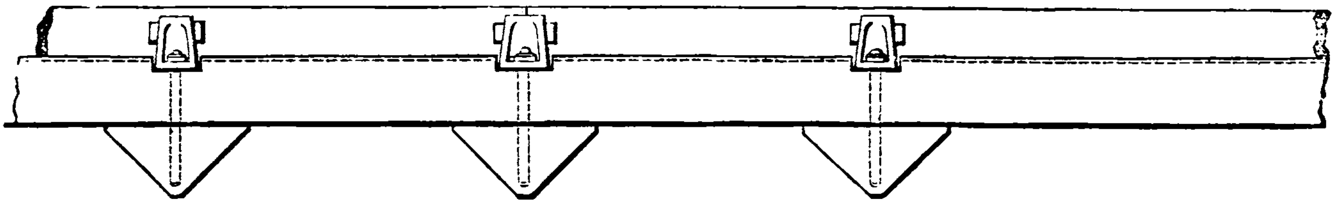
The amount of this permanent compression, or of the motion produced in the particles of the iron beyond the elastic limit, even supposing all the compression to take place on the rail and none on the tyres of the wheels, will evidently be infinitely small; but it may be fairly argued that such motion does take place, and renewed from time to time, from infinitesimal and insensible, becomes palpable and evident in its results.

It is difficult on other grounds to account for the rapid deterioration of rails,—the word deterioration being used in contradistinction to destruction, as the rails now removed on some of the leading lines have in many cases lost more than 2 lb. per yard of their original weight, showing that although rendered useless, they have not given out a fair amount of wear to the companies. For this information the writer is indebted to Mr. Dockray, and would take this opportunity of acknowledging the kind courtesy of that gentleman in permitting access to his very valuable report on this subject.

The cause of the removal of rails when not thoroughly worn out, is their becoming distorted in shape, such distortion being the result of lamination. Now this effect may be produced either from defective shape, or want of strength in the material itself to bear the superincumbent load. In regard to the usual T-headed rail, the impression very generally prevails that the shape is in fault, and it may very readily be imagined that a rail of this make, shall gradually grow distorted, from the pressure bending down the overhanging portions of the top table, without of necessity proving any motion to have taken place from absolute crushing. But bridge rails are found not to wear uniformly down, (as they should do if no crushing took place); the upper corners of the rail turn outwards, and when the wearing part of the rail has been rolled or crushed out sideways, the centre part of the top is driven downwards, and the sides turned completely over.

These observations would seem to confirm the conjecture previously hazarded, that under the weights now given to the engines, and with the limited extent of the tyre in contact with the rail in section, the rails themselves are gradually crushing; and remembering that the theoretical line of contact of the tyre on the rail in section must in all cases become a surface of greater or less extent, this effect is more to be attributed to engines with small sized wheels used for goods traffic, than to the weight or speed of engines for express traffic, whose wheels are so much larger in diameter. And could the matter be investigated, it would be found that the rails suffered more from the passage of goods or mineral trains, than from that of passenger trains at whatever speed.

Fig. 1.—Longitudinal Elevation, with Chairs let into Timbers.



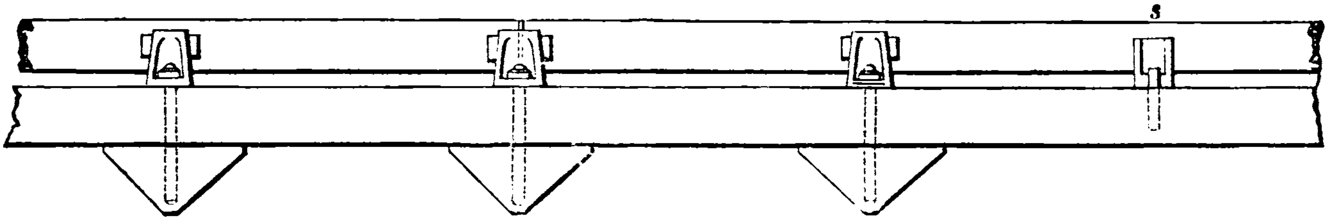


Fig. 3.—Longitudinal Elevation, with Intermediate Saddles.

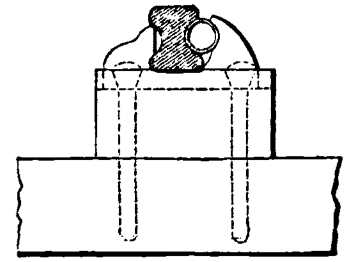


Fig. 2.

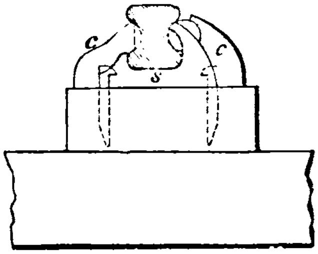


Fig. 4.

On the preservation of the perishable parts it would be beyond our limits to enter. Payne's process certainly has some effect in rendering the timber uninflammable, and therefore possesses advantage in the case of timber viaducts, or the planking of bridges. Saturating the timber with creosote, as adopted by Mr. Bethell, has produced very satisfactory results in preserving the timber from dry rot or decay.

The length to which this paper has extended will prevent more than a very cursory description of a permanent way which would embody the more desirable feature of efficiency and stability.

The engravings, figs. 1 and 2, show a wide double T-rail representing a fair bearing surface to the tyre of from 2 inches to 2½ inches, and possessing a considerable amount of side stiffness, being in depth 4 inches, and in width 3½ inches, and weighing about 100 lb. per yard.

The rail is secured by chairs to a longitudinal timber, 11 inches and 5½ inches, the chairs being sunk into the timber till the bottom surface of the rail is in contact with the top of the timber, along which a slight groove is cut, of such a shape that the rail shall bear harder on the outside edges of the groove than in the centre. Beneath the longitudinal timber, are sleepers of triangular section placed immediately under the chairs, 2 ft. 6 in. apart at the joints, and 4 feet in the centre of the lengths of rail, these last being supposed in lengths of 17 feet. The sleepers are cut out of 10 inch balk, and retain the road in gauge, whilst presenting an additional amount of bearing surface on the ballast, and admit of being packed without much removal of the ballast. In fact, these sleepers offer peculiar advantages for this mode of construction, although any others might be used. The chairs are secured through the longitudinal timbers to the cross sleepers by hard-wood tree-nails, the holes in the longitudinal timbers being bored slightly larger than those in the cross sleepers to prevent the timbers from splitting. The rails may of course be manufactured in such lengths as may be most convenient, and the cross sleepers distributed accordingly, and it may be found that the sleepers may be placed at wider intervals. The longitudinal timber is to be secured at the ends by a common half-lap joint, this joint to be always on one of the middle sleepers, and not under the joint of the rail.

A modification of this road is shown in figs. 3 and 4, in which a longitudinal timber 12 by 4 in. is used, and the chairs not let into the timber, but a saddle, *s*, introduced between the chairs. The rails may be secured to the chairs either by a hard wood or wrought-iron key; the latter of which is more efficient, as it is not affected by wet or dry, and it prevents the rails from driving forward in the chairs. The wrought-iron keys are more costly, but as in this case they are merely composed of short lengths of iron tube, the difference in expense would not be considerable. There is a difficulty in replacing the chairs which will readily be seen by the members, but in practice this may not be found a very serious objection.

The President observed, that it was an important subject for consideration; the main question seemed to be, whether the surface of the rails was actually suffering from the crushing action that Mr. Hoby spoke of. It looked almost as if they had reached the limit of their powers, when they began to crush the material.

Mr. M'Connell thought that a greater breadth of bearing surface of the rails would not be found to yield the advantage anticipated by Mr. Hoby; as it was so difficult to keep the bearing of the wheels in a straight line, and extending over the whole surface of the rails.

Mr. Woodhouse remarked, that the rail proposed appeared to him rather shallow for the purpose, being only 4 inches deep.

Mr. M'Connell said, he should be afraid that the rail would deflect between the saddles when a heavy weight passed over.

The President observed, that the rail was very considerably increased in thickness laterally, and appeared a strong rail, but it must be remembered that the strength was diminished in proportion to the square of the depth. He did not attach so much importance as the writer of the paper appeared to do, to the fact of the permanent way having deteriorated more rapidly in the last three or four years than previously. It was certain that on the older railways, which had been at work for 13 or 14 years, the deterioration of the rails had been much more rapid during the last three years of the time than the first three years, but he thought the wear and tear of the present rails had been much overrated. It must be remembered that the present heavy engines had been increasing in weight, whilst the rails had been getting older and more worn; and he believed that the weight of the present engines had got pretty nearly, if not quite, to the feasible limit.

Mr. Woodhouse remarked, there was an objection to the proposed plan, that broken chairs could not be replaced without taking the rail out, which would be very objectionable.

The President observed, it would certainly be a serious objection if the rail had to be taken out in order to replace a broken chair: all practical men were averse to it. He thought the lip on the inner side of the saddles might be dispensed with, which would allow them to be changed without disturbing the rail.

[The paper "*On a Patent Solid Wrought-Iron Wheel,*" by Mr. Henry Smith, owing to its length, we are obliged to postpone until next month, but we give the two shorter papers which followed it.]

BAINES' RAILWAY CHAIRS AND SWITCHES.

This Paper was read at the last meeting, but was not then discussed; the inventor, Mr. Baines, of Norwich, attended the present meeting to give further information and particulars on the subject.

Mr. Baines exhibited and explained specimens of the joint and intermediate chairs. The Joint Chair had one jaw on the outer side, fitting close up to the head of the rails, and the rails were fixed by a horizontal dowel-pin 1⅝ inches wide and ⅝ths inch thick, which was passed through a notch in the end of each rail, and a corresponding hole in the outer jaw of the chair, and was drawn up by a vertical cotter driven through the dowel-pin on the other side of the chair. A wrought-iron plate 9 inches long was placed under the head of the dowel-pin, fitting close up to the head of the rails on the inner side, and this plate was drawn up tight against the rails by driving the vertical cotter, and formed a stiff scarfing piece across the joint of the rails; this plate was a little cambered, and was sprung flat by driving the cotter. The Intermediate Chair was intended to hold the rail without the use of a key; the two jaws were of the same form, both fitting up close to the head of the rail, but they were placed obliquely instead of opposite to each other; the chair was slipped endwise on to the rail and then twisted at right angles to the rail, which made it grip the rail between the two oblique jaws. The chair was forced tight against the rail, either by screwed spikes with conical heads and eccentric countersink holes in the chair, which forced the chair further round and increased the pressure of the jaws on the rail when the conical head of each screw was drawn home into the countersink; or another plan for doing the same thing was by using square spikes tapered to a greater breadth at the upper part when they passed through the chair, so that by driving them down the chair was forced further round against the rail.

An estimate was presented of the comparative expense of laying a railway on the above plan and on the ordinary plan, and the following were the respective amounts stated in it,—the amount in each case being only the cost of the chairs, keys, and spikes, as the rest would be the same in each case:—

	£
The cost for a mile of single way, laid on the ordinary plan, with wood keys and iron spikes	348
The cost for a mile of single way, laid on the above plan, with square taper spikes	340
The same, with screwed spikes	363

but the square taper spikes were considered equally efficient, and they were more convenient than the screwed spikes for drawing out in repairs, &c., as well as less expensive.

Mr. Baines in answer to questions from the President said, the only trial that had yet been made of them was a short length of line at the entrance of Norwich Station, which had been at work with these chairs for eleven months with complete success, and had not required any repair of the chairs. It was situated where all the trains ran over in entering the station.

A trial of the joint and intermediate chairs would be made shortly on the main line of the North Staffordshire Railway at Danes Moss, near Burton. In the trial already made of them at Norwich, there had not been any looseness of the keys of the joint chairs, and they remained just the same as when first put down. He had made a trial of the joint chair by removing the whole of the ballast away from under the joint sleeper, and the joint chair held the rail ends so firmly, that scarcely any deflection could be perceived when an engine passed over. He thought these chairs would do away with the canting of the joint sleepers, and would prevent a great deal of the noise in passing over the joints.

Mr. M'Connell suggested that it would be preferable to make the dowel-pin with rounded edges, and the notches in the rail ends similarly rounded at the bottom, for the purpose of preventing any risk of the rails splitting from the angles of the notch.

Mr. Baines said, he did not see any objection to the proposal; but he thought there was not any risk of the rails splitting from the notch, because a clearance of ¼-inch was left between the dowel-pin and the top of the notch, so as to prevent any pressure ever coming upon the dowel-pin. The joint chair formed a coupling between the rail ends, and the rails supported one another.

The President observed, that if this joint chair stood the test of the working on a main line, it would be the thing desired, but he feared there were too many parts about it to stand well. He considered the construction of some secure fastening for railway chairs was of the last importance for railways, and thought the subject well deserving the attention of the members; it was desirable to have as few parts as possible, and those not very costly.

Mr. Woodhouse asked how it was intended to replace a chair becoming loose or breaking,—whether the rail would have to be taken out for the purpose?

Mr. Baines said, he proposed having some chairs cast wider in the jaws, which would allow them to be slipped on the rail from the underside, for the purpose of replacing any broken chairs without taking out the rail. But he fully expected there would be very little breakage of the chairs, because there were no keys driven into them, and a great proportion of the breakage of the ordinary chairs was caused by driving the keys; also the new chairs were made stronger than usual. He had tried one of the intermediate chairs by suspending it from one of the jaws, and hanging a weight of 10¼ tons from the other jaw for several weeks, and there was no failure in it.

Mr. Baines next explained the Switch, the principal improvement in it being the additional depth of the switch tongue, which was made about an inch deeper than the main rail, and the bottom flanch of the switch tongue worked under the main rail when the switch was shut; for the purpose of driving under the main rail all the dirt that got between them in the working of the switch, instead of driving the dirt against the main rail, which was an evil in the ordinary switches where the rails were all of the same depth, and caused the risk of accident by the switch being prevented from closing properly. Another advantage obtained from this construction was, that the bottom flanch of the switch was kept entire to the end, instead of being planed off on one side, as in the ordinary switches, and that increased the steadiness and strength of the switch tongue.

The President remarked, that the switch tongue was chamfered equally on both sides.

Mr. Baines explained that the tongue was formed according to Mr. Wild's plan, with the point dropping under the head of the main rail; and the tongue was shaped exactly the same on both sides, so that the switch could be used either right or left handed.

STEPHENSON'S EXPRESS ENGINE.

A Paper was read, accompanied by drawings, "*Descriptive of an Express Engine,*" manufactured by Messrs. Robert Stephenson and Co, for the York, Newcastle, and Berwick Railway, in 1848, and intended to run express trains between Newcastle and York, a distance of 83 miles, as soon as the relaying of the line is completed which is now in progress. It was intended to have tried a series of experiments on the working of this engine, and to have accompanied the present paper with the results of the experiments, but these have been unavoidably postponed in consequence of the relaying of the line; the engine is at present running between York and Darlington, and is working satisfactorily, with a small consumption of fuel.

The engine has inside cylinders with a crank axle; and six wheels, inside bearings for the crank axle, and outside bearings for the leading and trailing axles. The cylinders are 16 inches diameter, and 20 inches length of stroke. The valves are vertical, and are placed on the outer side of each cylinder, instead of the inner side; the exhaust passages are carried under the cylinders, and unite at the blast-pipe. The steam ports are 1¼ inches wide by 13 long, and the exhaust ports 2¼ inches by 13 inches; the traverse of the slide-valves is 4½ inches. The eccentrics are fixed on the ends of the crank-axle outside of the wheels, and the valves are worked by the expansion link motion. The pumps are worked by the same ecccentrics, and are fixed at the sides of the fire-box. The boiler is 3 ft. 10 in. diameter, and 11 feet in length, containing 174 tubes of 1⅞ inches outside diameter, and 11 ft 5 inches length. The inside fire-box is 3 ft. 9 in. long, by 3 ft. 8 in. wide, and 4 ft. 9 in. high from the top of the fire-bars to the underside of the roof.

The Heating surface in the Fire-Box is	82	square feet
Ditto ditto Tubes	964	„
Total Heating Surface	1046	„

The driving-wheels are 6 ft. 6 in. diameter, and the leading and trailing wheels are 3 ft. 9 in. diameter. The outside and inside framing consists each of a single flat wrought iron plate 1 inch thick and 8 inches deep; the inside frame is bolted to a flanch upon the cylinder and to a bracket on the fire-box; the outside frame is bolted to a flanch upon the steam-chest, which is in one casting with the cylinder, and is attached to the boiler by three wrought-iron brackets on each side. The weight of the engine in working trim is about 22 tons.

The President observed that this engine did not differ materially from the ordinary express engines, except that the steam chests were brought outside and the eccentrics placed outside the driving-wheels. He might state that he had seen the engine, and the consumption of coke including getting up the steam was 18 lb. per mile with the express trains, which were generally very small, having only three or four carriages.

INSTITUTION OF CIVIL ENGINEERS.

May 1, *and* 8.—Joshua Field, Esq., President, in the Chair.

The discussion on Mr. Crampton's paper, "*On the Construction of Locomotive Engines*" (given in last month's *Journal*), was continued through both these evenings. The same tone of argument was kept up, and numerous instances were adduced supporting the views of both sides; but without arriving at any definite result, other than that it was desirable in all engines to lower the centre of gravity, in order to establish a greater angle of stability, and to arrive at a ratio between the circumference of the driving-wheel and the cubic content of the cylinders: such as whilst the greatest speed might be maintained with an economical consumption of fuel, every facility should be afforded for starting rapidly, which was a point of importance on lines running frequent trains. On the one hand it was argued, that small driving wheels were essential for quick starting; and on the other hand it was contended, that with a given amount of evaporating surface in the boiler, the tractive power would be the same under all circumstances at the periphery of the driving-wheel, provided a given relative proportion existed between the cubic content of the cylinder and the circumference of the driving-wheel, and that large wheels reduced the wear and tear.

The long disposed of question of the stability of the long boiler engines was again cursorily touched on and disposed of.

The diminution of the wear and tear of the sides of the brasses of the engines, having the driving-wheels behind, and the greatest weight upon the extremities, leaving a comparatively light load on the centre wheels, was adduced as a proof of their stability, an engine of that kind having run twenty-five thousand miles without any appreciable lateral wear; whereas an ordinary engine on the same railway, had worn away a thickness of a quarter of an inch whilst running the same distance.

A paper was read, describing *"A kind of Permanent Way, which had been somewhat extensively laid down on the Lancashire and Yorkshire and other Railways, in the north of England."* By Mr. HAWKSHAW, M. Inst. C.E.

The principle was that of a bridge rail, weighing seventy-five pounds per yard, placed upon continuous longitudinal timber bearing, and the novelty consisted in having at each joint a malleable iron plate chair, with a projection on the upper surface, fitting within the interior of the rail, and the flanches, which were fourteen inches long by eight inches wide, and half-an-inch in thickness, attached to the rail by rivets in such a manner as to fix them firmly together, and yet to allow for the expansion and contraction caused by the variations of temperature. The details of the arrangement were very simple and complete, and it appeared to succeed perfectly, as in an extent of twenty miles of railway so laid, over which numerous heavy trains had ran daily, at considerable speed, for the last year, only three rivet-beads were found to have been knocked off when recently examined.

May 15.—The discussion on Mr. HAWKSHAW'S paper was continued throughout this evening.

Some interesting observations were made on the actual destruction of the cast-iron chairs and double-headed rails, and the advantages that would result from the more general substitution of continuous longitudinal timber bearings for the present transverse sleepers and cast-iron chairs. The gradual ameliorations that had taken place in the forms and strengths of the bridge rails and their various fastenings were discussed; and it was contended that the hollow bridge rail was more durable than any other, that the upper surface was more compressed in rolling, and that the system of connecting the end, whether by rivetting to a plate, or by bolts and nuts, made a better and more even joint, and therefore produced a more level surface for the engines and carriages to run upon. The duration of the timber was declared to be such, that a second set of bridge rails had been laid down on the longitudinal timbers, whereas the cross sleepers had never been able to bear that. This, however, it was asserted, arose principally from common timber being used for the transverse sleepers, whilst the best kind, well creosoted, was used for the longitudinal bearers.

The systems of inserting a piece of hard wood between the rail and the main timber, as on the Great Western Railway, was much approved, as was also the plan of side transoms halved into the main timbers, as it enabled a better system of drainage to be employed than had been usual with that kind of permanent way.

The new systems tried by Mr. Samuels on the Eastern Counties Railway, and of which several models were exhibited and described, received much commendation, particularly the plan for dispensing with the joint chairs and uniting the ends of the rails by two side pieces, or fishes, of cast-iron, bolted through and to each other, so as to render that part quite equal in strength to the body of the rail. The question of the means of allowing for the contraction and expansion of a line of securely-fastened rails was discussed, as was the creeping or advancing motion of rails in the direction of the traffic.

The general opinion seemed to be decidedly in favour of the longitudinal bearing, although it was admitted that many of the transverse-sleeper railways—for instance, such as had been laid on the plans of Cubitt and of Hawkshaw—were so good that it was not to be presumed they would be removed to make way for the longitudinal system.

May 22.—Mr. FIELD, the President of the Institution, held his Annual Conversazione on Tuesday evening, May 22nd, at the rooms of the Institution. The President was well supported in doing the honours of the evening by the vice-presidents and members of council, and by Mr. C. Manby, the secretary, whose general arrangements, and selection and distribution of the works of art and the models, claim the highest praise.

From such a large collection we can only particularise a few, and we must give the place of honour to the works of art. On the walls were the portraits of the celebrated engineers, Locke, Brunel, Fairbairn, and Mr. Isambard Brunel, by Grant, Hornby, and Patten. Around the walls and on the tables were beautiful specimens of the pencils of Etty, Haghe, Lee, Fahey, Scanlan, Pitt, Wood, Boxall, Richmond, Jutsum, Forrester, and many others.

Mr. Thomas contributed a beautiful marble chimney-piece, intended for Mr. Peto, and a statuette of Ariel commanding the storm. Mr. Behnes, also sent an excellent bust of Mr. C. Barry. Mr. Deighton's model of the Kneller Hall Training School was an excellent specimen of Mr. Mair's architectural skill and taste. Among the principal of Salter's models were, Mr. Fowler's New Holland Pier, and his Girder Bridge over the Trent; Mr. Jee's Dinting Vale Viaduct; Captain Moorsom's Viaduct on the Waterford Railway; Mr. G. Edwards' Bridge over the Waveney; Mr. Grainger's Bridge over the Calder; Mr. Stephenson's Tubular Bridge over the Menai Straits; and of the Bishop's Rock Pile Lighthouse, erecting in a most perilous position, by Messrs. Walten and Burges. Cochrane's Sawing-Machine excited great attention; as did Gordon's Cata-Dioptric arrangement, and Wilkins's Fourth Order Dioptric Light Apparatus.

The Earl of Rosse contributed the model of his magnificent Telescope, as did Mr. Cowper those of his own, Mr. Lassels's, and Mr. Nasmyth's method of mounting Equatorial instruments.

The Electric Telegraph Company had a fine collection of working instruments, and Messrs. Brett and Little contributed a series of theirs.

Mr. Strode's self-igniting gas burner, and Mr. Biddell's self-regulating gas-burner, were both much admired.

Messrs. Adams exhibited a complete series of improvements in railway carriages, permanent way, &c.; and Messrs. Johnson and Cammell an equally complete assortment of steel springs, files, &c.

Mr. Roberts had a beautiful collection of models and working instruments, exhibiting his usual talent of invention and beauty of execution.

Messrs. Mitchell had a series of models of the various applications and mode of using the screw-pile and mooring. Very complete models were also shown, by Mr. Woods, of Clements' sugar-refinery, and of a rotative dynamometer.

Messrs. James Wall and Co., sent two curious models of an engine with an oscillating cylinder, made by Murdock in 1785, and of a locomotive engine, by the same ingenious man, prior to 1784.

Messrs. Ransome and May exhibited some shavings of cast-iron, cut by tools of immense power, from railway wheels.

Messrs. Maudslay sent a model of a large gun, intended to be loaded and sponged by the breech; and a method of feathering paddles.

Messrs. Seaward and Co., contributed a series of models of plans for raising stern propellers; and Messrs Chubb also sent a beautiful specimen of an iron chest, very superior in workmanship and design.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

April 30.—T. BELLAMY, Esq., V.P., in the Chair.

The first part of a paper by Mr. J. W. PAPWORTH, *"On some Features of the Connection between the Architecture and Chronology of Egypt, with an account of a work by* M. J. B. Le Sueur, *'On the Chronology of Egypt illustrated by its Monuments'—to which the medal of the Institute of France was awarded in* 1847"—was read.

Recalling the traditionary origin and the literary, philosophical, and religious obligations of the Greeks to Egypt, the author proposed to consider the debt of architecture owing to the Greek translation of Egyptian skill:—for this purpose the first step would be to consider how the dates of monuments generally were fixed; next the monuments themselves would be described and dated; then their characteristic features could be placed in tables, from which his deductions would be drawn. He took as his text the opinions of Barry and of Jomard, "that the monuments alluded to are of very remote antiquity, or during the most flourishing period of the arts in Egypt; the general resemblance of the fluted columns to those of the Grecian-Doric order is manifest; and, in addition to many other remarkable indications in the Egyptian temple, clearly point to Egypt as the source of both Greek and Roman architecture." Slightly running through the stages of discovery and arrangement, the author mentioned Mr. Wathen's book as one in which his forthcoming deductions were most decidedly contemned; and adding a notice of the scope and value of Mr. Sharpe's last work, proceeded to give some account of the great work of Le Sueur, beautifully printed with *moveable hieroglyphic type*—the first, and a splendid first, child of the Republican Government Printing-Office. It contains, above all other matters, the interesting translation and adaptation of the great chronologic Canon of the Museum of Turin, in hieratic writing, formerly of very considerable extent,—and which, if perfect, might have set at rest the *quæstio vexata* of Manetho's Dynasties, for it is not divided into such portions, but into eras.

The dates of Le Sueur, which give 5000 B.C. to the pyramid builders, appear extraordinary to those who with many English *savans* consider that 1800 is quite remote enough. In accordance with the more moderate dates, a table was exhibited which showed the succession of the kings about to be named; and the author proceeded to show that the monumental history of his art on one hand proved the table,—while the table, on the other, accounted for the works. The Proto-Doric theory of Champollion, supported by Jomard, Rosellini, and Wilkinson, was mentioned as having incurred much ridicule; and the theory of Lepsius, as to an Asiatic influence on Egyptian art, was disowned by the author,—who proceeded, on the statements subsequently made by Lepsius, to divide Egyptian architecture into at least four classes or orders systematically arranged; the third and fourth, being imitative of nature, formed one division,—while the other was composed of the first and second classes, illustrated by dated examples (from Ghizeh, Karnak, and Quorneh for one period of art, and from Benihassan, Karnak, Dair el Bahri, Medinet Aboo, Eleutbyias, Kalabshe, Amada, and Samneh), whence the peculiar and geometric characteristics of the first division were drawn and put into juxtaposition.

A discussion on this part of the paper being very probable, Mr. Papworth was interrupted by the Chairman with a request to reserve the remainder of his paper, which was nearly concluded, for another evening, so that the discussion might have a sufficient period allowed to it. Messrs. Donaldson and Tite made some remarks to the same effect;—and the meeting adjourned to the 21st of May.

May 7.—This was the annual general meeting, and the following office-bearers were elected for the ensuing year:—*President:* Earl de Grey; *Vice-Presidents:* T. Bellamy, A. Salvin, and S. Smirke; *Honorary Secretaries:* T. L. Donaldson and J. J. Scoles; *Council:* W. J. Donthorn, H. E. Kendall, G. Mair, C. Mayhew, A. Mee, D. Mocatta, C. C. Nelson, C. Parker, F. C. Penrose, and T. H. Wyatt; *Treasurer:* Sir W. R. Farquhar, Bart.

May 21.—Mr. J. W. Papworth read the concluding portion of his paper commenced as above. He dwelt at some length on the progressive development of the features of the third and fourth classes of his system; which he illustrated by dated examples from Karnak, Ghijeh, Beni Hassan, the column in the British Museum, Luxor, and Elephantis for one period of art; and from Philæ, Esneh, Dendera, Ombos, and Edfou; whence the peculiar and *imitative* characteristics of the second division were drawn and put into juxtaposition. In summing up all the above, the author considered tha the had made it appear that two great epochs were established with certainty for Egyptian architecture, as well as for its political history,—each having its particular style: the first which arose from *rock-cut constructions*, and imitated also in monuments above ground; this style flourished in the old Pharaonic reigns before the Hyksos invasions, renewed itself probably under the seventeenth, and shows its last efforts under the eighteenth dynasty—under which, and at the commencement of the glorious period of Egyptian supremacy must be placed that great change which operated probably not only upon architecture, but on all the arts and on the entire civilisation of the people. Then was seen a new style of architecture; which, however, had its birth anteriorly, and by the side of the former style, embracing and developing the *principle of vegetation in its columns*, imitating in every point organic nature, and decorating them with allegoric ornaments.

Mr. Papworth afterwards read a supplemental paper, being a translation of the views of Lepsius "On the Relation of the later Egyptian Order to the Greek Column."

SOCIETY OF ARTS, LONDON.

May 9.—W. Tooke, Esq., F.R.S., V.P., in the Chair.

Mr. D. Wyatt, architect, read a paper "*On Metal Work and its Artistic Design.*"—He commenced with some remarks on the absolute necessity of the study of *specific design*, in order to confine the errant imaginations of artists within reasonable bounds, and in order fully to take advantage of all the natural properties, mechanical capabilities, and recorded experiences peculiarly belonging to all materials, in the elaboration of which it is requisite that an alliance between use and beauty may be effected. The author maintained that all propriety and perfection in manufacturing design were derivable from the result of such studies, and that the more clearly the objective individuality of every ingredient was preserved and enunciated in the finished article, the more satisfactory to both eye and mind would the character of its ornamentation appear.

The *specific design* of metal work was described as based on three great studies, a thorough knowledge of which was requisite to all who would either manufacture, compose, or criticise in any one of its various ramifications. The first of these was that of the distinctive characteristics and appliances of each metal. The second, its form as modified by all the mechanical processes of manufacture. The third, a thorough analytical and critical acquaintance with the best models in which reasonable and good proof of art can be traced, and through modifications of which pleasing associations of idea may be commanded at the will of the designer.

In accordance with his scheme thus laid down, the author proceeded to deduce the correct theory of the manufacture of each metal, from the properties with which it had been endowed by nature. He then described at considerable length the process by which almost all objects in metal must be produced, dwelling on those best harmonizing with the character of each substance, and the accredited conventionality of its use. Thus he emphasized the refining, beating into sheets, wire-drawing, stamping and torsion of gold, the beating in a plate, gilding, dead silvering, parcel gilding, soldering, &c. of silver, the hollow casting of bronze by means of wax and of moulds, and the solid founding of iron in complex forms. Having disposed of the structural processes, the author analysed the decorative or superficial; enumerating the leading peculiarities of engraving—matting, niello, cooking, burnishing; the six chief divisions of enamel, and three or four varieties of damaskeening. The mechanical limits of the art being thus pointed out, the impressions suggested by the history of past *chefs-d'œuvre* were cursorily examined. The great antiquity of metal work, and its details, among the Jews, Egyptians, Assyrians, Persians, Greeks, Etrurians, and Romans, was demonstrated from descriptions furnished by various authors and by monuments of wonderful merit still existing. The speaker passed quickly over the mediæval portion of the subject; and concluded by calling attention to the beautiful examples by which he was surrounded, and urging a systematic recognition of first principles and practical details to be superadded to the study of Beauty and Fine Art in the abstract.

May 16.—Mr. F. Whishaw read a paper "*On the Importance of thorough Ventilation in Collieries,*" by Mr. Edgington, the latter gentleman explaining, by diagrams on the walls, the various details.

After alluding to the vast importance of the subject, and the interest which was at the present moment drawn towards it, the writer explained the nature of fire-damp, or carburetted-hydrogen gas, which was continually more or less being given out in coal mines; and the several details of various analyses which had been taken, all productive of different results, each producing more or less of the light olefiant gas, hydrocarbon, &c. These analyses were taken after treating the gases with caustic, potash, &c., to free them from carbonic acid, which the writer regretted, as it would have been desirable to ascertain what quantity of carbonic acid fire-damp in its native state contained. The blue flickering flame seen towards the roofs of fiery mines arose from the presence of the bi-hydrate of carbon. He was aware that some of the first chemists of the age approved of the use of wire gauze as a preventive of the flame coming in contact with the outer atmosphere; but he considered the safety of such a lamp very questionable, particularly when affected by blowers, and when the interstices or meshes of the wire gauze became clogged with the fine particles of carbonaceous matter floating about in all mines, when it caught fire and formed a conductor to the outer explosive atmosphere, and from these circumstances he did not think it entitled to the proud title of *safety lamp*. What he meant by perfect ventilation was not a system aided by air-pumps, fan-blowers, high-pressure steam, or other artificial means; he wished to see a system by which a safety-lamp was not required, and the men might work securely by candles, and he believed it possible to adopt such a system of natural ventilation round the face of the workings where the men were at work. Under the present system, when an accumulation of fire-damp took place along an unbroken wall at the back of the goaf, and exploded, the men are thrown towards the open work, and their destruction is certain. The changes continually taking place in the atmosphere of a mine are not noticed, as the men, being intent on their work, cannot be always on the watch.

Mr. Edgington then proceeded to describe his plan of ventilation, for which purpose he referred to several diagrams, and a plan of Haswell Colliery. It will, of course, be impossible to follow the explanation in the absence of these; but the general plan recommended appeared to be with two shafts, a down-cast and an up-cast; space should be left to ventilate the back roads, and thus all gases set free will be immediately carried from the men. The air is to be so split that one-half should ventilate the goaf and the other half the coal face. There should be as many streams as there were stalls; and in these, when practical, the air should be returned. Mr. Edgington then further described his new plans of cutting headings from the roads to carry away the gas and air to the up-cast shaft, and connecting all the high levels together to drain the roofs. His system could be carried out in all existing workings, and the expense would be comparatively little or nothing, in proportion to the good effected, as naked candles might be used, and the collier pursue his work in perfect safety. He said the greatest evil at present in existence in the northern collieries was the want of any regulated arrangement in the ground works. In the Haswell Colliery (where, in the last explosion, 75 lives were lost), for want of this arrangement, there were no less than twenty-two current or divisions of air passing in all directions, and counteracting each other. Under the new system, on removing the walls, the currents of air should be reversed, and the safety of the mine would be continued. He also explained how, in cases of fallen roof, by cutting the end of the roadway up to a level with the roof or cutting a way diagonally down to the roadway, the current of the air and the gas would be continued uninterruptedly.

ROYAL SCOTTISH SOCIETY OF ARTS.

April 9.—George Lees, A.M., V.P., in the Chair.

The following communications were made:—

"*Account of a Binocular Camera, and of a method of obtaining Drawings of Full Length or Colossal Statues, and of Living Bodies, which can be exhibited as solids by the Stereoscope.*" By Sir David Brewster, F.R.S.

In this paper the author pointed out the changes which take place in the visual representation of bodies of three dimensions, such as statues, buildings, and living bodies, when they are viewed at different distances by one or both eyes, or when reduced copies of statues are viewed in a similar manner. He showed that full length and colossal statues, as works of art, are not so perfectly seen as reduced copies of them, and that there is *cæteris paribus* a certain ratio between the distance of the eyes and the magnitude of a body of three dimensions, when its visual form is best developed. The author then described a Binocular Camera, and explained a method of obtaining by its means such dissimilar drawings on a plane of full length, and colossal statues and living bodies, as will give the best representations of them in relief when united by the stereoscope. The Binocular Camera described by the author is composed of two semi-lenses, obtained by bisecting an achromatic lens. These semi-lenses are placed at the distance of the two eyes, or at such multiples of that distance as may be necessary to take dissimilar drawings of full-sized or colossal statues, for the purpose of reproducing the statue in the stereoscope. The author described and explained a method by which statues of all sizes, and living bodies, may be reproduced, as it were, and exhibited in three dimensions; and he pointed out the great advantage which the sculptor would derive from the possession of dissimilar drawings of works of art, and from the study of them when viewed in their true relief in the stereoscope. A Microscopic Stereoscope, with several curious diagrams, was exhibited, and, in particular, the effect of dissimilar drawings, made by the Binocular Camera, of Danneker's statue of Ariadne on the Leopard, when united in the stereoscope. The united image stood out in high relief as in the original statue.

"*Sequel to his Description of a Revolving Valve for Locomotive and other Steam-Engines.*" By John Anderson, Esq.

A description of this valve was read to the Society in 1846. The valve has a rotary in place of a reciprocating motion, and Mr. Anderson considers it much more suitable for locomotive steam-engines than the common valves.

"*On Improvements in the Roofs and Glazing of Conservatories and Hot-houses, with a Drawing.*" By Mr. William Cooper.

In this paper the author remarks that the Romans glazed their hothouses with a transparent substance, called *lapis specularis*, a fossil of the class of "talcs," with which they were chiefly supplied from the Island of Cyprus, and which is used to this day by lanthorn-makers; and so good a substitute is it said to have been, that the Emperor Tiberius had cucumbers at his table throughout the whole year. The author gives a description of the magnificent conservatory at Chatsworth, constructed by Decimus Burton, Esq., architect, London, for his Grace the Duke of Devonshire, at a cost of 32,000*l.*, and containing 70,000 superficial feet of glass; and such is its extent, and convenient arrangement, that three or four carriages have been driven in it at one time. Instead of wooden sash-bars, the author recommends wrought-iron bars, galvanised, which are by far the best and cheapest in the end, inasmuch as they require no painting, and are not subject to decay, the galvanised iron being an effectual remedy against the action of oxygen. The expense of copper bars of sufficient strength to bear a great weight of glass (especially during a hurricane, which has been proved to press at a weight of 50 lb. per superficial inch) entirely precludes its use for conservatories; besides, copper for this purpose is otherwise objectionable, because every drop of water containing oxide of copper carries death to the plants. Glass is now very cheap, and, instead of using panes of glass six inches square, as formerly, puttied close at the joinings, and which causes a drop of water arising from the condensed vapour, and which is injurious to the plants; the author recommends sheet glass from 30 to 60 inches long, and from 6 to 9 inches wide, cut to an elliptic form at the ends and overlapped, and to allow one half-inch of an opening at each joining, exactly at the centre of the elliptic, puttying the remainder across in the usual way, thus allowing breathing room to the plants, and the escape of the superabundant carbonic gas emitted from them. The author exhibited two drawings of conservatories of moderate dimensions, constructed on the most improved principles, with central coned roofs; the bend of the glass forming an arch, more effectually resists a storm. The air is heated by means of tanks and hot-water pipes, being the nearest approximation of artificial to natural heat. The best stones for pavement are found on the estate of Lindsay Carnegie, Esq., of Kinblethmont, near Arbroath. Glass ventilators are used instead of the old method of ventilation by raising the sashes, which is attended with risk and inconvenience, and often with serious injury to the plants. For some purposes, and for angular roofs attached to garden walls, the author recommends the use of rough plate glass ¼ or ⅜ inch thick, on account of its cheapness and durability.

"*Description of a Saw-Mill, intended for Colonial use where Metal is scarce and Wood abundant.*" By Mr. William Reid Douglas.

It was stated that this perpendicular saw-mill is particularly adapted for colonial purposes, owing to the small quantity of metal required in its construction—that it is also much simpler and less expensive in its construction than the ones in general use, and is adapted to saw either round or square timber. The motion is communicated to a shaft, on the one end of which is fixed a fly-wheel, on the other a crank communicating the motion to the working beam, the other end of which is attached to the under part of the saw-frame; on the same shaft is fixed an eccentric, which works a catch on a small ratchet wheel fixed on the end of a wooden roller, on which the rope winds as it draws forward the slide bench, the motion of which can be retarded by the application of pulleys, if required.

"*A Machine for Cutting down Standing Timber, capable of being used by one man.*" By Mr. George D. Howell

The machine is intended to be useful where labour is scarce. The saw being fixed in a frame, admits of one power pressing each way alternately. The body of the machine is so constructed that it may be taken to pieces, and rendered portable.

"*An Improved Glazier's Machine.*" By Mr. George D. Howell.

This glazing machine, by being secured by the screw underneath, was stated to be less liable to shift, or to jolt, or be unsteady, as when secured with the pins in present use: and by having the cross-bar padded, secures the paint inside from injury by friction. The common machine, it was stated, could be altered to this plan, with comparatively little expense.

ON BOILER CRUST

Mr. William West, of Leeds, lately read the following paper before the West Riding Geological and Polytechnic Society, "*On the Component Parts of the Crust or Fur in Boilers*":—"It has been common to speak of bicarbonate of lime, or carbonate of lime dissolved in water by excess of carbonic acid, according to the opinions on a theoretical point of authors describing the same substance, as yielding the crust, or 'fur,' of steam boilers; and either to deny or overlook the share which *sulphate* of lime has in the formation of this troublesome deposit. Among those who have gone so far as to deny the existence, or, at least, the practical importance, of sulphate of lime in these crusts, is Dr. Ritterbandt, the proprietor of a very ingenious, and, I believe, in some situations, a very effectual patent method for preventing incrustations of the carbonate, by introducing chloride of ammonium into the boiler. At that temperature carbonate of ammonia is driven off, and the highly soluble chloride of calcium remains, in place of insoluble carbonate of lime. I have, however, so often found in these crusts not merely a notable, but a considerable, portion of sulphate of lime, that I have on different occasions, when my subject required, called attention to its presence, and expressed an opinion, which I have found much to confirm, that it is even more troublesome and mischievous than the carbonate alone. The specimen now treated of was formed, under somewhat peculiar circumstances, in a low-pressure boiler. It contains not a trace of carbonate, yields not a bubble of effervescence with acids, and a portion dissolved in a large quantity of water yields, with chloride of barium, a quantity of sulphate of barytes, closely equivalent to what it would furnish if pure anhydrous sulphate of lime. It contains a little oxide of iron. It is not the curious salt discovered by Professor Johnstone, containing half an atom of water to each atom of sulphate of lime; for ten grains, finely powdered, lost by exposure to a red heat only three-tenths of a grain—less than a quarter of an atom of water, and, therefore, hygrometric or accidental; and the sulphate is essentially anhydrous. The deposition of sulphate of lime from a solution, far below saturation, takes place in the manner which I described some years ago, in the Journal of the Royal Institution. As each bubble of steam is disengaged during brisk ebullition, the sulphate of lime, of course, separates; for its re-solution time would be required, but before that can take place many other particles are separated, and these rapidly cohere into portions large enough to subside and to resist yet more the solvent power of the water. I have elsewhere, and on other occasions, stated my belief that though gypsum, in its hydrous and ordinary crystals, is a softer mineral than calc spar, yet that boiler crusts containing much sulphate of lime are harder than those composed wholly or chiefly of carbonate. The present specimen curiously confirms this opinion. I am assured by the workmen that not only was it with difficulty removed by the tools usually employed for such purposes, but that even the 'sate,' or hard chisel, used for cutting cold iron, is sometimes broken or turned by this crust."

BRUNTON'S NEW COLLIERY VENTILATOR.

At Gelly Gaer Colliery, a ventilator upon an entirely new construction, invented by Mr. Brunton, has been erected under his superintendence, for the special purpose of testing its power of rarefaction. On Friday the 4th ult., Thomas Powell, Esq., of the Gaer, proprietor of the colliery, together with several practical and scientific gentlemen, attended to see the machine put to work, and to ascertain its capability.

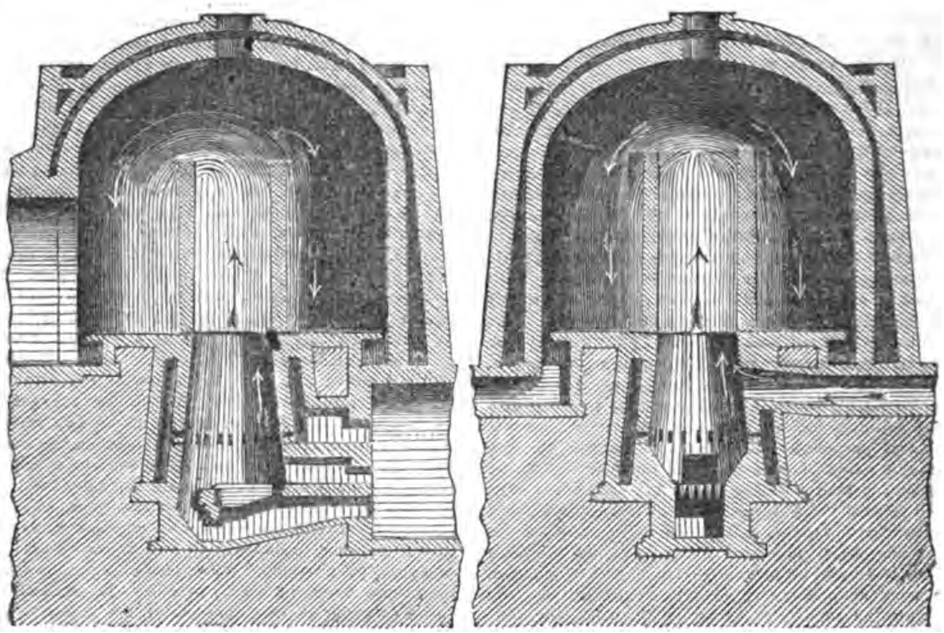
The machine is applied to the top of the upcast pit by a short tunnel or air-course, and is driven by a steam-engine. By the principles of this machine, the air is subjected to the influence of centrifugal force, whereby any degree of rarefaction necessary to the complete ventilation of a colliery may be attained with the greatest economy of power. The rarefaction produced was indicated by a water gauge; and being carefully noted and compared with the velocity of the machine, was found most satisfactorily to correspond with theoretical deductions. The rarefaction maintained in the upcast pit being equal to 2½ inches of water, or 13 lb. on the square foot, of course produced a strong current through the workings of the colliery, one of the air-ways of which, 20 yards long, has a mean area of 9½ superficial feet; yet such was the power of the machine, that 18,000 cubic feet per minute were propelled through this passage at a velocity of 32 feet per second, and afterwards in its way to the upcast pit, through an opening of only 4 superficial feet area, at a velocity of 70 feet per second, exhibiting a degree of rarefaction and power of propulsion (the chief objects of the experiment) to the entire satisfaction of all the gentlemen present. The quantity of air was measured carefully in its passage through one of the levels 6 feet square, where it travelled 20 yards in 7 seconds.

The mechanism of the machine is of the most simple and integral character; has no valves or separate moving parts; has no attrition, and all the friction is resolved into a foot pivot moving in oil. When at rest, offers no impediment to the air ascending from the pit,—liable to no derangement, and is very inexpensive: in short, it is a simple mechanical implement, whereby any degree of rarefaction necessary to ventilation is rendered certain, regular, and under visible inspection, being subject to the law of central forces, which is as fixed and determinate as that by which a stone falls to the earth.

On the following day a very important experiment was made by stopping the influx of air from the down-cast shaft, and in less than five minutes the whole of the colliery was thus artificially subjected to a rarefaction equal to, and in its effect upon the gas in the coal corresponding with, a sudden fall of the barometrical column of about two-tenths of an inch of mercury, and this may be greatly increased.

To this capability of drawing off at pleasure the carburetted hydrogen from the goafs and fissures, during the absence of the workmen and their lights, and the re-introduction of fresh air before the men resume their work, when the colliery will be found in a state of extraordinary purity of atmosphere, the inventor looks with great confidence as the most effectual means of preventing fire-damps, and also of promoting the health of the workmen. Mr. Calvert, a large coal proprietor, one of the gentlemen present, was so satisfied with the utility of the machine, having been underground during its operation, that he has since given Mr. Brunton an order for one to be fixed at his colliery immediately. We congratulate Mr. Powell on being the first to introduce so valuable an invention—the adoption of which, we trust, will be the means of saving the lives of many of our colliers.

PATENT BRICK AND TILE KILNS.



These kilns are introduced by the Ainslie Brick and Tile Machine Company, for burning bricks, tiles, and pottery ware, and are constructed on an entirely new principle, viz.:—that of burning *downwards*, in place of upwards, in a close kiln, and of applying the surplus heat of the burning kiln, which is now lost, to the complete drying and partial burning of the goods in the series of kilns in connection. Their superiority to ordinary kilns consists—

First—in a saving of fuel of more than three-fourths. The amount of fuel consumed in burning goods made from clay varies materially, according to the nature of the clay. The clay at the experimental works of the above company, at Alperton, is the London clay, and is very strong. In a very good kiln there, of the old construction, the quantity of coals used in burning 45,000 pipes of 1¼ inch diameter, 12 inches in length, is about 11 tons: whereas, in one of the company's-patent kilns 25,000 of the same sized pipes, of the same clay, are burnt in a very superior manner with only 1 ton and 14 to 16 cwt. of coals; and in another of larger dimensions, more recently erected, 40,000 of the same sized pipes are burnt with only 2½ tons; and when the series of four is complete, the company entertain no doubt of being able to burn 25,000 of such pipes with one ton of coals, or less than 1 cwt. per 1000. The kilns are equally adapted for wood and peat fuel.

Second—The saving in time. In a kiln of the description commonly used, the firing must be kept up for three or four days, but in the patent kiln, it is only necessary to fire 26 to 28 hours.

Third—their superior efficiency. In the common kilns, the loss in breakage, and in over and underburnt goods, runs from 5 to 20 per cent., whereas, in the kiln here shown, there is no loss whatever.

Fourth—the great simplicity. For burning the old kiln, considerable skill and great experience are required, whereas, the patent kilns can be managed by the most inexperienced workman.

Fifth.—As the same heat is made to pass through a series of two, three, or four kilns in succession, the *last* of the series is used only for the purpose of *slow-drying*, and the goods are placed in the kiln as soon as they have acquired sufficient consistency to bear the superincumbent weight. The advantages of this arrangement are, that in fine weather the goods can be placed in the kiln *the first or second day after they are made;* in moist weather, in three or four days thereafter; and the operation of brick and tile making can thus be carried on throughout the whole year, with the exception of the time of frost,—in place of five or six months only, according to the old system; and an immense saving in the extent of drying sheds is also thus effected.

Sixth.—These kilns are so constructed as completely to consume their own smoke.

Seventh.—A single kiln on this principle can be used, but the saving is greater in using the series.

The kilns may be seen in use at the Tile Works at Alperton, near Acton, Middlesex.

ON THE SEWERAGE AND OTHER WORKS OF CHESTER.

A very able Report to the Town Council of the City and Borough of Chester, on the Sewerage and other works under the Improvement Act, has just been issued by Mr. Baylis, the Borough Surveyor, from which we make the following extracts.

The Report commences by showing that the mortality of Chester is at the rate of 1 out of 32·6 of the population; and that the unhealthy state of the city may be greatly attributed to the improper supply of water, pumped up from the river without filtering.

It next describes the present system of sewerage, and gives a tabular statement of the old sewers, and the length of new sewers required. The following table will show the proportions and the cost:—

Estimate for completing the system of Sewerage, including the Cross Drains, Traps, Gratings, &c.

Sewers	ft.	in.	ft.	in.	Length in yards.	Price.	£	s.
1 Class	3	6 by	2	8	495	22s.	544	10
2 "	3	8 "	2	6	231	20s.	231	0
3 "	2	9 "	2	3	858	18s.	772	4
4 "	2	7 "	2	0	1028	16s.	822	8
5 "	2	4 "	1	9	3454	14s.	2417	16
6 "	2	0 "	1	6	3773	12s.	2263	16
7 "	12 in diameter				2363	10s.	1181	10
							£8233	4

Sewerage.—Much difference of opinion exists as to the proper size for sewers for town drainage. The Metropolitan Commissioners recommend the tubular system, varying from 6 to 24 inches in diameter, with a double line of pipes, and in low districts converging towards a central well, from whence the sewage is to be pumped by a steam-engine, and forced to an outlet on the banks of the river. In the carrying out of this system, it was intended only to have them of the bare minimum capacity required for house drainage, and storm water was to find exit in any way it could.

The Metropolitan Commissioners also condemned the sewerage works of the City of London, and the Corporation in consequence called in Messrs. Walker, Cubitt, and Brunel, the eminent engineers, to examine and report upon them. The report repudiated the idea of reducing the size of the city sewers, generally approved of the system adopted there, and recommended the extension of it to undrained streets and a system of flushing. They further state that London is the best drained city in the world, and that it is in advance of, and has taught all other cities lessons in sewerage.

Manchester, I believe, is the only town that has taken the initiative from the sanitary reports, and generally introduced tubular sewers, which if more efficient than brick construction, are also much more costly, as will appear by the following table:—

Egg-shaped Tubular Sewers. In.		In.		Per Yard.		Egg-shaped Brick Sewers of the same capacity.	
12	by	9	at	4s. 6d.	————	2s. 6d.	per yard.
16	"	12	"	7s. 6d.	————	3s. 0d.	"
20	"	15	"	10s. 6d.	————	3s. 6d.	"
25	"	18	"	15s. 0d.	————	4s. 0d.	"
29	"	21	"	21s. 0d.	————	4s. 6d.	"
36	"	24	"	27s. 0d.	————	5s. 0d.	"

This is exclusive of excavation in both cases.

An ingenious gentleman, named Wilkinson, of Newcastle, has invented a material for sewers, which he states is composed of a cement made in a peculiar way, and which will increase in hardness with age; it possesses advantages over similar articles made of clay, as it does not warp or twist, and the inverts can be made in 12 feet lengths, and the smaller size pipes in 4 feet lengths, they have also loose covers, so that they can be readily examined at any time. The prices are as follows:—

2 inches bore	3d. per foot.	6 inches bore	11d. per foot.
3 "	4d. "	10 "	1s. 4d. "

Sewer in Blocks, 4 feet by 2 ft. 6 in., 8s. per foot.
Blocks for Inverts, 2s. per foot lineal.

The tubular system of sewers as a whole is not generally adapted for towns, it may suit small towns, or small collateral streets of large ones, but they have not yet been manufactured large enough to be suitable as main drains for the drainage of large areas.

The sizes of sewers must depend entirely upon the area to be drained and the fall or declivity to be obtained to the point of discharge, and at the same time, they should be large enough not only for house drainage, rain and stone water, but an allowance should be made for extraordinary storms. It has been the custom with all our eminent hydraulic engineers not to apportion their hydraulic or other works to the bare minimum duty they have to perform, but to make due allowance for any unforeseen contingencies.

This has been strongly confirmed by the report on the City of London above alluded to, in which it is stated that sewers should be large enough to admit a man for the purpose of repair or to remove deposit, and that the size for the main sewers should be 5 feet by 3 feet, and secondary sizes 3 feet by 2 feet. They further state that the air of small sewers is worse than large ones, and that no evil effect can be apprehended from well-constructed brick sewers with a good fall and well cleansed, and they act as under drains for the surrounding earth, which the entire substitution of earthenware pipes with tight joints, would practically prevent.

Sewers with an inclination of 1 in 250 will keep themselves clean, without the aid of flushing; but when the inclinations exceed that, a system of flushing is indispensable to prevent deposit. But I consider in every case an occasional cleansing of the sewers, where a current of water cannot be obtained to pass through them, beneficial, as it tends to sweeten and purify them, and is the means of removing the causes of noxious exhalations.

The form of sewer I have adopted is one approximating to the egg-shape (the true egg-form not having yet been correctly developed for sewerage purposes), the arch is semi-circular, and the invert a series of segments. It departs as little as possible from the strong and advantageous form of the circle, (which is the figure of greatest capacity with an equal circumference) while from placing the narrow end downwards, it concentrates the flow of the water over a smaller area, reduces the friction, and thereby adds materially to its capability of discharging fluids.

It is generally considered that the cylindrical is the strongest form that can be adopted for sewers; but there are other questions to be taken into calculation, as before stated, besides strength, viz., the best shape for the passage and discharge of fluids, and that is now generally admitted to be the egg shape.

I would strongly recommend for our future operations, the use of the Portland or lias cements for the inverts of our sewers, and blue lias lime for the arches, as no other material should be used than good hydraulic mortar in structures that are in any way exposed to the action of water, and where durability is desired.

The Portland and blue lias cement is cheaper than the Roman cement, as it will bear a greater proportion of sand, while its strength and durability is superior. Puzzolano or Terras are good hydraulic cements for sewers, though probably more expensive than those above stated. From experiments recently made, I find that smiths' ashes, or black oxide, adds very materially to the strength of hydraulic mortar, though it adds also a little to the expense. I think if arrangements could be made, it would be desirable to have the inverts of our sewers manufactured in blocks, say one foot or more wide, and two or three feet lengths, so as to have as few joints as possible in the inverts; and this might be further improved by having the interior surface glazed. I have made inquiries from various manufacturers, and they state there would be difficulty in making them. Again, it may be a question whether or not a smoother invert may be formed by rendering the interior surface of the brickwork over with cement, as is the practice of some eminent architects.

The same objection applies to the formation of the inverts of our sewers in the rock, as to the dry brickwork alluded to above—the sewage will be certain to percolate through the fissures in the rock. The inverts of sewers should invariably be made impervious to moisture.

Ventilation of Sewers.—Much of the offensive gas that now escapes from our sewers, might be prevented by trapping the openings effectually, and by connecting air-shafts or flues with the sewers, or the walls of the highest houses on the summit levels, so that the foul air may be sent in the atmosphere, and dispersed where it could not possibly be injurious or offensive. This is a plan I proposed two years ago, it is very simple in its nature, and would, I think, prove effective.*

In London they are trying experiments to burn the gases by placing fires on gratings over openings in the sewers made for that purpose; from which it is proposed, I believe, to carry large chimney shafts to convey away the smoke and effluvia: but this is an expensive operation.

Contracts.—I would again endeavour to impress upon you the importance of conducting our sewage works on a different principle than we have hitherto done. I would recommend the earthwork to be let by contract; the brickwork I would execute, and I would employ first-rate workmen, at good wages, for that purpose. The bricks, cement, and mortar, we should find ourselves; and the whole should be done under competent inspection.

At the present time it is necessary to have an inspector at the sewers, to see that the brickwork is executed properly by the contractor. This same person could superintend the bricklayer as well as he could the workmen of the contractor, and thereby save the contractor's profit, which amounts to considerably more than his wages would come to; besides, we should have more efficient work. Mr. Newlaud, the borough engineer of Liverpool, has adopted the plan, and approves of it. He calculates it saves from 25 to 30 per cent.

Gratings.—It has been a practice with me to place our sewer gratings about fifty yards asunder; they are made slightly, dished in the middle, and with bars about ¾ in. apart, so as effectually to prevent stones and other solid substances getting into the sewer: the bars are also beveled on the under side, so as to prevent the dirt clogging to them. They measure 16 in. by 13½ in., and are about 2 cwt. each, and we connect them with the sewer with 9-in. pipes. The old gratings weighed about 5 cwt., and measured 30 in. by 24 in., with bars 1½ in. to 2 in. asunder. I often found them connected with the sewer by 9-in. drain pipes, of an area of 63 in., while the clear area or space between the bars was about 351 inches. The old traps also were of similar huge dimensions as to area.

I have recently introduced side gratings fitted into the curb stones, which are more efficient, and not so unsightly as the old gratings; these, I find, are recently introduced into Liverpool, and they have for many years been adopted in Birmingham and Paris.

In London, Liverpool, and other towns glazed pipes only are allowed to be used, and in the former places they are now entering into large contracts for supplies of them. Glass pipes are now being manufactured for the purposes of drainage and as water mains; from their straightness and extreme smoothness, they will discharge a greater amount of fluid than glazed pipes, but their high price, which is as follows, is rather an obstacle to their use.

1	inch, ……	7d.	per foot.		2¼	inch, ……	14d.	per foot.
1¼	" ……	8d.	"		2½	" ……	16d.	"
1½	" ……	9d.	"		2¾	" ……	18d.	"
1¾	" ……	10d.	"		3	" ……	20d.	"
2	" ……	12d.	"					

The ends of the pipes are now annealed, so they are not so liable to fracture as when first made, and the manufacturers have invented a collar and cement that is used for the purpose of joining them together, and which makes a perfectly water-tight joint.

As the best security against the passage of foul air from sewers and drains, all openings should be trapped, and the most effectual trap I consider yet invented for house drains is the syphon trap of glazed stone ware. I have recently introduced the patent valve trap, the pipe being composed of glazed stone ware, and the valve of galvanized iron, but I have discovered that it is not so effectual as the syphon trap, as you cannot ensure tightness at all times, but they effectually prevent vermin getting up the drains.

Street Cleansing.—The thorough cleansing of the streets of towns has a salutary effect on the health of the inhabitants. Our principal thoroughfares should be swept daily, and the inferior streets twice or thrice a week, and at the same time the streets are swept, the courts should be cleansed likewise. Our principal streets contain 22,202 superficial yards; second

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* This system of ventilation is vicious in principle: by it the air we breathe would become contaminated. By the action of the wind, the upper stratum of air becomes intermingled with the lower stratum.—Ed. C.E. & A. Journal.

class streets, 19,061 yards; and the third class 32,545 yards; making a total of 73,808 yards, which will require the labour of 49 able-bodied men to cleanse daily, and if cleansed as above stated, 18 able-bodied men. There are several methods recommended and adopted for cleansing streets—viz., by means of jets of water, (as adopted at Philadelphia), the patent sweeping-machine, and by hand labour.

Cost of cleansing by means of Jets of Water, 5½d. per 1000 yards.
———————— Patent Machine........ 10½d. ————
———————— (experiments at Salford) 8½d. ————
———————— hand labour (able bodied) 15d. ————
———————— pauper hand labour .... 24d. ————

The following is the result of experiments tried by Mr. Chadwick, member of the Board of Health, in Pall-Mall, London, to ascertain the relative cost of the two systems of hand-labour:—

The price for sweeping Pall-Mall was by pauper labour 3s. 10d.
———————————————— free —— 2s. 6d.

The paupers were paid 3s. 10*d*. a-day, the free labourers 2*s*. 6*d*.

The system of pauper labour has had a fair and impartial trial on the turnpike roads throughout the kingdom; and if the opinion of such men as Telford and Macadam are worth anything, it has been justly condemned, and generally abandoned on the score of inefficiency and costliness.

Street Surfaces.—The best material for the surface of streets has been a subject of much controversy.

Macadam's system of making and repairing street surfaces with stones broken small, resting upon the subsoil, is erroneous in principle: Telford's, with a solid foundation of sand or other stones, set or pitched by hand, and covered with a coating of durable granite, whin, or quartz rock, is much to be preferred; in fact I consider the roadway of streets formed with small broken stones totally inapplicable for towns, as being expensive, unhealthy for the inhabitants, and also as the means of adding very considerably to the labour of horses in draught.

The round or boulder stone pavement is also open to objection, as it allows the liquid filth to perforate through the large open fissures into the subsoil, with which it becomes saturated, and in certain states of the weather, gives off offensive exhalations; and as generally constructed, without a proper foundation, the stones being irregular in size, yield, in different proportions to the weight passing over them according to the superficial area of the bearing surface of the stones, which form ruts and hollows, and disagreeable inequalities in the streets.

But a good pavement may be formed of the round pebbles, provided a foundation of concrete or other solid material is previously prepared, and the stones carefully sorted, so as to have them of one uniform size.

As the best and most economical mode of preparing the roadway of streets, I would recommend the square set pavement, composed of granite, whin, or other equally durable stone, in blocks carefully squared, 6 to 7 inches deep, 2½ to 3 inches thick, and not exceeding 1 foot in length, to be set in the streets in regular transverse courses, about 1½ inch asunder, so as to afford a good foothold for the horses, and the lower part of the cavity between the stones filled up with good sharp gravel, and the upper part mixed with a little asphalte, so as to prevent moisture from penetrating through.

The foundation I would have prepared with concrete 12 to 18 inches thick, according to the amount of the traffic of the street; it may be formed of gravel, broken stone, or burnt clay, as may be found the most economical, mixed with a proportion of hydraulic lime and sand, and this thrown upon the prepared surface of the street from an altitude and afterwards shaped to the requisite curvature, and of one uniform thickness, will make a sound and durable bed for the sets.

The curvature of a street should form a segment of a circle, with a versed sine of not more than is required just to throw off the surface water. The great error in the form of many of our streets is the extreme roundness that is given to the cross section. I consider that a versed sine of four inches in a street thirty feet wide, ample.

The cost of the different systems are as follows:—

Macademized Roads: 4*s*. per superficial yard; if on pitched foundation, 6*s*. 6*d*. ditto.

Pebble Paving: 2*s*. per superficial yard; if on concrete foundations, 4*s*. ditto.

Square Sets: 4*s*. per superficial yard; if on concrete foundation, 6*s*. ditto.

Curb Stones.—The material for curb stones I should prefer of granite, or other stone equally strong and durable. When set in their places, the face of the stone should be previously wrought to suit the bevel of the wheels of carriages. They should be set level with the crown or middle of the street. If an arrangement could be made so that the curb and channel stones could be formed in one piece of stone, with the channel merely hollowed out at the angle or foot of the curb, so as to receive the surface water, they would make better channels for its passage, and less liable to be deranged.

Channel Stones.—The old channels are so badly constructed as practically to reduce the width of the streets some three or four feet; but I have introduced an improved method of paving them with square steps, by which means the whole width of the carriage road can be used up to the curb stones. I have used as a further improvement stones prepared purposely for channels ten inches wide and six inches deep, which makes a better channel, from having but few joints, for the passage of surface water; but a channel formed out of the curb stones hollowed out at the angles, would make a better channel.

Reservation of Town Manures.—The whole of the liquid refuse of our towns has for a long period been allowed to run to waste, and it is not until recently that attention has been turned to its value as a manure for land, and to the practicability of conserving it for that purpose.

In some of the continental towns it has been practised for a considerable period on a small scale, but it has been left to the enlightened men of this country and the present generation to develope plans to carry out its principles and to effect the object.

It is the general opinion of those scientific men who have turned their attention to this subject, that the liquid manure of towns is worth at the minimum 10*s*. per annum for every inhabitant, and some assign a much higher value to it.

But if we assume the minimum price at 10*s*. per head, Chester, with its population, should produce near 12,000*l*. per annum; but this of course would not be net income, as it could not be obtained without a considerable preparatory outlay and annual expense.

At Edinburgh, Ashburton, Mansfield, and Manchester, it has been tried on a limited scale; and it appears from the reports given of their works, with a favourable result; but it is yet to be seen whether, when applied on a general system, such great benefits can be derived from it as those theorists, who have so warmly taken up the question, seem to anticipate.

In Edinburgh, where it has been practically applied to about forty acres of barren land, it has enhanced its annual value from 3*s*. to 30*l*. and 40*l*. per acre; but the cost of the feeders and the preparation of the land was 25*l*. per acre.

Mr. Newlands, borough engineer of Liverpool, estimates the sewage water of Liverpool to be worth, at the rate above stated, 185,000*l*.; that if raised by steam-power 200 feet, it might be made to irrigate 60,000 acres of land in the Vale of Alt, but the cost of the preparation would amount to 600,000*l*., which he considers quite a bar to the scheme, even if the water cost them nothing.

He estimates the expense of pumping the sewage to be as great as the supply of water to Liverpool.

He further states that the sewage of Liverpool would amount to eighteen million tons per annum; that as it could not be applied to land at all seasons, it would require reservoirs to store it up, and they would occupy 600 acres of land. The engine necessary to raise it would be 600-horse power, and the total expense of land, reservoirs, engines, pipes, apparatus, &c., would be 15,000,000*l*., and the annual expenditure 1,225,612*l*, which, if applied to 900,000 acres of land (or a square of nearly 38 miles on the side that he calculated) it would fertilize, the prime cost of the manure would be about 1*l*. 7s. per acre for the manure.

According to this estimate, the total expense of the works would be about 40*l*. per head, and the annual expenditure about 3*l*. 6s. per head of the population.

In Manchester the system has been practically tested. The manure is brought from the sewers to the banks of the canal, where it is stored in tanks at 3s. per ton, and the contents of the tanks are transferred, by means of a syphon, into barges that are used to convey it to wherever it is wanted to be applied.

It is applied to the land by means of canvas hose, and forced, by a small steam-engine on board the vessel, to about half a mile on either side of the canal. The cost of irrigating is about 1s. per ton; and it takes three tons to the acre of concentrated manure, diluted with from three to six times its weight of water. This, according to the opinion of Mr. Smith, of Deanston, and other eminent scientific agriculturists, is the cheapest and most effectual way of manuring land—viz., by applying it in a liquid state; as when manures are applied dry, or in the ordinary way, they must be dissolved in water before they can be appropriated or absorbed by the plants.

The manure, when applied as proposed, in a liquid form, disappears from the surface in about three hours, and cattle will eat the grass on the following day.

The Liquid Manure Company of Manchester charge for twenty tons of sewage 1*l*. per acre for irrigating land, and 6d. per mile additional from the source of supply. It is stated that near Manchester a comparative experiment was made of the effect of liquid manure and guano. One cwt. of the Peruvian guano dissolved in water, was substituted for a ton of the undiluted manure, and applied to different parts of the field. The superior effect of the liquid manure upon the land was pointed out by the proprietor, who was ignorant of the substitution.

Mr. Higgs's method it appears was brought before the public in the year 1846, and in the subsequent year it had the sanction of the legislature in an act for putting it into operation in Bermondsey, in the county of Surrey; but previous to the erection of the extensive works by the act, it was thought advisable to erect experimental works, where every operation might be fully tested by actual working. This was done at Northumberland Wharf, London, and fully verified the most sanguine expectations which had been formed of its success. These experimental works were visited by many scientific gentlemen, who invariably expressed satisfaction at the results; they were likewise inspected by the consulting engineer, and chief surveyor of the Metropolitan Commission of Sewers, who, in a report to that commission, say—"Under proper regulations, we believe that the work may be accomplished without annoyance to the neighbourhood, and with considerable advantage to the river Thames, by the interception of solid matter. It appears a simple scheme that deserves encouragement, promising in its character, and inexpensive to work."

If these plans are carried out, it will be necessary to abolish all cesspools, so that all the valuable matter that now flows into them may be conveyed away to the collecting tanks, where it will subside and undergo the process of deodorization and distribution.

Courts.—Our courts are what are usually denominated *Cul de Sacs*, and but few, if any of them, are of an area sufficient for the number of the inhabitants, if we allow the usual average of 25 square yards for each individual, the minimum area that health demands. Being very narrow, and generally closed at one or both ends, they are very imperfectly ventilated, and therefore a larger area per inhabitant should be afforded them, if the health of the city is to be maintained; or the number of the inhabitants should be reduced to the minimum the space will allow, according to the preceding scale.

NOTES OF THE MONTH.

The Floating Railway Bridge for the Frith of Tay.—This novel and extraordinary piece of naval architecture has had her engines fitted at Mr. Napier's dock, at Lancefield. She lately made an experimental trip down the river to Greenock and back. The vessel is of iron, 175 ft. long, 34 feet broad, and 10 feet deep, the bottom being a very flat curve; both ends are alike, and quite square, so as to abut against the quay, and receive the trains on deck from either end. The deck is flush, and clear fore and aft, and on it are three lines of rails, so as to enable it to take the longest train likely to require it. The steering wheel is amidship, elevated between the paddle-boxes, and connected with the rudders at each end by long chains; as the vessel will not be turned, these rudders will, of course, be used alternately, as either end becomes the stern. There are two engines entirely independent of each other, and instead of a shaft connecting the paddles, each is moved solely by one engine, by which means extraordinary command is obtained over the movements of the gigantic machine, independent of the rudders. The diameter of the cylinders is 56 inches, with a 8 ft. 6 in. stroke; the valves work with great ease, and each engine is 100-horse power. The valve gear is on deck; there are two eccentrics which are thrown alternately in and out of gear, as either end of the vessel becomes in turn the head. The boilers are amidships, with a clear space all round for facility of cleansing and repairs. She draws but little water, made eight knots per hour, and is expected to be in operation in two months. There are two small extra pumps for supplying the boilers, in case of the water running low, and every precaution appears to have been taken to prevent accident.

Marine Engines.—Mr. Napier, of Glasgow, is now constructing a pair of engines for the American mail steamers, with cylinders 96 inches diameter. When completed they will be nearly 900-horse power.

Exhibition of Machinery at Ghent.—A special exhibition of machinery, frames, looms, and implements of trade (of Belgian or *foreign* make) employed in the manufacture of yarns and tissues of all sorts, is to be opened at Ghent (on the occasion of the exhibition of the produce of the industry of Flanders) in the month of July. Special rewards, consisting of commemorative medals, of gold, silver, and bronze, will be awarded to such exhibitors as shall appear to merit such a distinction.

Mode of Silvering Glass by the Employment of Gun-cotton.—M. Vohl has recently discovered that a solution of gun-cotton, in a caustic ley, possesses, in a high degree, the property of precipitating silver from its solutions in the metallic form. In fact, on bringing gun-cotton into contact with a caustic ley, of sufficient strength, the cotton will become dissolved in the ley, giving out ammonia with a considerable degree of heat, and producing a deep brown liquor, somewhat thick: on pouring an acid into this, a brisk effervescence is produced, carbonic acid and nitrous acid being disengaged. The action of the gun-cotton, in this instance, shows that it is not simply dissolved, but undergoes decomposition, by which the atoms of oxygen, in the nitric acid, enter into combination with the atoms of carbon in the gun-cotton, thus producing carbonic acid, which, as well as the nitrous acid produced by the nitric acid, combines with one part of potash. A fresh decomposition of nitrous salt by the potash, in presence of hydrogenated substances, furnishes ammonia. The most remarkable property of this alkaline solution is the following:—On pouring into it a few drops of a solution of nitrate of silver, and adding ammonia until the oxide of silver formed is redissolved (the mixture being slowly heated in a water bath), the liquor will, at a certain period, assume a dark brown colour, and effervesce, the whole of the silver being precipitated on the sides of the vessel. The mirror thus produced is much superior in brilliancy to those produced by means of etherial oils or ammoniacal aldehyde; and the facility with which it is produced will doubtless render it of practical importance. This property is not exclusively possessed by gun-cotton; it is found also in cane sugar, sugar of milk, manna, gums, and other substances which may be rendered explosive by treating them with nitric acid. Picro-azotic acid produces, under the same circumstances, a reflective metallic surface; and it appears that this reaction takes place with all bodies which, when treated with nitric acid, do not furnish products of oxidation, but another series of bodies which admit of carbonic acid for forming one of their constituent parts, since they at the same time give up an equivalent of water.—*Technologiste.*

Method of Cleaning Vessels and other Articles of Silver.—Boil thirty grammes of finely pulverised and calcined hartshorn in a quart of water, and while on the fire put as many silver articles in the vessel used for boiling as it will hold, and leave them there for a short time; then withdraw them, and dry them over the fire. Continue this until all the articles have been treated in the same manner. Then introduce into the hartshorn-water clean woollen rags, and allow them to remain until saturated; after which, dry them and use them for polishing the silver. This is also the best substance which can be employed for cleaning locks and brass handles of room doors. When the silver articles are perfectly dry, they must be carefully rubbed with a soft leather. This mode of cleaning is excellent, and much preferable to the employment of any powder containing mercury, as mercury has the effect of rendering the silver so brittle as to break on falling.—*Ibid.*

Method of Soldering Cast-iron with Wrought-iron.—The following process has been recommended for this purpose:—First melt filings of soft cast-iron with calcined borax in a crucible; then pulverise the black vitreous substance which is thereby produced, and sprinkle it over the parts which are intended to be united; after which, heat the pieces of cast and wrought iron and weld them together on an anvil, using only gentle blows. This method is peculiarly applicable for the manufacture of iron articles which are intended to be made red hot, and are required to be impervious to fluids or liquids; as such a result cannot be obtained by simple fastening.—*Ibid.*

Self-Lighting Gas-Burner.—A self-igniting gas-burner, invented by Mr. Strode, of St. Martin's-le-Grand, is an adaptation of the zinc hydrogen, or Dobriener's light, to the purpose of lighting a jet, or other burner, of coal-gas. In this case, however, the hydrogen gas is generated in an improved manner by the galvanic action of a small battery of amalgamated zinc and platinised silver plates, immersed in sulphuric acid, diluted largely with water. The hydrogen gas so generated, is directed through a fine jet on a ball of spongy platinum, and, when ignited, moved across the coal-gas burner. The two cocks are ingeniously connected by means of a brequet movement; and an instantaneous light is thus produced by one movement of the hand. The effect is magical, and pretty in the extreme; and the apparatus, which is small and portable, is a very becoming burner for the office desk or library table, where we have no doubt it will be extensively used and appreciated, as soon as Mr. Strode shall have announced it as ready for general sale. So far it has only been used privately in the way of experiment; but several months' constant use have served to prove its perfect uniformity of action. The safety it affords, by the avoidance of the use of lucifer matches, is a consideration which will weigh with the prudent; and the ease with which it is lighted and extinguished, will be very valuable, if only in the avoidance of unnecessary heat. For chambers, bed-rooms, offices, and libraries, in private houses, and for the hall table at night, it is perfect, and, above all, safe. It is also easily connected to the ordinary gas branches by a union connection fitting the common burner screw, and a flexible or other tube.

Machine for Manufacturing Envelopes.—M. Rémond, of Birmingham, has just constructed a very ingenious and complete machine for the manufacture of envelopes. The machine, we are informed does its work in a very efficient and admirable manner, the envelopes which it turns out being more perfect and uniform in their construction than those produced by hand in the ordinary manner; but the quantity of work which the machine accomplishes is the most astonishing. Supposing it to be turned by manual labour, one man, with the aid of three or four young girls or boys to gather the envelopes, would, it is calculated, by its means, be able to manufacture from 30,000 to 35,000 in an ordinary working day, the paper being cut beforehand; while an expert hand, in the ordinary way, exclusive of the cutting, cannot, upon the average, make more than 2,000 in the same manner as those in question, which have a device stamped upon them at the point where the seal is usually placed.

Swivel Bridges.—Mr. Dodd, of St. Vincent-street, Glasgow, has designed a swivel bridge, for the Midland Junction Railway, to cross the Clyde canal at Falkirk. The two main beams of the bridge are constructed of hollow rectangular panelled tubes of wrought-iron, stretching across the water-way; they are stayed transversely by wrought-iron tension-rods and diagonal timber-frames, and are further supported from the centre cast-iron pivot by four cast-iron box-beams, which act as struts, and convey the strain from the roadway to the top of the pivot. Two open ornamental cast-iron frames rest one on each side of the upper circular plate of the pivots, and are attached together at top by a capital, and carry the saddle for two diagonal tension-rods, bolted to the girders, which they stiffen to a great extent. The pivot is in form of an inverted truncated cone, cylindrical at its upper end, where it is guided by a set of stationary anti-friction pulleys. The bottom enters a small chamber through a water-tight stuffing-box, in connection with a hydrostatic ram, by which water can be pumped in beneath the cone, which will elevate the whole structure, sufficient to clear the bearings, when it can be swivelled round. This is effected by two hydraulic rams, placed horizontally at right angles with each other, working a shaft, around which and the cylindrical top of the pivot, is an endless chain, the communication of the movement of the rams to which may be effected by the adoption of various mechanical arrangements, according to circumstances.

Guildford Drainage.—The various plans for the drainage of Guildford, sent in competition, were submitted by the committee to Mr. Hosking for examination, to assist them in making the award. Three plans have been selected for final consideration—"Pioneer," "Specula," and "C. Engineer."

Railway Bridges.—Upon the extension line of the Blackwall Railway, from Stepney to Bow, are two bridges, which are of a peculiar form, and the first of their class erected for railway purposes. The roadway upon them is supported on wrought-iron girders, placed transversely between two arches, or ribs, formed entirely of wrought-iron. The clear span of one is 120 feet, of the other 116 ft. 8 in. Each arch or rib of the latter bridge, which carries the railway over the Regent's Canal, is formed of a box built with iron boiler-plates 11-16ths inch in thickness, and angle-iron firmly rivetted together, its breadth being 2 ft. 10 in., its depth about 2 feet, and sectional area 81 square inches, and is connected at the base by a wrought-iron tie-bar, which receives the horizontal thrust of the arch, and is formed of links having a total sectional area of 69 square inches, bolted together with bolts 2¾ inches in diameter, aided by eight others at each joint, ¾ inch in diameter. Between the tie-bars and the arch a system of vertical and diagonal bracing has been introduced, so as in a manner to distribute the weight of passing loads equally over the whole arch. These ribs so formed are laid in cast-iron plates, fixed at one end, and free to move at the other over rollers, so as to allow scope for the expansion and contraction of the metal. The clear interval between the bearings is 116 ft. 8 in. and the rise of the arch is 8 feet to the underside of the box of which it is formed, the roadway being beneath the arch, and about 2 feet above the bottom of the tie-bar. The structure is exceedingly light; but appears, nevertheless, sufficiently strong to carry the weights which may come upon it in practice, as far as the areas of the arch and bowstring, or tie, are concerned, and has stood the test of a dead weight of 240 tons (in addition to its own weight of 59 tons), distributed in weights of 34½ tons at equal distances over its length, with a deflection of 3 11-16ths inches, and recovered entirely its original position upon the removal of the load. As this proof exceeds considerably any weight that can be brought upon it in practice, I am of opinion that it may be used with safety for the passage of trains; but as it is of so novel and light a construction, and the action of the cross-bracing and connection of the tie-bars have not been ascertained by continued experiments of moving weights, I should recommend that it be examined from time to time, so that any defect, if it should exist, might be ascertained, more particularly as the weight of the whole bridge, including the double line of roadway and covering, only amounts to 194 tons, and is very easily set in vibratory motion by any moving power.—Capt. Simmons's Report.—[A small engraving of this bridge is given in the Journal of October last (Vol. XI., p. 300), and an engraving by the inventor, Mr. Harrison, in the Journal for January 1848, p. 1.—Ed. C.E. & A. Journal.]

London and North Western Railway.—The new station at Euston-square just opened, comprises a building 220 feet in length, by 170 feet in depth, designed by Mr. P. C. Hardwicke. No expense has been spared to make it convenient, spacious, and ornamental. The cost is said to be about £150,000. It contains all the necessary offices for carrying on the business of this great establishment, including a large room, 75 feet in length by 45 feet in width, for the purpose of holding the half-yearly and special meetings of the proprietors. Several of the new offices are already occupied, and when all the offices are removed to the new building the old station will be taken down. According to a report just presented to the directors by Captain Huish and the resident engineers, it appears that by reserving an annual sum of £20,700, at 4½ per cent., with compound interest, the permanent way of the London and North-Western, 438 miles in length, may be renewed as occasion may require.

English Locomotives in France.—The Northern Railway Company, since its extension to Calais, now run their extra trains and employ locomotives on Crampton's principle, and travellers may now go from London to the French capital, via Dover, in 13 hours; from Paris to Brussels in 10 hours; and to Cologne in 21½ hours. The Paris and Orleans and the northern lines were the first to employ English locomotives, and which caused great jealousy on the part of the French engineers. Since the revolution the republic has been more liberal than the preceding Government, and at present English engines are becoming more general on all the lines. These engines are not shipped to any of the French ports, but enter France by way of Belgium, and then to their local destination by means of the northern line. The revision of the French tariff, particularly as regards British machinery, iron, and coal has been proceeded with, and will come into operation soon after the installation of the new National Assembly. The republic is evidently desirous to carry out the free system gradually, as the means of increasing their own trade and commerce, and opening up a more lively intercourse with this country.

Royal Arsenal, Woolwich.—Considerable improvements have recently been made in this important naval and military depot, especially in the foundry and carriage departments. In the former a superior 30-horse power steam-engine has been put up, and an entire new set of gearing for driving the different kinds of machinery in the dial square for the manufacturing of guns. The engine has been fitted with Fairbairn's double-beat equilibrium valves; the exhaust valve opens during the whole half-stroke, and the steam valve can be set to work at any degree of expansion, and by that means effect a great saving in the consumption of fuel, 3 lb. of coal being found sufficient for each horse-power per hour. In the carriage department the large open spaces in the square have been covered over with corrugated iron roofs, well lighted. At the eastern end one of Nasmyth's hammers has been put up, of 20 cwt., with a stroke of three feet three inches, for the purpose of reforging the old pieces of iron and again making them available for useful purposes. A neat engine of one-half horse power has been attached for pumping water to the boilers, and two furnaces for heating the metal. The saving which will be effected by these additions will be considerable, and the quantity of work which can now be executed by machinery brought to such perfection as to be far superior for every kind of heavy work formerly performed by manual labour, places the authorities in a position to meet any demand in cases of emergency.

The Iron Steam-Frigate "Megæra."—This frigate, built by Messrs. W. Fairbairn and Sons, for her Majesty's service, and launched from their yard, at Millwall, on Tuesday, May 22, is of the following dimensions:—Length between perpendiculars, 207 feet; breadth of beam 37 ft. 8 in.; depth of hold 24 ft. 3 in.; tonnage, 1391 31·94. She is constructed to carry—two guns on the spar-deck, 56-pounders, 85 cwt.; four guns, 68-pounders, 65 cwt.; four guns, 32-pounders, 25 cwt.; four guns on main-deck, 32-pounders, 56 cwt. The keel and stern-post of the Megæra are of wrought-iron, 8½ inches wide, and of proportional thickness; the frames consist of angle-iron, 5 inches by 3 inches, placed 12 inches apart, in the way of the engine-room, and increasing in distance fore and aft to 18 inches. The floors are 14 inches deep, by 7-16ths of an inch thick, and the sheathing-plates vary from 11-16ths to ½ an inch in thickness, according to their position. The engines of the Megæra have been constructed by Messrs. Rennie. She is to be propelled by a screw upwards of 13 feet in diameter, provision having been made for disconnecting, and also for shipping and unshipping the same, at pleasure.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM APRIL 19, TO MAY 24, 1819.

Six Months allowed for Enrolment, unless otherwise expressed.

Charles Alexander Broquette, of Rue Neuve St. Nicholas, St. Martin, France, chemist, for improvements in printing and dyeing fibrous and other materials—Sealed April 21.

William Kilner, of Sheffield, York, engraver, for improvements in manufacturing railway and other axles, and wheels and machinery to be employed in such manufacture—April 24.

Lewis Vernet, of Buenos Ayres, for a method of preserving from destruction by worms, insects, decay, and fire, certain vegetable and animal substances.—April 24.

Thomas Harcourt Thompson, of Blackheath-hill, civil engineer, for certain improvements in apparatus for preventing the rise of effluvium from drains, sewers, cesspools, and other places; and in apparatus and machinery for regulating the levels of waters in rivers, reservoirs, and canals.—April 26.

George Simpson, of Newington-butts, chemist, and Thomas Forster, of Streatham, manufacturer, for improvements in manufacturing or treating solvents of india-rubber, and of other gums or substances.—April 26.

John Barsham, of Chelmsford, Essex, manufacturer, for improvements in separating the fibre from cocoa-nut husks.—April 26.

Charles Iles, of Bordesley Works, Birmingham, machinist, for improvements in manufacturing picture-frames, inkstands, and other articles in dies or moulds; also in producing ornamental surfaces.—April 26.

William Faulconbridge, of Long-lane, Bermondsey, Surrey, for improvements in the manufacture of hose-pipes, driving-bands, and valves for atmospheric railways.—April 26.

Bartholomew Beniowski, of Bow-street, Covent-garden, major in the late Polish army, for improvements in the apparatus for, and process of, printing.—April 26.

Robert Oxland, and John Oxland, of Plymouth, chemists, for improvements in the manufacture of sugar.—April 26.

William Henry Burke, of Tottenham, manufacturer, for improvements in the manufacture of airproof and waterproof fabrics; and in the preparation of caoutchouc and gutta-percha, either alone or in combination with other materials, the same being applicable to articles of wearing apparel, bands, straps, and other similar useful purposes.—April 26.

John Horsley, of Ryde, Isle of Wight, practical chemist, for certain improvements in preventing incrustation in steam and other boilers; also for purifying, filtering, and otherwise rendering water fit for drinkable purposes.—April 26.

Alphonse Garnier, of Paris, France, but now of South-street, Finsbury, merchant, for certain improvements in extracting and preparing colouring matter from orchil. (A communication.)—April 28.

James Wilson, of Old Bond-street, tailor, for improvements in trusses.—May 1.

James Godfrey Wilson, of Millman's-row, Chelsea, engineer, for certain improvements in the manufacture of glass, and in machinery and apparatus connected therewith.—May 1.

Alexander Munkittrick, of Manchester, merchant, for an improved composition of matter, which is applicable as a substitute for oil, for the lubrication of machinery, and for other purposes. (A communication.)—May 1.

John Dalton, of Hollingworth, Chester, calico printer, for a certain improvement, or certain improvements, in printing calicoes and other surfaces.—May 1.

Samson Waller, of Bradford, York, manufacturer, for certain improvements in machinery or apparatus for weaving.—May 3.

Thomas Wentworth Buller, of Sussex-gardens, Hyde-park, esquire, for improvements in the manufacture of earthenware.—May 3.

Matthew Kennedy, of Manchester, cotton-spinner, for certain improvements in the method of packing cops of cotton, and other fibrous materials, and in the apparatus connected therewith.—May 3.

Thomas Whaley, of Chorley, Lancaster, coal proprietor, and Richard Ashton Lightoller, of the same place, cotton-spinner, for certain improvements in machinery or apparatus for manufacturing bricks and tiles.—May 3.

William Edward Newton, of Chancery-lane, civil engineer, for improvements in the jacquard machine. (A communication.)—May 5.

George Edmond Donisthorpe, and John Whitehead, of Leeds, manufacturers, for improvements in preparing, combing, and hackling fibrous matters.—May 8.

Samuel Wilkes, of Wednesfield-heath, near Wolverhampton, brass-founder, for improvements in the manufacture of knobs, handles, and spindles for the same, for doors and other purposes; and improvements in locks.—May 8.

Robert Sutcliffe, of Idle, near Bradford, York, cotton-spinner, for improvements in machinery for spinning cotton, silk, and other fibrous substances.—May 8.

George Henry Dodge, of the United States of America, now residing at Manchester, manufacturer, for certain improvements in machinery for spinning and doubling cotton yarns and other fibrous materials; and in machinery or apparatus for winding, reeling, balling, and spooling such substances when spun.—May 10.

Charlotte Smith, wife of Jabez Smith, of Bedford, for improvements in certain articles of wearing apparel.—May 14.

Samuel Allport, of Birmingham, gun-maker, for a certain improved method of making or manufacturing a certain part or parts of looms used in weaving.—May 14.

William Phillips Parker, of Lime-street, London, gentleman, for improvements in the construction of piano-fortes. (A communication.)—May 15.

John Thom, of Ardwick, near Manchester, calico printer, for improvements in cleansing, scouring, or bleaching silk, woollen, cotton, and other woven fabrics and yarns, and in ageing fabrics and yarns when printed.—May 15.

Henry Bessemer, of Baxter-house, Old St. Pancras-road, engineer, and John Sharp Cromartie Heywood, of Islington, Middlesex, for improvements in expressing and treating oils, and in the manufacture of varnishes, pigments, and paints.—May 15.

Moses Poole, of London, gentleman, for improvements in apparatus for drawing fluids from the human or animal body. (A communication.)—May 15.

Louis Alfred De Chatanvillard, of Rue St. Lazare, France, gentleman, for improvements in fire-arms, cartridges, bullets, bayonets, and ordnance. (A communication.)—May 15.

Pierre Armand Lecomte de Fontainemoreau, of South-Street, Finsbury, for certain improvements in weaving. (A communication.)—May 22.

Francis Edward Colegrave, of Brighton, gentleman, for improvements in the means of communicating between the passengers and guard of a railway train, or between the guard and engine-driver; parts of which improvements are also applicable to working signals on railways.—May 22.

Solomon Israel Da Costa, of St. Helen's, city of London, civil engineer, for improvements in vessels for holding solids or fluids, and in machinery for manufacturing such vessels—May 22.

Rees Reece, of St. John-street, Smithfield, and Astley Paston Price, of Margate, Kent, chemist, for improvements in the manufacture and refining of sugar or saccharine matters.—May 24.

Andrew Crosse, of Gloucester Place, New-road, Middlesex, esquire, for improvements in tanning hides and skins, and also in dyeing fabrics and substances.—May 24.

Thomas Goodfellow, of Tunstall, Stafford, earthenware manufacturer, and George Goodfellow, of Shelton, Stafford, potter, for improvements in the method or methods of preparing plastic materials for manufacturing purposes.—May 24.

Andrew Smith, of St. James's, Westminster, engineer, for improvements in machinery for, or methods of, manufacturing rope or cordage, and improved modes of fitting and using the same.—May 24.

Frederick Steiner, of Hyndburn, near Accrington, Lancaster, Turkey-red dyer, for improved processes and apparatus to be used in the Turkey-red dye on cotton and its fabrics—May 24.

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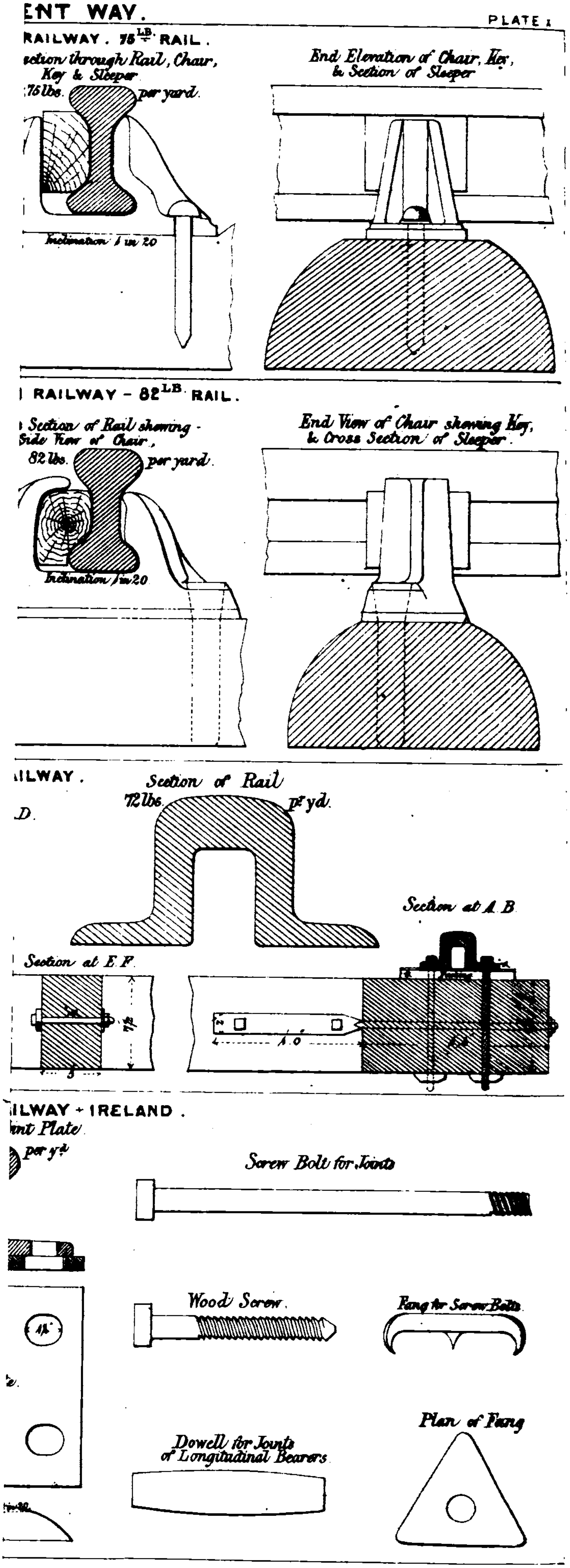
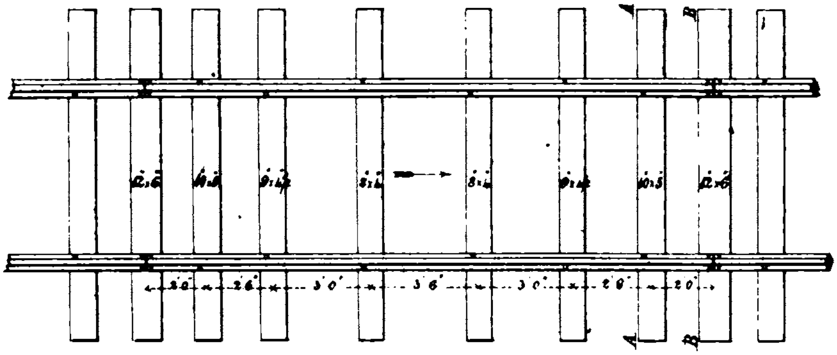


GREAT SOUTHERN AND WESTERN RAILWAY, IRELAND.

DRAWING No. 5.

PERMANENT WAY.

General Plan.



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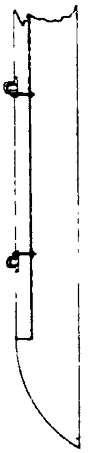
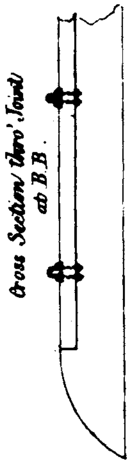
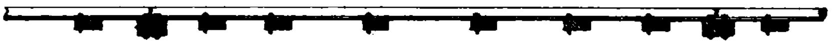


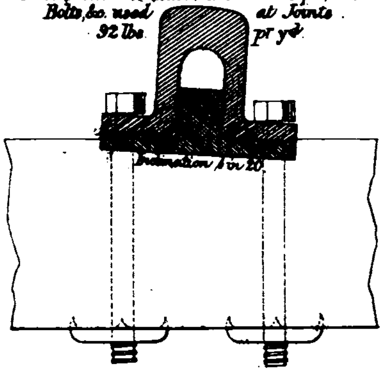
Cross Section thro' Joint at B B



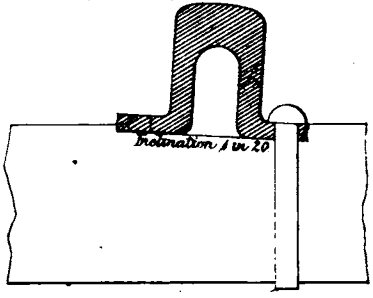
Longitudinal Elevation of Rail showing Cross Section of Sleepers.



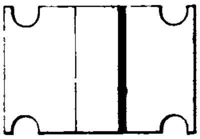
Cross Section of Rail, Chair & Sleeper, showing Bolts, &c. used at Joints. 92 lbs. pr yd.



Cross Section of Rail & Sleeper, showing fastenings used between the Joints.



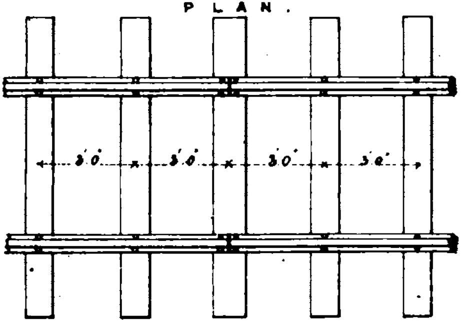
Plan of Joint Chair. Wrot Iron.



No. 6.

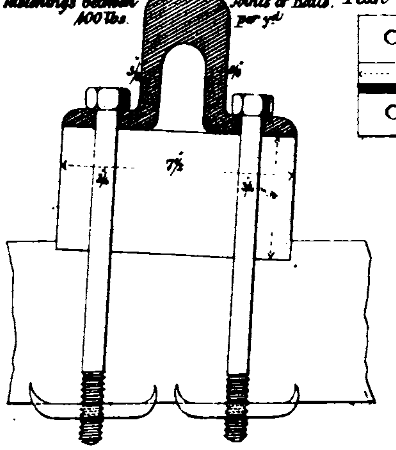
PLAN OF PROPOSED PERMANENT WAY.

PLAN.

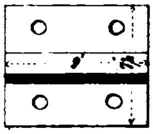


Longitudinal Elevation of Rails showing Section of Sleepers.

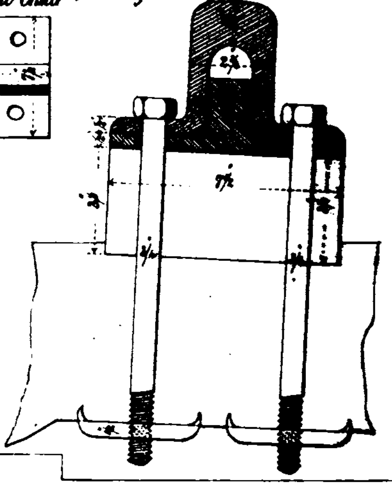
Cross Section of Rail showing fastenings between Joints of Rails. 100 lbs. per yd.



Plan of Joint Chair



Cross Section of Rail, Chair & Sleeper, showing fastenings at Joints of Rails.

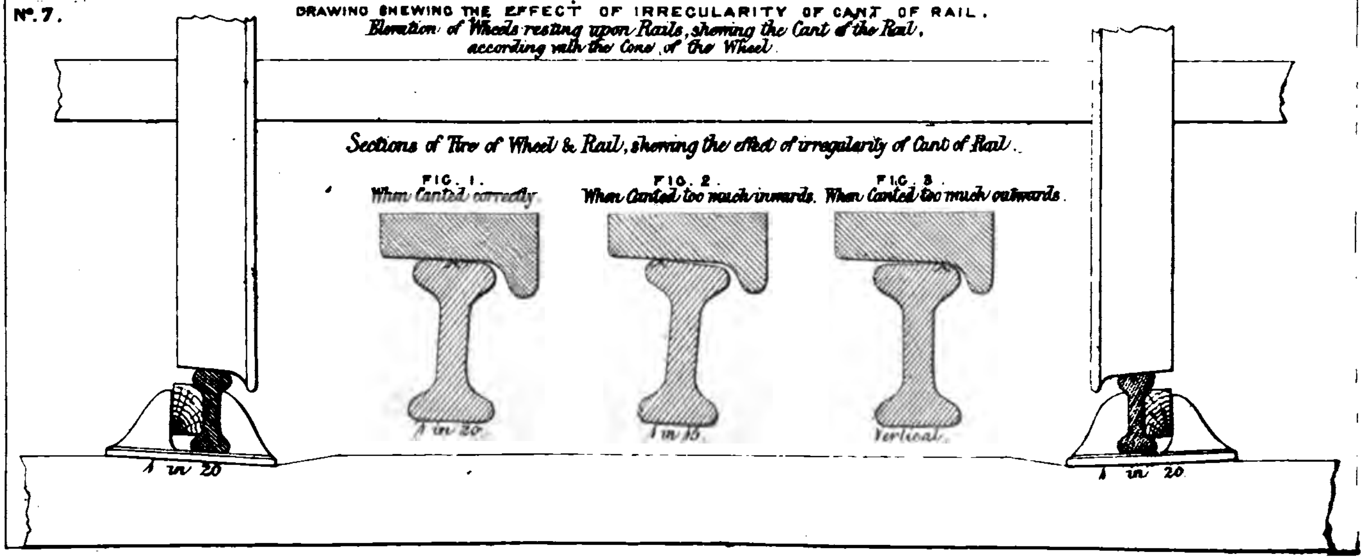


LONDON AND NORTH WESTERN RAILWAY.

No. 7.

DRAWING SHEWING THE EFFECT OF IRREGULARITY OF CANT OF RAIL.

Elevation of Wheels resting upon Rails, showing the Cant of the Rail, according with the Cone of the Wheel.



Sections of Tire of Wheel & Rail, showing the effect of irregularity of Cant of Rail.

FIG. 1. When Canted correctly.

FIG. 2. When Canted too much inwards.

FIG. 3. When Canted too much outwards.

RAILWAYS' PERMANENT WAY.

(*With Two Engravings, Plates* X. *and* XI.)

Report on the Construction of Permanent Way. By Robert B. Dockray, Esq. (By order of the London and North-Western Railway Company.)

To the Committee of Way and Works.

Gentlemen—In accordance with your directions, that I should examine and report to you upon the permanent way as laid down by Sir John Macneill, upon the Dublin and Drogheda and Great Southern and Western of Ireland Railways, I went to Dublin on the 20th ultimo, and remained there until the 26th, and in the interval travelled several times over portions of the lines, as well as of others terminating in that city, and I carefully examined all the details of construction.

Sir John Macniell very handsomely gave me all the information I required, and was at some pains to explain the principles which have governed him in adopting the peculiar construction which he has introduced.

In laying before you the following remarks, I have thought it desirable to extend my observations to the construction of permanent way generally, with the view of determining the best mode of carrying out the renewals upon the Southern Division of your railway, which have become necessary at a period of time earlier than I had anticipated, consequent upon the comparatively new circumstances of the great increase not only in the weight, but in the speed of the engines.

I would here remark, that when competition was developing the present high velocities upon railways generally, Mr. Robert Stephenson gave it in evidence as his opinion, that the limit would be found not in any particular gauge, or in the evaporating power of the engines, but in the economic endurance of the permanent way to bear the additional weight which must, as a matter of necessity, accompany every increase of speed. Time is, in my opinion, rapidly demonstrating the truth of this observation. Every new class of engine which appears, surpasses its predecessor in power and in speed; and it is evident from the large size of some of those about to run upon your line, that at any rate the builders do not consider that they have as yet reached the limit of their scale.

The rapid deterioration of the permanent way, however, about which there can be no doubt, raises the question whether the speeds already attained have not approached the economic limit to which Mr. Robert Stephenson refers. If this be the case, railway companies must look to a considerably increased outlay in the shape of renewals of permanent way. It may be financially disguised for a time, but sooner or later it must be met as a regularly-recurring charge.

I have no doubt that the wear and tear of the carrying stock is also increased in a high ratio with the speed, and I do not see why the public are to reap the whole advantage, leaving the railway company the burden of the additional cost. Means should be taken by the railway body generally to raise the express fares, and thus in some measure to share the benefit with the public.

Returning to the construction of the road, it is evident that in all renewals, increased weight of rails, and increased dimensions of the materials generally, must be adopted to meet the increased duty required. It is of great importance in re-construction, that we should ascertain the weak and defective points: with this view I have carefully inspected many portions of the line, and have availed myself of the knowledge of the experienced overlookers who have been in your service since the commencement of the works.

I find, as a general result, that stone blocks are not adapted to high speeds,—they are rigid, the chairs cannot be retained firmly upon them, and from this cause they are subject to rapid wear; and as they are in this district very expensive in first cost, I should recommend their being renewed with sleepers.

Wherever the stratum under the formation line (the bottom of the ballast) is sound and hard, and there is a sufficiency of ballast, the wear and tear of the road is confined, for several years, to simple renewals of keys,—until, in fact, the rails begin to split and laminate, under the action of the trains. This period will vary with the traffic: in ordinary cases I estimate it at from 15 to 20 years. There are still many years' wear in the rails laid down at the northern end of this division of the line. Under this head I should class the permanent way of the railways which are laid upon the older geological formations, especially those I saw in Ireland, where the substratum is almost universally of the very best description for railway works. When, however, works are constructed in the clays of the tertiary and some of the secondary formations—all of which are highly susceptible to the action of water—the expense of maintaining permanent way is much enhanced.

The lapse of time in developing the action of water upon the clays, shows itself in a gradual softening of the substratum, so that it no longer presents an uniform surface under the ballast, but protrudes itself upwards,—and gradually mixing with the ballast, so far deteriorates its quality, as to render it soft and non-resisting. In this state, the ballast slides into the railway ditches, carrying the road with it, so as to require constant care in correctly maintaining the gauge. In all such cases the blocks must be removed, and replaced with sleepers. Another evil is, that in ballast so deteriorated no repairs can be executed except in fine dry weather; it presents no resistance to the beaters, and consequently the defective bearings cannot be raised by any ordinary process of repair—to open out such road in bad weather only increases the evil. The remedy for this defect is to lift the road, wherever practicable, and add a few inches of good fresh ballast.

Permanent way laid upon a substratum as above described, is subject to much more rapid wear than in the case previously mentioned; the soft yielding nature of the bottom permits so much movement amongst the parts, that they soon loose their fit, the rails become injured at the joints, the chairs are worn, and the keys require constant renewal.

On the Southern Division of this line we have many miles of such road—in fact, with the exception of the chalk district, there is very little sound material south of Rugby.

With the view of bringing before you the whole subject, I have prepared a set of drawings of permanent way as laid down on various lines of railway, selecting those which I consider best of their kinds; they are as follows:—

1st, The mode adopted by Mr. Robert Stephenson. (Drawings No. 1 and 2.)

2nd, That of Mr. Brunel. (Drawing No. 3.)

3rd, That of Mr. Hemans, on the Midland Great Western of Ireland. (Drawing No. 4.)

4th, That of Sir John Macniell, on various Irish lines of railway. (Drawing No. 5.)

Mr. Robert Stephenson's Method.—(Drawings No. 1 *and* 2.)

These drawings represent the permanent way on the London and North-Western Railway, No. 1 being with a rail 75 lb. in weight per yard, and No. 2 with a rail of 82 lb. per yard. The latter shows the improvements recently introduced in the form of the rail, increased weight of chair, &c.

The cost of 5 yards of single line of No. 1 is *5l. 14s. 5d.*
The cost of 5 yards of single line of No. 2 is *6l. 5s. 0½d.*
The number of parts in the same length of No. 1 is 47
The number of parts in the same length of No. 2 is 49

—(For further details, see *Appendix.*)

The bearings are transverse sleepers, placed 3 feet apart on the average.

This mode of construction is that generally adopted on the narrow gauge lines of railway. The cross sleepers possess many advantages; they secure the accuracy of the gauge and of the cant of the rail; they afford great facilities for surface drainage, and any repairs or renewals are readily executed; they also at once show, by the working of the ballast, when and where the road is out of order, affording certain indications to the workmen where their attention is required.

The weak point is at the joints of the rails: most engineers endeavour to remedy this defect by drawing the sleepers nearer together at the joints, and by selecting the largest sleepers for this bearing. To a certain extent, this is found to answer the purposes, but it is apt to disturb the uniformity of the bearing surface on the ballast, a point which I am inclined to think is of some importance, as affecting the steadiness of the motion of the trains.

Mr. I. K. Brunel's Method.—(Drawing No. 3.)

This drawing is taken from the permanent way of the Cheltenham and Great Western Union Railway, at Gloucester, and which I was informed embraced all the last improvements introduced by Mr. Brunel.

The weight of the rail is 72 lb. per yard.
The cost of 5 yards of single line of railway is *6l. 14s. 5½d.*
The number of parts in the same length of road is 81.
—(see *Appendix.*)

The bearings are longitudinal timbers, with a transome at every 15 feet apart, to retain the gauge. Thin pieces of wood are laid across the timber bearing, and upon these the bridge rail is laid:

these packings (placed the cross grain of the wood) are to prevent the rail bedding itself into the longitudinal bearing.

Great care appears to be necessary in laying down and fitting the timbers together, before the plate-layers can lay the rails. There are a great number of parts, which presupposes increased complexity: any repairs or renewals must necessarily be difficult to effect, as a general disturbance of the parts must result from the renewal of any one: the continuity of the bearing cuts off the cross drainage of the surface of the ballast, and induces an expensive system of sub-drainage, which is always liable to derangement. In lifting the road, it must be a very nice operation to maintain the cant of the rail at the proper angle.

The advantages of a longitudinal bearing are the uniformity of the bearing surface on the ballast, and the continuity which it gives at the joints of the rails; in this latter respect, it is much superior to the detached bearing.

Hemans's Midland Great Western of Ireland.—(Drawing No. 4.)

This road is on longitudinal bearings, differing from Mr. Brunel's in that the transomes are placed under the longitudinal bearing.

The weight of the rail is 75 lb. per yard.

The cost of 5 yards of single line of railway is 6*l.* 3*s.* 7*d.*

The number of parts in the same length of single line is 44. —(see *Appendix.*)

This road may be considered as a combination of the transverse and longitudinal systems, and although in some respects defective, yet there is much to be learned from it. Mr. Hemans informs me that in the portions of the road laid upon peat, or where the bottom is soft, he puts in more transverse sleepers, with great advantage to the stability of the road; and that in repairing such portions, the men lift and pack the cross sleepers, without reference to the longitudinal bearing.

Sir John Macniell's Method.—(Drawing No. 5.)

Sir John Macniell has introduced on the railways constructed under his directions in Ireland, a description of permanent way which from the attention bestowed upon its details merits particular notice. It consists of a bridge rail weighing 90 lb. per yard, laid upon transverse sleepers, placed at an average interval of 2 ft. 6 in. apart.

The cost of 5 yards of single line of railway is 6*l.* 4*s.* 4½*d.*

The number of parts in the same length of single line is 36. —(see *Appendix.*)

This road possesses great simplicity of construction: there are no chairs or keys; the bed of the rail on the sleepers is cut out by a machine, which at the same time bores the holes for the fastenings. In laying the road, the rail is simply dropped into its bed on the sleeper, and no further gauging is required. The materials are so prepared before they are brought upon the ground, that any ordinary labourer can lay the road with accuracy: this operation is performed with an economy and dispatch which I never before witnessed.

Sir John Macniell appears to consider that accuracy in the cant of the rail, to suit the cone of the wheels, is the main desideratum in permanent way, and the whole of his peculiar mode of construction has mainly this object in view. For this purpose, the adzing of the sleepers claims much of his attention: it is effected by machinery in such a way as to ensure that the inclination shall in every case be exactly the same. Next, he adopted the bridge rail, with its broad bottom flanch, in order that he may at once attach the rail to the sleeper without the intervention of chairs and keys, and by this means avoid the fitting of two additional parts,—accuracy in each of which is necessary to insure the correctness of cant in the rail. The rail is also carefully examined before being laid, and made perfectly straight, and all twist removed.

Sir John has thus reduced this road to one of the utmost simplicity, consisting of but two parts—the rail and the sleeper. He takes every precaution that each individual of these parts shall be exactly alike, and when brought together that they shall fit each other, and thus produce an uniform surface of the rails.

On a careful examination which I made of this road, I found that attention to these details has produced the effect which might be anticipated—the top of the rail is wearing with unusual uniformity, and there is no appearance of the flanches of the wheels having come in contact with the edge of the rail.

On the subject of the cant of the rail, I am of opinion that much of the side motion observable in railway trains is attributable to irregularity in this respect. Drawing No. 7 has been prepared to illustrate this question. In figs. 2 and 3, the rails are shown irregularly canted, and in opposite directions. The circumference of the wheel where it touches the rail in fig. 2 is nearly ¾ths of an inch less than in the same wheel when touching the rail as shown in fig. 3: the effect of this variation in the size of the wheel is to induce the carriage to describe a series of curves in its attempt to equalize the diameter of the wheels; the side motion thus induced is often suddenly arrested by the flanch of the wheel coming in contact with the edge of the rail, and the vibrations are thrown in an opposite direction,—thus great irregularity of motion is produced, and often continued, and even augmented, long after the vehicle may have passed the original disturbing cause. In no other way can I account for the side motion so often noticeable in our trains,—not at any particular part of the road, but irregularly, sometimes at one place, sometimes at another, and often on portions which, on after-inspection, appear to be in excellent order.

Proposed Method.—(Drawing No. 6.)

Having now noticed the good and the defective points in the various descriptions of permanent way under consideration, I beg to lay before you Drawing No. 6, which describes a construction of road which I have every reason to think will meet the peculiar circumstances of our case. These circumstances are the number, weight, and speed of the trains; the soft nature of the substratum of the road; and the inferior quality of the ballast.

This permanent way consists of a longitudinal timber (which I adopt simply for the purpose of breaking the joint of the rail), accurately laid upon cross sleepers. The rail, 100 lb. per yard, of the bridge form, has its bottom flanch of the same width as the longitudinal timber, which it entirely copes; it is secured down to the cross sleepers by fang bolts, at intervals of 3 feet apart.

The longitudinal timber is dressed to a gauge, so as exactly to fit the groove formed in the cross sleeper; this groove is cut to the proper cant. The longitudinal timber having parallel sides (when laid on the cross sleeper), will also correspond with the cant, and the rail being laid upon it will present an upper surface of a uniform inclination throughout its whole length.

The cost of 5 yards of single line of this road will be 7*l.* 5*s.* 5½*d.*

The number of parts in the same length, 38.—(See *Appendix.*)

In conclusion, should the Board adopt this suggestion, I should recommend that an experimental length of permanent way should be laid down, with as little delay as possible, in such part of the line as may place it under the most unfavourable circumstances.

I am, gentlemen,

Your obedient servant,

Euston-square, August 23, 1848. ROBERT B. DOCKRAY.

APPENDIX.—PERMANENT WAY.

Comparative Estimates, showing the number of pieces required and the expense in constructing 15 *feet length of Single Line by each of the following methods, exclusive of Labour in laying down the Road.*

London and North-Western Railway. (Old Method).—Drawing No. 1.

Number.	Description.	Weight. lb.	Rate. £	s.	d.		Amount. £	s.	d.
2	Rails (75 lb. per yard)	750	10	0	0	per ton.	3	7	0
2	Joint Chairs	60	7	10	0		0	4	0
8	Intermediate ditto	160	7	10	0		0	10	8½
20	Iron Spikes for Chairs	10	0	0	4		0	3	4
5	Sleepers	—	0	5	6		1	7	6
10	Keys	—	0	0	2¼		0	1	10½
47							5	14	5

16,544 parts in a mile of single line.

Cost of ditto, exclusive of labour in laying £2013 14 8

London and North-Western Railway (New Method).—Drawing No. 2.

Number.	Description.	Weight. lb.	Rate. £	s.	d.		Amount. £	s.	d.
2	Rails (82lb. per yard)	820	10	0	0	per ton.	3	13	1½
2	Joint Chairs	82	7	10	0		0	5	6
8	Intermediate ditto	224	7	10	0		0	15	0
5	Sleepers (16½ feet cubic)	—	0	5	6		1	7	6
10	Keys	—	0	0	2¼		0	1	10½
22	Trenails for Chairs	—	0	0	1⅛		0	2	0¼
49							6	5	0¼

17,248 parts in a mile of single line.

Cost of ditto, exclusive of labour in laying £2,191 18 8

Great Western Railway (Mr. Brunel).—Drawing No. 3.

Number.	Description.	Weight. lb.	Rate. £	s.	d.		Amount. £	s.	d.
2	Rails (72 lb. per yard)	720	10	0	0	per ton.	3	4	6
2	Joint Plates	13	0	0	1½	per lb.	0	1	8¾
2	Straps for fastening Transomes	4½	0	0	4		0	1	6
4	Bolts for ditto	12	0	0	4		0	4	0
6	Nuts for ditto								
6	Washers for ditto								
8	Spikes for Rails								
4	Screw-bolts at joints of Rail								
4	Fangs ditto ditto								

Number.	Description.	Weight. lb.	Rate. £ s. d.	Amount. £ s. d.
38	.. .. Brought Forward		.. ..	3 11 8½
40	Hardwood Packings under Rails (6 in.)	—	0 0 4½	0 2 1½
2	Longitudinal bearers (23½ feet cubic) ..	—	0 2 3	2 16 10½
1	Transome 1 ft. 8 in. cubic	—	0 2 3	0 3 9
81				6 14 5½

28,512 parts in a mile of single line.
Cost of ditto, exclusive of labour in laying £2,365 14 8

Midland Great Western of Ireland (*Mr. Hemans*).—*Drawing No.* 4.

Number.	Description.	Weight. lb.	Rate. £ s. d.	Amount. £ s. d.
2	Rails (76 lb. per yard)	760	10 0 0 per ton.	3 7 10½
2	Joint Plates	18	0 0 1½	0 1 8
16	Screws to hold down Rails	29	0 0 4	0 9 8
8	Screw-bolt at Joints			
8	Fangs for ditto			
2	Longitudinal Bearers (15 feet cubic). ..	—	0 2 3	1 13 9
2	Transverse Sleepers (4½ feet cubic)	—	0 2 3	0 10 1½
4	Trenails for joints of Longitudinal bearers	—	0 0 1½	0 0 6
44				6 3 7

15,488 parts in a mile of single line.
Cost of ditto, exclusive of labour in laying £2,162 11 2

Sir John Macniell's Method.—*Drawing No.* 5.

Number.	Description.	Weight. lb.	Rate. £ s. d.	Amount. £ s. d.
2	Rails (92 lb. per yard)	920	10 0 0 per ton.	4 2 2
8	Screw-bolts at Joints	8·33	0 0 4	0 2 9
8	Fangs for ditto	8·	0 0 4	0 2 8
10	Spikes	8·	0 0 4	0 2 8
2	Wrought-iron Chairs	12	10 0 0	0 1 1½
6	Sleepers (20 ft. 9½ in. cubic)	—	0 5 6 each.	1 13 0
36				6 4 4½

12,672 parts in a mile of single line.
Cost of ditto, exclusive of labour in laying £2,171 8 0

Mr. Dockray's Proposed Method.—*Drawing No.* 6.

Number.	Description.	Weight. lb.	Rate. £ s. d.	Amount. £ s. d.
2	Rails (100 lb. per yard)	1000	10 0 0 per ton.	4 9 3
8	Screw-bolts at Joints	—	——	0 2 9
8	Fangs for ditto	—	——	0 2 8
10	Spikes	—	——	0 2 8
2	Wrought-iron Chairs	—	——	0 1 1½
6	Transverse Sleepers	—	0 5 6	1 13 0
2	Longitudinal Sleepers (6ft. 3 in. cubic).	—	0 2 3 per foot	0 14 0
38				7 5 5½

13,376 parts in a mile of single line.
Cost of ditto, exclusive of labour in laying £2,560 1 4

SUMMARY OF THE COST OF FIVE YARDS.

	£	s.	d.
London and North-Western Railway (Old Method) ..	5	14	5
Ditto ditto (New Method) ..	6	5	0½
Great Western Railway (Mr. Brunel)	6	14	5½
Midland Great Western of Ireland (Mr. Hemans) ..	6	3	7
Sir John Macniell's Method	6	4	4½
Mr. Dockray's Proposed Method	7	5	5½
	£38	7	4
Average Cost	£6	7	10¾
Cost of Single Road per yard ..	£1	5	6¾

CANDIDUS'S NOTE-BOOK,
FASCICULUS XCV.

> "I must have liberty
> Withal, as large a charter as the winds,
> To blow on whom I please."

I. I resume my comments on the "Seven Lamps" by quoting the excellent passage last alluded to. "Of Proportions," says Ruskin, "so much has been written that I believe the only facts which are of practical use have been overwhelmed and kept out of sight by vain accumulations of particular instances and estimates. Proportions are as infinite (and that in all kinds of things, as severally in colours, lines, shades, lights, and forms) as possible airs in music: and it is just as rational an attempt to teach a young architect how to proportion truly and well by calculating for him the proportions of fine works, as it would be to teach him to compose melodies by calculating the mathematical relations of the notes in Beethoven's Adelaide, or Mozart's Requiem. The man who has an eye and intellect will invent beautiful proportions, and cannot help it; but he can no more tell *us* how to do it than Wordsworth could tell us how to write a sonnet, or than Scott could have told us how to plan a romance. But there are one or two general laws which can be told: they are of no use, indeed, except as preventives of gross mistake; but they are so far worth telling and remembering; and the more so because, in the discussion of the subtle laws of proportion (which will never be either numbered or known), architects are perpetually forgetting and transgressing the very simplest of its necessities."—After this, it is to be hoped that writers will deal less in quackery and mystification on the subject of Proportion than they have hitherto done; and in such manner, too, as to contradict themselves, by representing it as an exceedingly subtle and abstruse matter, yet at the same time so exceedingly simple as to admit of being reduced to the plainest arithmetical rules, which, as they pretend, serve equally well alike for the most opposite cases. According to such truly mischievous doctrine, an architect has no occasion whatever for an eye for Proportion, since rules and computation will serve his purpose just as well, or even better, inasmuch as machine-like accuracy is secured,—cold, spiritless, and lifeless. The doctrine of some, Vitruvius included, would go to convert our art into a sort of barrel-organ, upon which all can grind music alike. Of course they do not say as much in plain words, neither are they themselves, perhaps, aware of the tendency of their own doctrines and opinions—viz., that nothing ought to be done or attempted now except what has some time or other been done before; as if among all possible forms and combinations there were none yet untried that would be found beautiful: such doctrine is, no doubt, excellently well-suited to, and accordingly finds favour with, the *Incapables*, who have no artistic instinct or æsthetic feeling to guide them, and who, therefore, are not only glad to be spared the trouble of thought and invention, nothing more than ready-made ideas being required of them, but rejoice also that others should be prohibited from exercising them by the dread of being set down at once for licentious innovators. Your small critics, too, who gabble only by book and by rote, entertain a mortal dislike to aught pàrtaking of freshness of mind and invention, because it puts them quite out; yet, although they do not know what to make of it, they do know that they may very safely sneer at it as heterodox and capricious. It is not, indeed, from every one that we can expect any really new ideas worth having, yet there surely must be some who are capable of detecting latent sources of the beautiful, and of manifesting power of invention subordinated to that correct taste which, it may be presumed, has been nourished in them by previous study,—and by *study*, a very great deal more is to be understood than the elementary discipline and training of the office, or than becoming familiar with the various styles of the arts hitherto practised, such study being merely of a passive sort, and requiring the exertion of no other faculty than the memory; whereas, the study which is most needed is that diligent scrutiny and thoughtful examination of styles and their monuments, by which, while learning what has been done, we learn also to perceive what more may be done. In comparison with this last kind of study, the getting by heart—as it is called—of the history of styles, is work only for girls and old women—old ladies of the masculine gender, and all ages, included. *Valeat quuatam;* it is serviceable enough in its way, but will no more make an architect than poring over Vasari and Lanzi will make a man a painter. As matters are managed at present, however, we seem to be well content to get architecture without having architects,—content with what amounts to no more than new editions of the architecture of former times, without original authorship. In architecture we have contrived to get to *Finis*, which is surely a very fine feather in the cap of this nineteenth century.

II. Ruskin lays by far too much stress upon the value of material as absolutely essential to excellence of design. Most unquestionably, genuine and therefore durable materials enhance the satisfaction we experience in contemplating an edifice that is beautiful as a production of architecture, and we reasonably enough expect to find such materials to be employed for public structures that ought to be enduring monuments of art. But Mr. Ruskin pushes what is in itself a proper feeling into downright extravagance and absurdity when he denounces the making use of artificial and imitative materials as "direct falsity of assertion respecting the nature of the material or the quantity of labour," which falsity he asserts to be nothing less than a *moral delinquency!* —insomuch that he holds it to be "as truly deserving of reprobation as any other moral delinquency;"—which does not say much for Mr. John Ruskin's notions of morality. He is consistent, however, in attributing a high degree of positive merit to mere cost of labour and workmanship for its own sake, leaving merit of design and the artistic value of the work altogether out of the question. Yet, very certain it is, that, so far from giving pleasure, sumptuous material and expensive workmanship excite a painful feeling—one of regret if not actual disgust when employed for, or rather wastefully thrown away upon, an inferior or even decidedly bad design. Insisting so strongly as he does upon excellence of material and workmanship as a *sine-qua-non* in architecture, and as if they were of themselves all-sufficient—for, although perhaps he may intend that it should be inferred, he says nothing as to the necessity for corresponding excellence of design, notwithstanding that there is very great occasion for insisting mainly upon that as the foundation of all other excellence,—Mr. Ruskin seems after all to entertain but rather low, not to say vulgar notions of architecture and its powers as a fine art. A building that can be admired—as far as it can be admired at all—only for the beauty and money-worth of its materials,—and there are many such—is so far from being an honour to, as to be a reproach to the architect. It is for the latter to confer a value upon even the homeliest materials, and to stamp a charm upon costly ones that shall enhance their original market value hundredfold, or even more; not for the material and mere manual execution to give a vulgar £ *s. d.* value, as has frequently been the case ere now, to Pecksniffian taste and Pecksniffian design. And so far, Mr. Ruskin shows himself to be too much of a *materialist* in art, and to be strangely devoid of æsthetic sensibility.

III. Even where there is equal beauty of both material and design, it is for the latter alone that the architect himself can claim any merit, for as to the other, and the workmanship of it, they belong not to him, but in the first instance to his employers, and in the next to the actual operatives. As far as his own talent is concerned, it makes no difference whether his ideas be realised in genuine or fictitious materials. That there usually is a great deal of vulgar, barbarous, and paltry taste shown where such materials are made use of, is not to be denied; yet that is more the fault of the design and the designer, or of paltry and slovenly execution, than of the deception itself; which, if it be such as to impose upon and consequently perfectly satisfy the eye, produces just the same effect as would result from employing the actual materials which are simulated. That refined taste and elegance may be displayed with materials which are in themselves of little or no money-worth, is proved by Greek fictile vases and many antique terracotta ornaments. Certain also it is that as objects of art, well executed plaster casts from approved originals are preferable to ordinary marble statues. It is owing to tastelessness and trumperiness of design, and to slovenly coarseness of execution, far more than to the ordinary quality of the materials employed, that we have so much architectural trumpery. Because embellishment with fictitious materials costs comparatively little, it is generally offensively overdone, and thereby alone proclaims itself to be spurious; whereas, were it applied with proper reserve and discretion, decoration of the same kind—of course provided it were satisfactorily executed—might pass unquestioned.

IV. So great is Mr. Ruskin's enthusiastic admiration of cost and labour for their own sake, that he would have the same degree of finish bestowed upon those parts of a building which are out of sight, or nearly so, as on those which can be closely inspected. "The principle of *honesty*," he tells us, "must govern our treatment: we must not work any kind of ornament which is, perhaps, to cover the whole building (or at least to occur on all parts of it) delicately where it is near the eye, and rudely where it is removed from it. That is trickery and dishonesty." My good Johnny Ruskin, what an admirably honest world we should live in had we no more dishonesty and moral delinquency than such deception amounts to, to encounter or complain of. Now, it is a generally received maxim among artists that they should proportion the degree of finish they bestow on their work to the distance at which it is intended to be viewed. So long as there be the appearance of finish, it matters not how it is produced; nay, rude touches of the pencil or chisel may tell effectively where the same careful manipulation as is required for similar decoration that can be closely examined would not tell at all. Even Mr. Ruskin is somewhat at variance with himself when he afterwards says in another place: "It is evident that for architectural appliances, masculine handling, likely as it must be to retain its effectiveness when high finish would be injured by time, must always be the most expedient; and as it is impossible, even were it desirable, that the highest finish should be given to the quantity of work which covers a large building, it will be understood how precious the intelligence must become which renders incompletion itself a means of additional expression; and how great must be the difference, when the touches are rude and few, between those of a careless and those of a regardful mind." To the passage just quoted I fully assent,—not, perhaps, very disinterestedly, because it in fact makes strongly for my own argument against what Mr. Ruskin had previously urged. There is, indeed, no greater test of genuine artistic skill than the producing by means of what considered in themselves would appear to ordinary eyes mere rude and random touches, just the desired effect—the labour of the mind sparing all superfluous and unnecessary labour of the hand.

V. The following is an excellent piece of advice, and one of the best and most pertinent remarks in Mr. Ruskin's book: "Among the first habits that a young architect should learn is that of *thinking in shadow*, not looking at a design in its miserable liny skeleton." The necessity for so doing requires to be impressed upon the student, because according to the now almost universal practice, on the continent especially, of showing architectural subjects in mere outline engraving, the expression derived from light and shade in all their various modifications and effects, is entirely withdrawn from the student's consideration; whereas it is what—if he is ever to become an artist in his profession—deserves his most thoughtful attention. "Liny skeletons," as Mr. Ruskin very happily calls them, give us rather abstractions of buildings—disembodied unsubstantial *spectra* of them—than actual representations of them as they show themselves to the eye. No wonder therefore that, excellent as they may be in themselves, works engraved in that manner have no interest for any except professional men and a few studious amateurs. It must be admitted that outline engravings are eminently serviceable in one respect, because they show form in all its minutest lineaments more clearly than shadowed ones can do; and they thereby lead to correctness of eye and hand in drawing. Their insufficiency consists in their not showing buildings as they really do appear, or designs as they will appear, when executed. Many a building which when so shown has a very disagreeably bald and vacant look, may, when seen in its proper substantiality, and in all the vigour of broad light and shade, be a striking object; and so, on the other hand, one which looks exceedingly well when judged of by its *pattern* in outline, may be, or turn out to be, comparatively unsatisfactory, tame, and spiritless. The greater part of the details, perhaps, which show so well as ornamental pattern upon paper, will be found hardly to show themselves at all or very imperfectly in the actual structure. It is owing to the practice of architects giving their attention too exclusively to linear appearance alone, instead of at the same time "thinking in shadow" also, that we get so much of *mere pretty pattern*. We frequently see a great many "very *nice*" parts—a "nice" bit there, another "nice" bit there, and so on;—just the very things, perhaps, for an architectural scrap-book, where they would be in their proper *place*. We can dispense with fragmentary *niceties* of that sort in our buildings, which ought to show well-considered artistic compositions, and not be mere scrap-books in stone.—I have here been interrupted by a visitor, who, on my pointing out to him what Ruskin says as to the necessity for thinking in shadow, observed: "Aye, and of thinking and feeling like artists, which very few of our architects seem ever to do when they sit down to their drawing-board. Were some of them to *think* a great deal more, and talk not quite so much maudlin, frothy stuff as they now do, it would be better for themselves and for their art also." My friend went on in a similar strain for some time, I listening to him the while far more patiently, nay complacently, than most other persons would have done.

MR. FERGUSSON AND THE BRITISH MUSEUM.

Although little more than a *brochure*, the new production from Mr. Fergusson's pen,* which has just appeared, is likely to obtain far more general notice, and that too immediately, than his larger work lately reviewed in several successive numbers of this *Journal*, for the latter appears to be quite a *noli-me-tangere* to the rest of the fraternity of reviewers—even those who profess to take especial notice of everything bearing upon and connected with Art. His present "Observations," on the contrary, are so exceedingly stirring that they can hardly fail to excite public attention, and perhaps excite some commotion also in several quarters. While many will be startled at the magnitude of some of his schemes, others will marvel not a little at the fearlessness with which he has probed and dissected the *magnum opus* of a living architect, and proved it to be utterly naught. Such operating upon the "living subject" is, we hardly need remark, quite contrary to the usual etiquette of architectural criticism, which, perhaps for fear of getting into scrapes, cautiously abstains from passing formal

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* Observations on the British Museum, National Gallery, and National Record Office, with Suggestions for their Improvement. By James Fergusson, M.R.I.B.A., author of "An Historical Inquiry into the True Principles of Beauty in Art."—London: J. Weale.

judgment upon the doings of "contemporaries;" yet, for our part, we do not see wherefore living architects should not be damned with just as little ceremony as living authors;—that is, of course, supposing they deserve it.

For the present we will confine ourselves to the British Museum alone, and to what Mr. Fergusson says of that monstrously costly, and egregiously unsatisfactory national edifice. We certainly do not quarrel with him for his opinion of the building itself, which he minutely examines, and proves (*very satisfactorily?*) to be as unsatisfactory as it well could be. If we quarrel with him at all, it is for his too-studied attempt to exonerate the architect himself from the disgrace justly due to him. "I would not, on any account," says Mr. Fergusson, "be understood to say one word against Sir Robert Smirke, personally." Neither do we, nor have we ever done so; for of the man himself we know no more than we do about the man in the moon. As a man he may be excellent, and even exemplary for aught we can say to the contrary, but as an architect we hold him to be a most wretched one, and prosaic besides; in short, no better than a Pecksniff on a larger scale. After calling "the Museum as bad and as extravagant a building as could well be designed," Mr. Fergusson immediately adds, "but let the blame be thrown on the right shoulders;" and then proceeds to lay the whole of it on those of the unlucky Trustees. Now, so far from thinking, as Mr. Fergusson appears, or is willing to appear to do, that the Trustees dictated to Smirke, we should rather fancy that it was Smirke who dictated—that is, recommended to them the style and character their new building should be in. There most assuredly is nothing in any of his previous works to show that he would have chosen any other style or mode of design had he been left to his own free and unbiassed choice, and granted a complete *carte blanche*. At any rate, even if the Trustees did dictate the style, they did not stand over him while he was making the design, and insist upon his introducing all the blunders, faults, and absurdities which we now find in it. To suppose that would be supposing that the architect was a mere mechanical agent or machine, that worked just as they impelled and directed its movements. Either the design of the Museum is Sir R. Smirke's, or it is not:—if, as the very natural supposition is, it really be his own, he of course is answerable for it, and for all its defects, deficiencies, and short-comings; and if, on the contrary, he has been no more than a mere clerk of the works, acting under other persons' instructions and directions, in like manner as in case of success he would have reaped the full credit due to their judgment and good ideas, he must now abide by the discredit attached to failure. We hardly know whether Mr. Fergusson is to be understood as speaking with sarcastic irony or not, when he says that, had not Smirke fallen in with the ideas of the Trustees, contrary, as is of course implied, to his own better judgment, they "would certainly have wished him a good morning, have sent for some more compliant person, and he might have retired to obloquy and"—oh! dreadful—"to starvation!" Nothing, it seems, but his compliance with the whims of the Trustees, saved poor Sir Robert Smirke from pauperism and the workhouse,—though we think he must have feathered his nest pretty well long before. From *starvation* his compliance may possibly have rescued Sir Robert, but most certainly not from *obloquy*, unless there be more of praise than obloquy in its being said—and Mr. Fergusson himself says it—that it is, after costing about seven hundred thousand pounds, as bad as bad can be. Whether Sir Robert will now be glad to shelter himself from the pitiless pelting of criticism under such excuse, we know not; but Mr. Fergusson certainly looks upon him as having been a mere instrument, implement, or tool in the hands of the Trustees, and accordingly observes, "Though I have much to say against the building, I entirely exonerate the architect"!—so that Sir Robert is after all a very fortunate man, for if he has got his head broken, he has also go it well plaistered up again by the same hand that cracked it, and now stands "entirely exonerated"—just as safe and sound as ever. Sir Robert may stick that feather of "entire exoneration" in his cap, without any one envying him.

Luckily for them, the Trustees have excedingly broad shoulders, and a good many pair of them, so that they can perhaps very well bear the whole of the very weighty burthen which Mr. Fergusson lays upon them. For one thing, they certainly are highly censurable,—for they being only trustees for the nation, and the work a national one, to be paid for out of the nation's money, they ought to have endeavoured to secure the most efficient architectural talent to be found in the country, instead of blindly confiding in an individual on the mere strength of his general repute. Had Sir R. Smirke previously erected a Museum which had obtained general favour as a successful work of its kind, it would have been quite a different case. But he had not done so; consequently, a structure for such very particular purpose would be quite as much a first attempt on his part as on that of the most obscure individual in the profession. Nay, it is very possible that some amongst the obscure and unknown might have, in the course of their studies, given attention to the particular subject. At all events, it was the duty of the Trustees—both the big-wigs and the bald heads which compose that many-headed body—to call upon the best talent procurable, and afford it the opportunity of coming forward and manifesting itself. If there was objection to a general public competition, as merely opening the door to self-sufficient mediocrity and a troublesome mass of designs, the majority of which must at once have been set aside, at any rate a limited number of known talent might have been invited to submit their ideas; from which the better points might have been selected, and afterwards combined together, two or even more architects being associated in the work—supposing no individual design was so satisfactory as not to be capable of improvement by engrafting upon it something borrowed from others. This, as it appears to us, is the safest and most rational course to be pursued; and the fairest to be adopted in public—at least, all government works. Instead of which, they are if not actually made jobs, made to appear to be such.

By throwing all the odium of the failure of the British Museum upon the Trustees, Mr. Fergusson has, perhaps quite unintentionally, levelled a blow that falls very hard in a different quarter; for he scruples not to call the new building at Buckingham Palace "so hideously ugly that both the sovereign and the people must be glad to get rid of them." The latter perhaps may, because they had no hand in, nor were even so much as consulted about it; but, as there is no evidence, or even so much as a doubt, to the contrary, the natural presumption is that the design was found satisfactory and approved of in what the newspapers term "a very high quarter." Therefore, the excuse put forth for Sir Robert Smirke is equally valid for Mr. Edward Blore. "As a servant of the public," the former "did what he was told to do;" and as the official architect or surveyor of the Palace, the latter acted, no doubt, similarly, and did as he was directed to do, although both the one and the other might have shown skill and taste in complying with the general directions given them. To hint that her Majesty would now be glad to get rid of the costly improvement—or, to speak more correctly, the costly addition to the Palace, and to say that the Palace itself so improved "will not long be tolerated, but a new one demanded," is anything but flattering to some other persons besides Mr. Blore, whom we accuse not, because he, no doubt, has done his very best. Let us hope, then, that it has saved the poor man from the horrors of "starvation."

After this digression, we return to the Museum, speaking of whose façade, Mr. Fergusson says: "If it is not beautiful, it is inexcusable; if it is beautiful, a strong case is made out in its favour. It certainly does not possess what is the strongest objection to the [inner] court, which is that it is not seen; for no one can either approach or pass the Museum without its catching the eye; it is therefore in the right place, which the other is not; and if ornament was to be added to the Museum, it was here that it was to be placed. Is it then beautiful? This [that] is a matter of taste which each must answer for himself." As regards the last remark and the doctrine implicated in it, we do not at all hold with Mr. Fergusson,—because when a man comes before the public as a critic, it is for him to instruct by plainly discriminating between good and bad taste. All art is matter of taste; so that if one man's taste be just as valid and of equal authority as another's, many of the *dicta* and verdicts of careful and conscientious criticism might be reversed. Of the thousands, or tens of thousands, and even hundreds of thousands, who in the course of a year visit the British Museum, how many are there who can fully appreciate, and who sincerely relish the Elgin Marbles? Shall we say a score? —ten would be nearer the mark. If it is to be left to every one to answer for himself whether a work of art, or what makes pretension to be considered such, be really meritorious, there is, as it seems to us, an end to all criticism—all æsthetic reasoning; and one man's judgment, or fancy without any judgment at all, becomes quite as valid as another's.

Notwithstanding, however, the lenity with which he leaves every one to judge for himself how far the façade is beautiful, Mr. Fergusson gives it immediately afterwards as his own opinion that the design is "both cold and unartistic,"—adding, "there is a dismal funereal look about this specimen, which to my mind is singularly repulsive;" and further says: "Since it has been erected I have not heard one voice raised in its praise, and certainly not one word of laudation has been printed that I am aware of; but, on the contrary, blame has been both loud and deep." That, indeed, as we are informed in a foot-note, was written before Mr. Ruskin's "Seven Lamps" had appeared, to throw a cheering gleam of light on Smirke's Museum; and a very scanty gleam it is, for it leaves us altogether in the dark as to what are the beauties and merits that obtain for it Mr. Ruskin's "sincere admiration."

Mr. Fergusson appears to attribute the defects of the design—its coldness and unartistic character—rather to the style than, as we do, to the architect's very prosaic treatment of it. Yet, surely the style itself is not deficient in beauty; and, in fact, what of beauty there is in the design at all, is derived entirely from the Ionic columns alone, for in every other respect the building is so frigidly bare as to have hardly the look of being finished. Even the columns themselves, too, are so disposed as to produce more of wearisome sameness and monotony than of architectural richness. There is so little agreement between the colonnades and the building behind them, that the former might be taken for an afterthought, and be supposed to have been added merely to eke out and dress up the other. Unless the spirit of the style evidently aimed at by the colonnades could have been faithfully kept up in all the rest, it would have been better to have let it be seen that the antique Greek character was not professed to be adhered to. Smirke, on the contrary, has so managed it that his tame and scrupulous accuracy with regard to antique columniation occasions such a disparity of parts, that integrity of *ensemble* is quite forfeited.

We have said that the colonnades might pass for being an afterthought, and they actually do appear to have been designed without any regard to what is behind them, because—as may be seen by the plan given by Mr. Fergusson, who, however, does not point out that very singular blunder—many of the windows are not in the same axis as the corresponding intercolumns; and in two places, a window comes immediately behind—that is, in the same axis, as a column. This gross infringement of one of the simplest rules of architectural grammar will probably be attributed to carelessness on the part of the engraver, especially as the plan is on a small scale; whereas it occurs in the building itself, where it has always pained our eyes. In a view either way straight down along the colonnade, from the entrance, the vista is sadly marred, and made to have quite a *lop-sided* look, by the window seen at the end of it being out of the axis, and, moreover, squeezed up against a corner.

Mr. Fergusson has pointed out how, by placing the staircase (which is lighted from above) on the south side, instead of next the inner court, which last situation would have been better for the first gallery,—windows might have been dispensed with in that part of the colonnades; and by a very little contrivance in the plan, they might have been got rid of in the corresponding portion on the other side of the entrance. As to the windows within the return colonnades, where the irregularity above-noticed takes place, they seem to be quite uncalled for, the rooms there (mostly private ones) being lighted from the opposite side also, and some of them even from a third side.

As far as character is concerned, there is nothing whatever in the building to express plainly to the eye at once its specific purpose; which particular definite expression might surely be imparted to a museum far more easily than to a public edifice of any other class. That it is the Museum is perfectly well known,—and so was the former old building; yet surely the merely being known as such is not sufficient, nor to be received in lieu of intelligible architectural character, and marked indication of its peculiar purpose. If there be any edifice which more than another admits of, or rather demands architectural luxury, it is a public museum of works of art, for it ought to be a finished work of art itself; and thereby tend to improve public taste. If we are content with a mere warehouse or repository for books and sculpture, well and good. The saving money in building, in order to apply it to enlarging the collections, is intelligible and rational economy; whereas, to squander it away by hundreds of thousands, to produce what is after all a poor, would-be-fine, botched-up structure, wherein the grossest bungling, the most paltry meanness, and the most offensive eyesores display themselves,—is provoking and mortifying beyond expression. The only comfort we now feel, is that the mortification which we ourselves feel is, after what Mr. Fergusson has said, likely to become very general, and to be most felt just where it ought to be.

Although he has shown no contrivance whatever in any other respect, Sir Robert Smirke has contrived to make his Ionic colonnades look no better than mere *frippery*—a sort of architectural "cover-slut" to a very ugly and mean-looking brick building; and, moreover, put on so slovenly, that it does not even so much as conceal what it is intended to mask and hide. Even were the central mass of the general façade many degrees better than it actually is, and in itself satisfactory, still all the rest—the parts mixed up, for we cannot say combined, with it—are such exceedingly ordinary, everyday, and some of them even vulgar stuff, that grandiose composition—and considering what has been expended, we ought at all events to have had that for our money—is quite out of the question.

Good, substantial, but quite plain brick houses would surely have been good enough for the officers of the establishment; and had a range of such houses been erected in continuation of those on the west side of Montague-street, besides great saving as to cost, two decided advantages would have been obtained,—for, in the first place, those houses would have screened out the ugly brick mass to the which the "grand" Ionic façade is merely tacked on; and, in the next place, there would then have been an opportunity of providing additional accommodation for the increasing collections, by erecting, for the enlargement of the Museum itself, two extreme wings brought nearly up to the main structure, so as to form together with it one consistent and well-balanced, yet varied, composition. Such extension in front is, however, now rendered impossible; yet, that enlargement in some way or other would be required within a few years, had become tolerably evident even before the two ranges of official dwellings, which are made to officiate as wings, had been commenced. Perhaps the very best course that can now be pursued would be to adopt what Mr. Fergusson recommends, which is to convert the gallery of antiquities, and other rooms occupied by the several collections of sculpture and natural history, into a repository for the Public Records,—so that they and the Library would form a vast national collection of literature and historical documents treasured in one and the same building. This would require no alteration of the structure itself, and the merely fitting-up the rooms for their new purpose would be attended with comparatively small expense. The chief obstacle in the way of its being done is that such scheme involves the necessity of a further one also proposed by Mr. Fergusson, which is to incorporate the collection of sculpture and antiquities now in the Museum, with the National pictures. He accordingly suggests that the Barracks at the rear of the National Gallery should be removed elsewhere, and additional galleries be erected on the site; and the whole plan be gradually extended in the course of time, so as to take in St. Martin's Workhouse also, and ultimately occupy the whole space bounded by Whitcomb-street and Dorset-place on the west, Orange-street and Hemming's-row on the north, and St. Martin's-lane on the east. And there we think he might very prudently have stopped; instead of which, he further proposes that the present National Gallery should be taken down and rebuilt; which certainly does appear to us a very uncalled-for, and therefore wanton, piece of extravagance. Even Mr. Fergusson himself vindicates that structure from the senseless abuse heaped upon it while several others which are many degrees worse are allowed to escape perfectly censure-free. He questions whether we should get anything much better upon the whole instead of it; and further admits, that as far as they go, the present picture-rooms answer their purpose sufficiently well. Then, why, in the name of common-sense, should that be destroyed which requires only to be enlarged?—as may be done with the greatest facility, provided the *pou sto*, the ground for additional buildings, and of course, the requisite "wherewithal" or funds, also can be obtained. So far, then, we do not altogether agree with Mr. Fergusson; and we think, besides, that where so much is asked for, or proposed all at once, alarm is likely to be taken,—and so in the end nothing whatever be done. One effect, however, Mr. Fergusson's "Observations" will certainly have, though his "Suggestions" may have none; since the former can hardly fail to make the Trustees of the British Museum open their eyes pretty widely, and stare at each other very profoundly, when they find out how blunderingly they have managed their building,—and, what is worst of all, that the public are now informed how egregiously they have blundered from first to last. As for Sir Robert Smirke, he, it appears, is intact, and remains *totus, teres, atque rotundus*. At the very worst, he can console himself by saying:

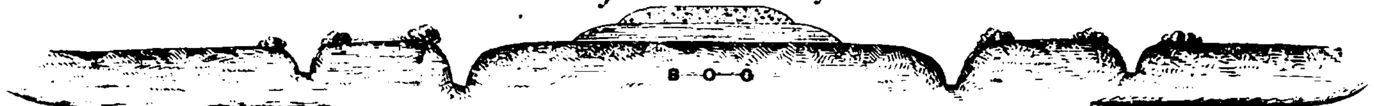
> "Populus me sibilat; at mihi plaudo
> Ipse domi, simul ac nummos contemplor in arcâ."

Mural Paintings at St. Cross.—Coloured drawings of these paintings, recently discovered on the walls of the Church of St. Cross, were exhibited by Mr. Francis Baigent, at a recent meeting of the Archæological Association. Some are exceedingly elegant in design, and apparently of the early part of the fifteenth century.

SECTION OF A ROAD CARRIED BOG.

ALSO PLAN AND SECTIONS OF A SINGLE WOODEN CULVERT.

Fig. 1. - Section of Roadway.



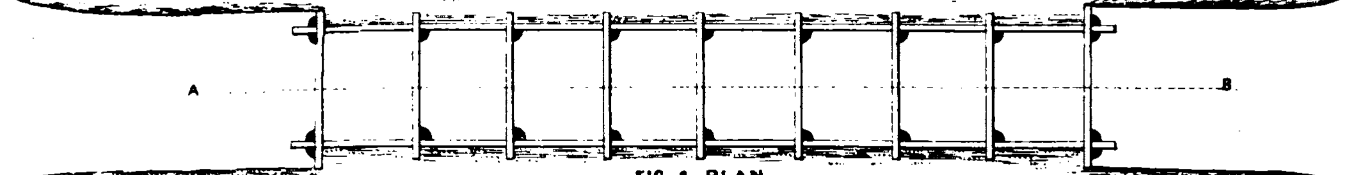


FIG. 2. PLAN.

FIG. 3.

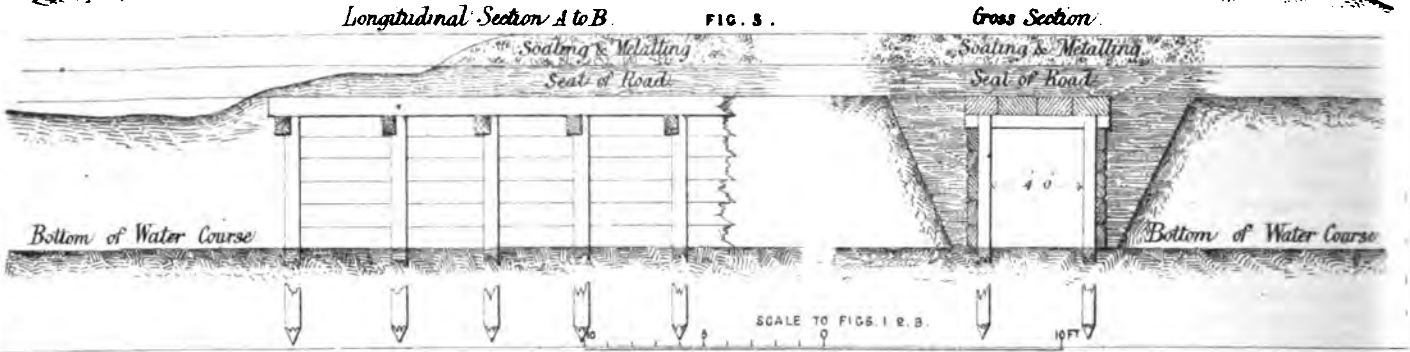
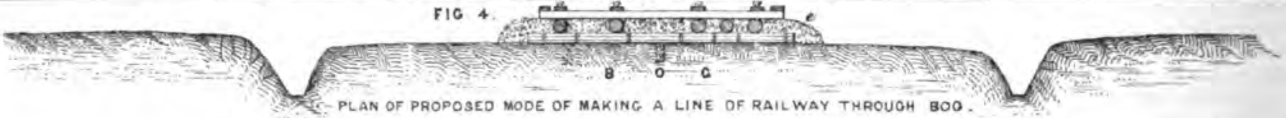


FIG. 4.



PLAN OF PROPOSED MODE OF MAKING A LINE OF RAILWAY THROUGH BOG.

FIG. 5.

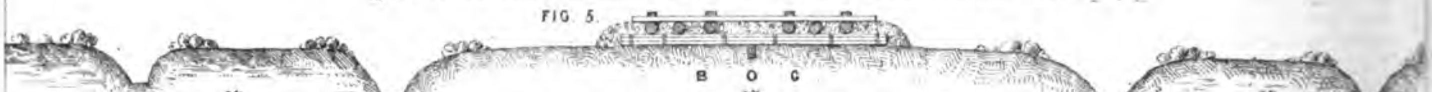
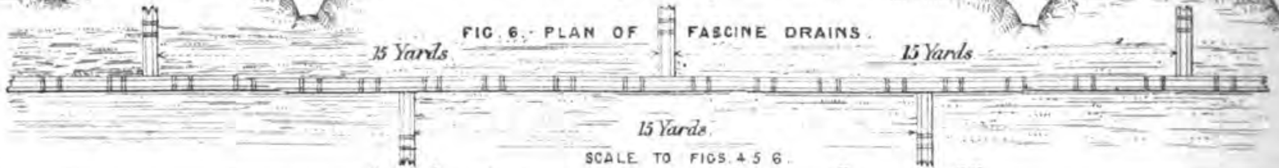
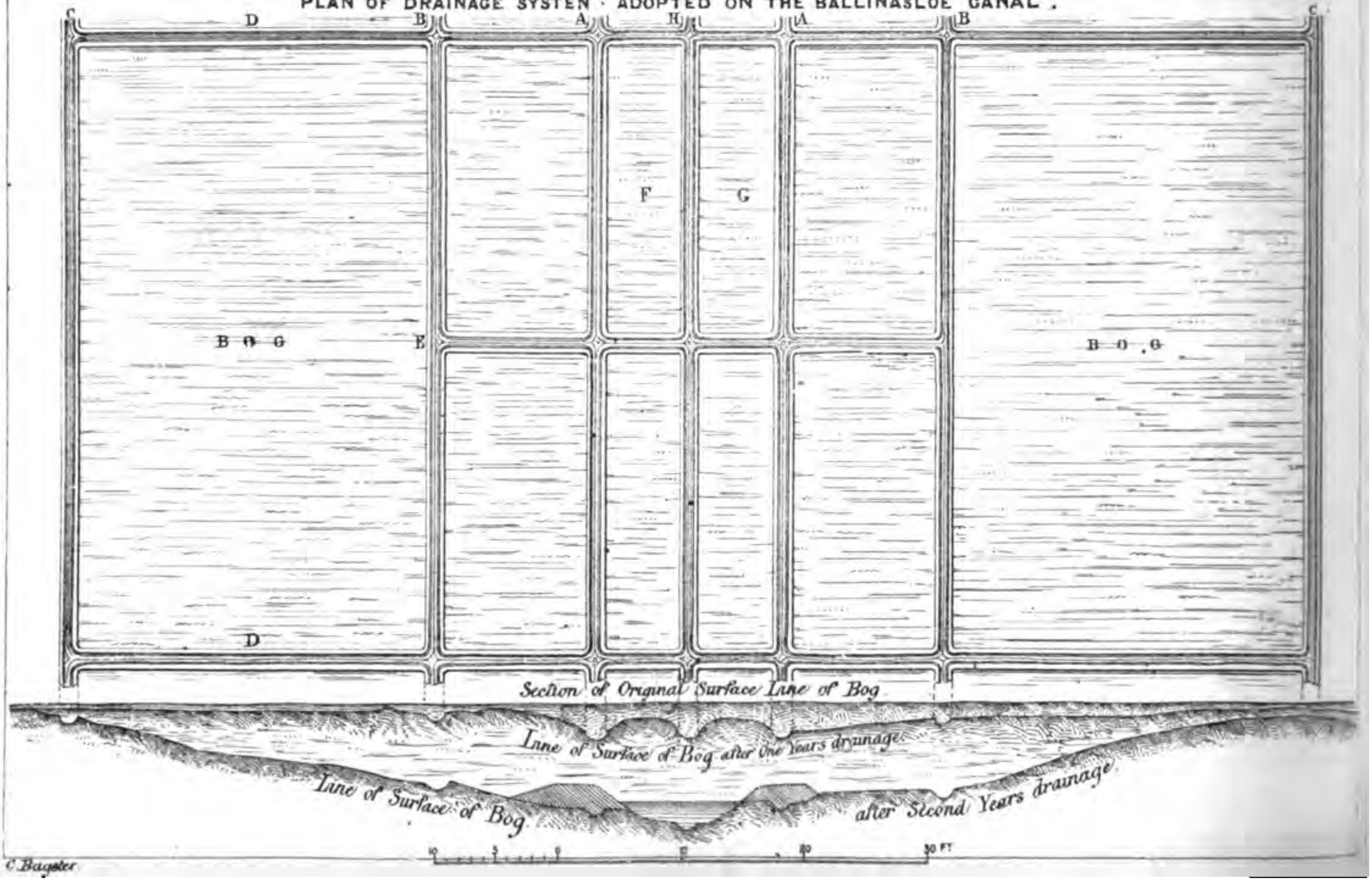


FIG. 6. PLAN OF FASCINE DRAINS.



PLAN OF DRAINAGE SYSTEM ADOPTED ON THE BALLINASLOE CANAL.



C. Bagster

SOLID WROUGHT-IRON RAILWAY WHEELS.

(*With Engravings, Plate* XII.)

On a Patent Solid Wrought-Iron Wheel. By Mr. HENRY SMITH, of West Bromwich.—(Paper read at the Institution of Mechanical Engineers.)

The subject of the present communication is a new wrought-iron railway wheel, which is forged solid in one piece, and is manufactured entirely by the forge hammer; the wheel is disc-shaped, the disc portion being about ⅝-inch thick, and gradually swelled out to the thickness of the nave and the tyre.

The following may be stated as the chief desiderata in a railway wheel:—1st. The greatest possible strength with the least possible weight.—2nd. Durability, implying also facility of repair.—3rd. Economy in cost.

On the first of these points it is conceived there will be no difference of opinion about the disc shape being the strongest possible; and also that when a wheel is made in one entire piece, it must necessarily be less liable to the effects of wear and tear than one which is composed of a number of pieces. This will be made more manifest by analysing the mode of manufacturing railway wheels in the old or ordinary way. For this purpose, and for the sake of drawing the fairest comparison between the wheel now under consideration and the ordinary wheels, a wrought-iron wheel is selected of the most improved make, having a wrought-iron nave, with the spokes welded to the nave and to the inner tyre. The following is the mode of manufacture of such a wheel:—Pieces of iron with wedge-shaped ends, are brought together all converging to a common centre. These are then welded together to form the nave or boss, and the inner ends of the spokes, of the intended wheel. Other pieces, T-shaped, are then welded to the ends of these spokes and again to each other, forming the inner tyre of the wheel. This done, a rolled tyre-bar of a suitable length, is bent into a circle of a proper diameter to go on the inner tyre, and is welded to form a perfect circular hoop. This hoop is then heated in a furnace and put upon the inner tyre, and then the wheel is immersed in cold water to occasion such an amount of contraction of the tyre as shall firmly fix it upon the wheel. Rivets or bolts are then passed through both to secure them together.

Now, it is submitted that the whole process of thus producing a wheel is open to many well-founded objections—such as the following:—The possibility of a want of dexterity in the manipulation of the different parts, in the making and bringing them together. The chance of doing so when the iron is not in a proper condition for welding; then, the uncertainty of the hoops or tyres being exactly the same length, or the wheels with the inner tyre of precisely the same diameter; and again, the amount of contraction of the outer tyre depending upon its slow or rapid cooling, will be affected by any variation in the temperature of the wheel itself and the water in the "bosh" or cooling cistern, and these of course cannot be kept uniform.—All these circumstances are opposed to wheels being well made with *loose* tyres, whether with wrought-iron naves and arms or with cast-iron naves.

In reference to the second head, Durability, it is conceived from the contingencies already alluded to, that it must be obvious, a wheel made in one piece will be the more lasting; but on this point, the wheel which forms the subject of the present inquiry has other claims to prefer. In consequence of the iron in the wheel being both granular and laminar, inasmuch as by the mode of manufacture hereafter explained this result is ensured, and the grain of the iron being brought to stand at right angles to the direction of the wear, and the body of the iron being of a denser and more compact character than rolled iron, it must doubtless be much stronger and more durable than any rolled tyre-bar of piled iron, which is liable to lamination, and altogether of a softer nature. Again, the torsive and abrasive effects of the carriage-breaks will not produce the same results on a solid disc wheel, as on one with a loose hoop or tyre of rolled iron. Then as regards repairing, when the tyre of the disc wheel is worn down so much as to require a renewal, the wheel can be put into the lathe and turned cylindrical, to receive a tyre in the ordinary way, secured on by bolts screwed into the tyre from the inner side, or by countersunk rivets through the tyre; and it must be then a better wheel than any yet manufactured.

On the subject of Cost, it can only be observed at present, that as the first expense does not determine this point, it must be left to be settled by the results of a sufficient experience.

The following is a description of the mode of manufacturing the *new solid disc wheels.* In the first place, a straight bar of hammered or rolled iron is taken, of 4 or 4½ inches width or more if required, and sufficiently long to form a hoop of such a diameter as is most suitable to make the intended wheel. Other pieces of bar-iron are then laid flat and close together, and cut in lengths to the same circle as the hoop, to form the base of a "pile;" the hoop is then placed upon this foundation, and filled with scrap-iron. The whole is then put into a reverberatory or heating furnace and when at the proper heat, is hammered in the tools or dies shown by drawing A, to form a "mould;" the face of the hammer is recessed in such a shape as to form an approximation to the shape of one side of the intended wheel, but only about two-thirds of the diameter; and the anvil-face has a circular recess, flat-bottomed, into which the hammer-face enters. Two of these "moulds" are then put together back to back, heated in a similar way and hammered between the tools or dies B, which are of the same sectional form and nearly the full-size scale of the finished wheel; but these tools embrace only a segment of about one-fifth part of the entire wheel. The "mould" is turned round horizontally during this process, being turned a little between each blow of the hammer, and it is thus hammered out to the form and size of the required wheel. The wheel is then put into an annealing furnace, and is planished between tools similar to the last, which are of the form and the full-size scale of the finished wheel, as shown by drawing C, and the wheel then only requires the tyre and the nave turning in a lathe, and the centre boring out. The finished wheel is shown in drawing D.

By this mode of manufacture it will be perceived that Low Moor iron, or any other description of iron or steel, can be used if required for the tyre of the wheel, and thus in all cases ensure a clean wearing surface, and a compound character of fibrous and granulated iron, which it is believed no other system of making wheels affords.

The centres for large spoke wheels are also manufactured in one solid piece in a similar manner, by the tools or dies shown in drawing E; the top and bottom tools are both alike, and are recessed in the form of the nave of the intended wheel, with a short portion of each of the spokes radiating from the nave. The centre of the wheel is thus stamped out by the hammer with a portion of each of the spokes about a foot long, ready for welding on to the T-pieces to form the inner tyre and the remainining portion of the spokes. A thin web or fin is left in the centre between the spokes, which is afterwards cut out by the smith. The object of this construction is to surpass in certainty of soundness the precarious method of making them at present in use.

It is unnecessary to urge the importance of obviating, as far as possible, the occurrence of such accidents as have too frequently happened in consequence of defects of railway wheels; but a few of these cases may be alluded to here, in illustration of the subject.

The accident on the Edinburgh and Northern Railway in October last, when the tyre of the leading wheel of the engine broke and threw the train off the line. That on the East Lancashire Railway in November last, where the tyre of one of the carriage wheels broke. That upon the Brighton Railway in September last, when the tyre of one of the engine wheels broke, throwing the train off the line. And that upon the Great Western Railway, about two years ago, where the tyre of a carriage wheel broke, and a portion of it fell through a carriage, causing a fatal accident.

With the view of obtaining some practical information upon the comparative resistance of the air to the revolution of the disc wheels and of the ordinary spoke wheels, some experiments have been tried at the Vulcan Iron Works, West Bromwich, by Mr. Henry Smith, with the assistance of Mr. Marshall, the Secretary of the Institution; and the results of these experiments are appended in the following table.

Experiments on the Resistance of the Air to the Spokes of Wheels.

No. of Experiment	1	2	3	4	5	6	7
Description of Wheel	Losh.	Disc.	Losh.	Haddn	Disc	Disc.	Disc.
Weight of Wheel, in lbs.	451	414	451	423	414	414	414
Weight suspended, in lbs.	56	56	56	56	56	56	71½
Distance fallen by Weight, in feet	270	270	279	279	279	279	279
Time of revolution of Wheel, in seconds	55	62	60	60½	68	66	75
Total number of revolutions	148	161	166	176	220	222	257
Average speed per hour of Wheel, in miles	17	17	18	19	21	22	22
Length of rope, in feet	270	270	355	355	355	355	355
Time before rope was detached, in seconds	15	15	17	17	17	17	12
Number of revolutions before rope was detached	38	38	50	50	50	50	50
Weight of tail rope, in lbs.	None.	None.	7	7	7	7	7

These experiments were performed at an old mine shaft 279 feet deep. The axle was placed across the top of the shaft and carried by two bearings with brass steps; the wheel under experiment was fixed on one end of the axle outside the bearing, and the counter connected to the other end of the axle. The counter was so graduated and arranged that the most correct observation could be taken of the number of revolutions completed in each case.

A drum 2 ft. 3⅛ in. diameter was fixed on the centre of the axle, and a rope ⅜-inch diameter was coiled on the drum, with the moving weight attached to the end of it hanging over the centre of the shaft; the other end was not attached to the drum, but held only by the grip of the second turn of the rope, so that when the rope was run off the drum by the weight falling to the bottom of the shaft, the end of the rope detached itself from the drum without any check. As there was not any means of descending the shaft to bring up the rope and weight, a tail rope of the same length and size as the main rope was attached to the weight at one end, and the other end made fast at the top of the shaft, the rope hanging double halfway down the shaft; this served to bring up the weight and main rope after they had fallen to the bottom of the shaft in each experiment. These two ropes weighed 7 lb. each, and the weight of the main rope caused a gradual acceleration in the moving weight, varying from nothing at the beginning of the descent to 7 lb. at the end; whilst the tail rope acting at first with half its weight, caused an increase varying from 3½ lb. to nothing at the end. The result was therefore, a total increase of the moving power varying from 3½ lb. at the beginning of the fall to 7 lb. at the end; and as this was the same in each case and the moving weight was also the same (56 lb.), its effect may be neglected in ascertaining the comparative results for the present purpose.

The wheels tried in the experiments were one of the solid wrought-iron disc wheels, a wrought-iron flat-spoked wheel of Losh's pattern, with spokes 3$\frac{1}{16}$ inches broad, and a wrought-iron flat-spoked wheel of Haddan's pattern, with spokes 3$\frac{1}{16}$ inches broad. These wheels were selected as near the same weight as was practicable, the Losh's wheel being one-length heavier than the disc wheel, and the Haddan's wheel one-forty-sixth heavier than the disc wheel. All the wheels were 3 feet diameter.

Deducting in each case the 14 seconds during which the power was in action, the results are 46 seconds with Losh's wheel and 53 seconds with the disc wheel, for the time of motion after the power was detached; which are in the proportion of 100 to 115, showing that 15 *per cent. more resistance* was experienced by the spoke wheel than by the disc wheel.

The average result from both sets of experiments is 16½ per cent. difference of resistance in favour of the disc wheel, and this is attributable to the additional resistance of the air caused by the flat spokes of the spoke wheel, as the friction of the axle caused the same resistance in each case, the weight being nearly the same of each wheel; and to prevent any change in the friction of the axle, the wheels were changed without taking the axle out of its bearings during the experiments. The axle journals were 2¼ inches diameter and 2½ inches length; and the friction of the journals was overcome by a weight of 15½ lb. acting on the drum when the wheel was upon the axle, and by a weight of 5¾ lb. when the wheel was taken off.

As these experiments were made with wheels revolving on a stationary axle, it is requisite to consider what would be the comparative effect if the wheels were rolling on their circumference whilst revolving at the same rate on their axle, as in the practical case of the wheels of railway carriages running on a railway. In the former case the motion of the spokes is at a uniform velocity, and always at right angles to the direction of the spokes; but in the latter case of a rolling wheel the motion of the spokes is at a varying velocity, and always inclined obliquely to the direction of the spokes, except at the moment of each spoke being in the vertical position. This is illustrated by the accompanying engraving, where the successive positions of the spokes are shown. The outer ends of the spokes move in a cycloidal curve, having double the velocity of the revolution of the wheel when they arrive at the top of the wheel, but becoming stationary at the moment of touching the rail at the bottom of the wheel. The average velocity of the outer ends of the spokes is about 1¼ times greater than when the wheel revolves on a stationary axle at the same rate of revolution. The average velocity of the inner ends of the spokes is about 3 times greater when rolling than when revolving on a stationary axle. As the resistance of the air increases in proportion to the square of the velocity, the average resistance to the outer and inner ends of the spokes will be about 1½ and 9 times respectively greater in the former than in the latter case. But this is reduced by the oblique position of the spokes as regards the direction of their motion in the rolling wheel; the motion of the spokes being twice during each revolution in the direction of the spokes, and consequently the resistance of the air reduced to nothing at those points. By measuring upon the diagram the comparative velocity of several points in a spoke in various positions during a complete revolution of the wheel, and the inclination of the spoke to the direction in each of these positions, the following approximate result has been obtained:—that the total resistance of the air to the spokes when the wheel is rolling is 3 times the total resistance to the same spokes when the wheel is revolving at the same rate of revolution on a stationary axle.

It follows that the result of the foregoing experiments has to be multiplied by 3, and consequently the excess of the resistance of the air to the spoke wheel over the disc wheel would have been 3 times 16½, or 49½ per cent., if the wheels had been rolling in this case instead of revolving on a stationary axle. This excess of resistance of the spoke wheel would not be so great in the practical case of the wheels of a railway carriage running on a railway, as the friction of the axle journals is greater in that case than in the experiments, from the weight pressing upon them being greater; and consequently the resistance of the air to the spokes of the wheel would then bear a less proportion to the friction of the axle journals.

Remarks made at the Meeting after the reading of the foregoing Paper.

Mr. M'Connell said, he had tried two pairs of these wheel centres at Wolverton, and had found them perfectly solid, and they were an excellent job; they were for the leading and trailing wheels of an engine 3 ft. 9 in. diameter.

Mr. Smith said, in answer to questions, that his hammer with which the wheels were forged was rather more than 9 tons weight; it was a helve taking up under the belly, and was driven by bands. The weight of the finished disc wheel was about 4¾ cwt.; it was made with the first tools that he had started with, and he had adhered at present to his original section of wheel, but he did not profess it to be the best form of section that might be adopted. He had made about 200 of these wheels; there were some now at work on the Birmingham and Gloucester line, and he had an order to prepare some for the travelling post-office to register the number of miles run by them. As to the cost of the wheel, he was ready to put himself in competition with other parties.

The President remarked, that the durability or life of the body of the wheel was so very much greater than that of the tyre of the wheel, which must be renewed when only about a tenth of the life of the wheel was gone, and would then require a secondary process to put on the new tyre; and consequently it appeared to him preferable not to incur any additional expense and trouble by forging the tyre on to the wheel, but to manufacture the disc alone, and put on a separate tyre in the first instance.

Mr. Smith replied, that it was not any more trouble to forge the wheel with the tyre than without it; it was easily done, and the cost of manufacturing the wheel would be less than putting on a separate tyre. There would he a little more trouble and expense in retyring the wheel for the first time, but he thought that the iron of the tyre would be much more durable than any rolled tyre could be, on account of the process of manufacture.

Mr. Woodhouse asked what advantage the wheel would possess over a cast-iron wheel if it were forged without the tyre; but he thought there was certainly danger of fracture from expansion in a cast-iron disc wheel.

Mr. Beyer remarked, that he had seen some cast-iron wheels that he thought would last as long as wrought-iron ones, and he never could understand why they were not more used; there were many wheels of cast iron, even large driving-wheels of 6 feet diameter, that had been running many years, and he thought it was an important question of economy in railways.

The President observed, that when locomotive engines were began, some 25 years ago, they were driven to wrought-iron wheels, and thought it a great advantage; and he thought that for rapid railway travelling, they must admit, as a body of engineers, that wrought-iron was better than cast-iron for such purposes. The present facilities for the manufacture of wrought-iron had been so strikingly shown to them on the present occasion, that he thought it was hardly possible to save anything worth mentioning by the adoption of cast-iron, particularly in the expense of a pair of large driving-wheels.

Mr. Smith said, he had been informed that the tyres were found to wear longer on solid wheels than on spoke wheels.

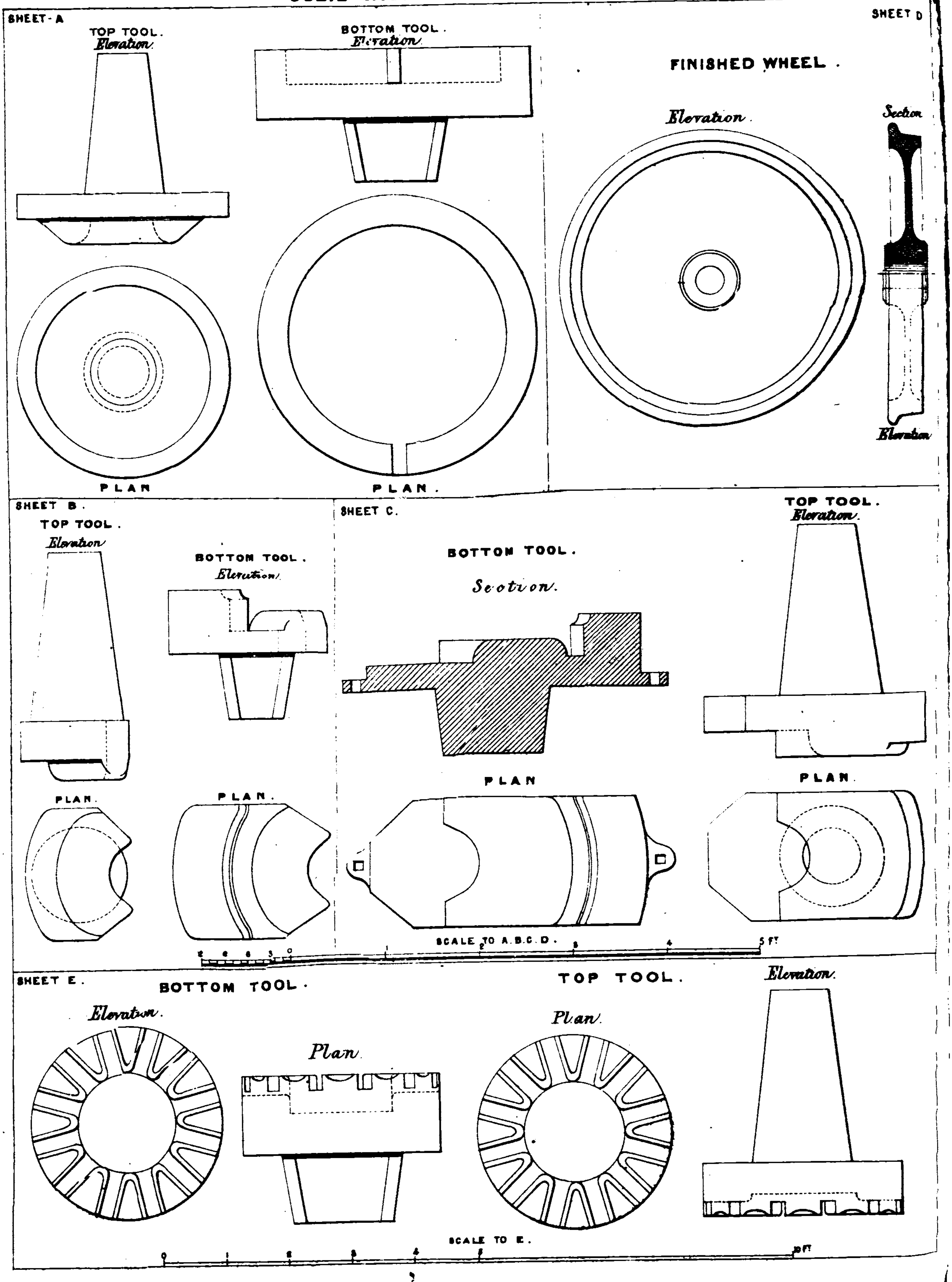
The President remarked, that the tyre of large wheels would no doubt deflect between the spokes, and this would not be the case with a disc wheel; there was certainly a bending process going on which might contribute to the wear and tear. But judging from the effects of rigidity in the wear of rails, he thought the tyre would wear faster on a rigid wheel; it was certain that rails laid on a block road wear much faster than when laid on an elastic road, and the difference in their wear was very marked.

Mr. Middleton observed, that Mr. Ephraim Boulton had a patent for a disc weeel, and many of them had been used on the Great Western Railway, but they were not approved, and were all cast aside.

The President said he believed those wheels were a double disc, and the tyre was riveted on; he understood that one principal reason for their being discontinued, was the singular drum-like noise they made.

SOLID IRON RAILWAY WHEELS.

PLATE



Mr. Adams said, that these wheels were made with two wrought-iron discs riveted to a ring of T-iron to form the inner tyre, and riveted to the two faces of a cast-iron nave which was turned to receive them; they had been in use eight years, and he thought they would last many years, and were as good wheels as the one under consideration, and much cheaper; he did not know why there had not been more of them made.

Mr. Smith observed, that by forging the tyre solid on the wheel, the risk of accident from the breaking of the tyre would be avoided whilst the original tyre lasted; and he thought that advantage was worth ensuring, as many accidents had been caused by the tyres breaking or coming loose.

Mr. Beyer asked whether the wheels were all as good as the specimen exhibited to the meeting, and whether the two moulds of which the wheel was made were always perfectly united at the outer face of the tyre.

Mr. Smith said, he would guarantee the wheels to be all as good, and the moulds were united as thoroughly and soundly in the forging as the bars in piled iron.

Mr. Slate asked if he could tell what would be the probable wear of these wheels; but Mr. Smith said there had not been sufficient experience of their working to ascertain that.

Mr. Allan remarked, that the disc part of the wheel was almost everlasting; it would last 100 years, but the tyre would not last more than 3 years.

The President said, it was certainly a very good wheel, independently of the question of the tyre; and he was of opinion that the railway world was very likely to be greatly indebted to Mr. Smith for his very excellent wrought-iron wheel, and he saw no reason why it should not come into extensive use. About the tyre he had yet some doubt whether it was desirable or essential for the sake of a small portion of additional safety for two or three years, to forge the tyre solid with the wheel. He thought the mode of manufacturing the wheel was highly interesting, and it was a triumph in forging that he was not prepared for.

RECLAMATION OF PEAT BOG.

(*With Engravings, Plate* XIII.)

On the Origin and Reclamation of Peat Bog; with some Observations on the Construction of Roads, Railways, and Canals in Bog. By Bernard Mullins, Esq., C.E. Vice-President of the Institute of Civil Engineers of Ireland; and M. B. Mullins, Esq., A.M., C.E., Member.

The following interesting paper is an abridgment of one read before the Institution of Civil Engineers of Ireland. Its great length precludes our giving the introductory part: it chiefly relates to agriculture, and may be seen in the *Transactions* of the Institution.

Roads in Bog.

Good roads and navigable canals through bogs aid so much in the process of reclamation, and have proved such stumbling-blocks to projectors generally, that it is not inappropriate to make a few observations on these subjects.

Hardness and smoothness of the surface are the chief objects to be obtained in road making. The elasticity of the soil offers a great impediment to the attainment of these qualities; we therefore must calculate on considerable difficulties in making a bog road unless managed with skill; indeed, when practicable at a cheap rate, the peat should be entirely removed. However, as this could not be done in the great majority of cases, we must have recourse to other means; and although the elasticity of a bog can hardly ever be destroyed, as may be seen by the shaking of the water of the drains when a vehicle passes along the oldest roads of that description, yet, if brought to a uniform and even bearing, and not liable to those alternate ups and downs which are almost always met with, the perfect flatness which is attainable compensates much for the impediment produced by its elasticity.

In every line of public road through deep bogs, drains should be made, 63 feet apart, enclosing the site of the road; and parallel and external to these a catch-water drain at either side, at a distance of 21 feet, thus occupying five plantation perches, as shown at Plate XIII. fig. 1.

This great breadth of enclosure is necessary, in order to ensure the drainage to an extent sufficient to give bearing and stability to the elastic seat of the road; cross drains, will, in most cases, be necessary, at a distance of say two perches asunder, leading at right angles into the fence drains. The whole of these drains, being made to such dimensions as the state of the bog will prescribe, should be repeatedly widened and sunk, and the spoil of the side drains thrown on the ramparts, or 21 feet spaces; when the enclosures shall become sufficiently firm, the cross drains are first to be filled-in with the bog material taken out of them, and the spoil that had been heaped on the ramparts to dry, should be wheeled in barrows to make the base or convex bed of the road, which should be raised in the middle 2 feet in the first instance, to admit of subsidence, and formed gently sloping on either side. The breadth of this formation may be for public roads 30 feet, and for accommodation roads 20 feet; for the latter an enclosure of four perches in breadth will be sufficient. Great care should be taken to have the bog material well chopped and trodden. If the spoil be insufficient to form the bed of the road as described, additional material may be had with most advantage by widening and sinking the side drains, particularly the catch-water or outside drains, which, besides carrying off the surface-water of the adjacent bog at a distance from the road, will tend materially, by the more rapid drainage and consolidation of the ramparts, or 21 feet spaces, to resist the subsidence of the seat of the road which becomes, as it were, propped on either side by banks of solid peat.

In wet bogs it will be necessary to continue the gradual operations described, for about two years before the road material can be put on. At the expiration of that time, a soaling of stiff clay from 8 to 10 inches in depth, should be laid on, and over this a covering of finely broken stones or gravel, about 8 inches in thickness.

If partial subsidence of the road should take place, a frequent occurrence from insufficient drainage, the road material should be taken up, and the sunken parts raised with dry bog-mould, firmly punned or trampled, the soaling and metalling may then be again laid on. The common practice of raising the sunken parts with heavy road material is an error, for the tendency to sink is thus greatly increased. It is, therefore, obvious that uniform pressure is one of the chief objects to attain in bog road making.

Where sufficient time is not allowed for consolidation by drainage, a foundation is made with a layer of brushwood, or the slender branches of trees which are tied up in bundles 10 or 12 inches in diameter, and 10 or 15 feet long; these, known by the name of fascines, are much used in Holland, and are laid firmly bound together in alternate transverse and longitudinal layers; over these a covering of earth is placed, and then the pavement or metalling is put over.

This mode, as may be inferred, is not so good, and is greatly more expensive than that recommended by us, and is only to be had recourse to in particular spots where drainage is extremely difficult, or in railroad making, where sacrifices are made to save time; but no expedient ought to supersede a system of proper drainage whether for railways or other roads—in the former a "grillage" of cross timbers of large scantling and longitudinal bearers will be the best mode of sustaining the rails, and it will be found that the elasticity of the road, if made of the bog material as described, will tend greatly to its stability and cheapness of maintenance, there being no tractive contact as in common roads with the surface. Bundles of furze or heath are sometimes used as fascines in passing a road over a quagmire, but they are a mere temporary expedient, and in every respect inferior to those made of small branches of sufficient length, made in the manner subsequently to be described.

In dry shallow bogs catch-water drains may not be necessary; with this exception, the same system of making is applicable in all cases.

Where rivulets and streams are intercepted by the line of road, they should be passed under it by suitable culverts, which, if built of stone or brick, would in many cases be a work of much difficulty and expense in the carriage of building materials, sinking foundations, and keeping out water during their construction. These considerations suggest the expediency of making culverts of wood (Plate XIII., figs. 1, 2, and 3), such as we had recourse to with effect in the execution of the Ballinasloe Canal, twelve miles of which pass through deep bog; the sides to be formed of round native timber piles, 9 inches diameter, adzed off on one side to receive the sheeting, lightly shod, hooped, and driven firmly into the hard, to the depth of 2 feet under the lowest assumed level for the ulterior drainage of the district. Two rows of these piles to be driven in the line of the waterway, 4 feet apart from centre to centre, and 4 feet from each other in the longitudinal direction; three rows will form a double culvert.

Transverse capping pieces, of 9 inches by 7 inches to be notched down on the heads of opposite piles, as per sketch, and bolted to them with sufficiently jagged bolts; longitudinal sheeting of sawn elm or beech plank, 3 inches thick, to be laid closely together on these capping-pieces to which they are to be spiked; the sides to be sheeted in like manner, from the level of the capping to the bottom of the watercourse, with round wood of not less than 7 or 8 inches diameter, having one cut through the middle longitudinally; this sheeting to be firmly spiked on at right angles to the piles; the height of the capping-pieces above the bottom of the culvert will necessarily be governed by circumstances which we cannot anticipate; sufficient waterway in all cases should be left. Where the bottom of the watercourse is remote from the gravel line, it will be necessary to floor the bottom of the culvert to prevent its being choaked by the rising of the bog, the effect of pressure on the sides. Cross pieces should be carried from opposite piles, as at top, and on these the planking should be spiked to prevent the floor being forced up. Sheeting piles may be driven at the upstream end if necessary, to prevent the water running under the flooring.

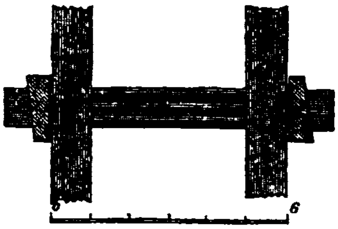
The principle here suggested has this additional advantage, that it will admit of the deepening of the watercourse for drainage purposes, without detriment to the efficiency of the conduits. In cases where a waterway of 2 or 3 feet in breadth is sufficient, hurdles may be substituted for the sheeting of the top and sides.

Railways in Bog.

The subject of Railway making through bogs being very little understood, we propose the following system in preference to throwing in earth to replace the peat, an operation which may be extremely expensive if the material be remote, and the bog deep and wet, for a complete embankment must in that case be made, whose base will rest upon the gravel or clay at the bottom; it would, in fact, be tantamount to embanking through a lake, as the light wet peat, instead of being compressed, would be forced up on all sides by the heavier material.

The same preliminary operations being performed as for common roads—namely, side and catch-water drains, at the prescribed distances, and forming the bed or seat with dry peat well chopped and trampled, we recommend, if the bog be wet and deep, and time cannot be allowed for drainage, that a layer of fascines, 12 inches square, and closely connected by pickets or twig-bands, be laid transversely on the bog, as shown in Plate XIII., figs. 4, 5, and 6; over these are to be placed longitudinal pieces of native round timber of about 9 inches diameter, passing each other 2 or 3 feet at the ends; the number of these will depend on circumstances, but there should not be less than one under each rail; part of the upper surfaces of these round timbers is to be adzed off, to make a level bed for the rough cross pieces of say 12×6 inches, which are to be firmly spiked down upon them at a distance of 4 feet apart from centre to centre; longitudinal pieces of half baulk are then to be placed on these to carry the rail; the space may then be filled to the level of the bottom of the rails with gravel and sand, better known in railway language, as ballasting and boxing. If the longitudinal round timbers be numerous, cross pieces of 4-inch plank may be substituted for half baulk.

It is proposed to adjust this road in lateral parallelism, as shown in the annexed woodcut, by means of brackets *e*, bolted or spiked on the cross timbers, and keys or wedges *i*, driven between these brackets, and the longitudinal sleepers *f*, brackets at the centre and joints may be sufficient; the vertical adjustment to be made by wedges driven between the cross and upper longitudinal pieces; and when subsidence takes place to the extent of admitting a filling piece, the wedges may be taken out; the gauge of the road to be preserved from within by chocks, or straining pieces between the longitudinal sleepers. It is to be observed, that the mode of bracketing recommended, obviates all the difficulty of adjustment which occurs when the road pieces are fastened by bolts and spikes.



The object sought to be obtained by the method proposed, is in the first place to include within the drains an extent sufficient to give stability; and in the next instance, to ensure the permanency of the state of drainage at which it may be thought advisable to construct the framing, in order to attain by continuous bearing the uniform resistance of the elastic material, of which the seat of the road is composed.

Fascines in Bog.

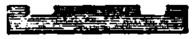
If the bog be tolerably dry and not very deep, fascines, which are not desirable, unless as a means of drainage, may be partly dispensed with; in that case the round timbers may be laid on the bog; in other cases, where a quagmire is to be got over, two or three layers of them may be necessary, placed in alternate longitudinal and transverse layers, the transverse one being uppermost, to receive the longitudinal round timbers.

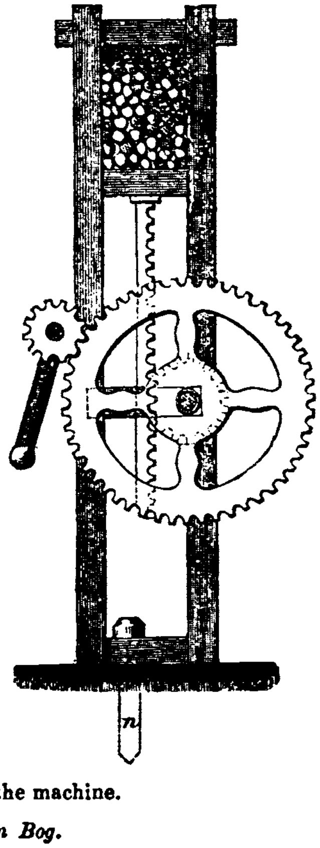
When fascines are used merely for drainage (Plate XIII., fig. 6), for which purpose they are particularly well adapted in bog, a single continuous row of them should be laid with a proper fall in the centre of the road under the level of the round timbers; cross rows leading from the side drains are to be made to communicate with the centre, at distances of 15 yards apart, and by alternating the cross rows at opposite sides, instead of making them meet each other at the centre, a cross-drain will be had at every 7½ yards in length, and the portion of the drain not under the road may be left open.

The bavins or fascines used by Belidor in waterworks and in military operations, were made of shoots of six or seven years growth, from 7 to 11 feet long, and 30 inches round, well tied with three bands, the first 1 foot from the head, the second 3 feet, and the third 6 feet, so that there remained about 4 feet of brushwood or small ends not bound; such a form, although answering the purposes intended—namely, for breakwaters or foundations, would not make a continuous drain; neither does the contrivance adopted by military engineers, called the "fascine choaker," give any other than a circular form, and an insufficient and uneven pressure, both equally unsuited to drainage; to obviate these defects, we have had recourse to a contrivance shown in the annexed woodcut, which gives a square form, and the degree of compactness required.

Shoots of branches or brushwood of the requisite length being procured, should be laid on the moveable sole, on which copper wires to serve as bands, are to be placed transversely, in number proportionate to the intended length of the fascine, a band in every 2 feet will be sufficient; the faggot when put in, should be 1 foot broad, and its depth about three times what it is intended to be compressed to; thus 3 feet may be compressed into 1 foot thick, and 4 feet into say 18 inches.

It will not be necessary to be very particular in placing all the shoots longitudinally, a sufficient number, however, must receive that direction to give continuity; the press will bring all the rest into proper form, which being done, the copper wires are to be tightly drawn and twisted, and the ends of the fascines sawn evenly off, so as to make a close butt-joint; the press may be enlarged to suit any length required; fascines ought not to be less than 6 feet long; the cuttings of hedges, if held by a sufficient number of longitudinal branches, will form an excellent bavin when pressed in the manner described, which is one of the great advantages of the machine.





Canals in Bog.

The process of canal making through bog is a subject demanding especial consideration and inquiry; so much depends on local circumstances that no rigid system of operations applicable in all cases can be specified—the position of the bog, its depth, its contiguity to recipients for drainage, the level of the substratum upon which it rests in reference to the level of those recipients, the level at which the canal is intended to enter the bog, the depth of cutting to be removed, and the nature of the bog, whether firm or flow, are considerations which must influence the course to be adopted, as well in the choice of site, as in the method of performing the work, upon both of which the success of the undertaking will depend.

Smeaton, the ablest civil engineer of his day, having been consulted in the year 1773 by the Grand Canal Company on the extension of their canal, fell into a grave error in advising "To avoid bogs if possible, but of all this going deeply into them." (Smeaton's *Reports*, Vol. XI., p. 267.) In our time we are taught by experience to inculcate contrary doctrine.

Bog lands are, in our opinion, particularly favourable to canal extension; the site of the canal is purchaseable at a low rate, it is cheap and facile in execution—always presuming that the line is judiciously chosen and skilfully worked; it is perfectly retentive; does not gutter the slopes at the water's edge as in clay and gravel banks; and the elasticity of the towing paths is such, that they continue for years without repair if used exclusively as trackways. Moreover, a line of canal passing through bog furnishes the means of reclamation on an extensive scale, as well in the preliminary process of draining as in the conveyance of manure for its cultivation. The increase of fuel, and the employment which its manufacture would afford to the working classes in its vicinity, are great inducements to give a decided preference to bog lands for the site of a canal,—of course, other requirements being suitable.

We are not surprised at Smeaton's advice to avoid bogs if possible, seeing the principle advocated by him of not going deeply into them. The canal from the Forth to the Clyde, 35 miles in length, passing partly through bog, was commenced by this celebrated engineer in 1768, and was not finished until 1790, having cost the large sum of 280,000*l.*

Bogs do not constitute the master difficulty of canal making, as is sufficiently attested by the history of the great undertakings of that description. The canal of Languedoc required the great genius of Vauban, and the munificence of Louis the Fourteenth, to carry it through its difficulties. Peter the Great was obliged to abandon the projected canal from the Don to the Wolga after a very large sum had been expended on it, owing to the unskilful laying out of the line. These examples, which might be multiplied, will suffice for our purpose.

That portion of the Grand Canal passing near the town of Edenderry, in the King's County, furnishes a two-fold instance of the difficulty of making a canal through bog, where the level of the substratum is below that of the adjacent river, and of the ill effects of not going deeply into the bog. It was supposed that the level chosen, which afforded from 6 to 9 feet depth of cutting, was such as would enable the undertaking to be completed at the least possible expense, assuming that the depth of cutting (allowance being made for subsidence), would give a finished canal of the required dimensions—namely, 24 feet width of bottom, 46 feet wide at top, and 8 feet in height from bottom of canal to upper surface of trackway. The excavation and drainage were carried on concurrently, and that which was expected to be an unusually cheap reach of canal in shallow cutting, ended, after several years of unremitting labour and enormous expense, in the formation of a bank on either side, 45 feet high for a distance of 80 perches, so that the canal with the carrying up of its sides and bottom to the required level, containing 6 feet of water, was in the centre of a high artificial embankment, having a base of fully 400 feet. Indeed the difficulties were so great, that it was more than once contemplated to abandon the line, and to make a new cut; but through the influence of the proprietor of the town of Edenderry, an example has been furnished, for the benefit of the engineering world at least, of an error of the gravest character having been carried to a successful termination.

The following process was adopted in making this canal. Parallel drains, at 10 perches from the centre line on either side, were made, and at 2 perches distant from these, and from each other, a series of parallel drains, to the extent of 34 perches from the centre line on either side, were then made, embracing a breadth of 68 perches; these were crossed at right angles, at 2 perches distant from each other, so that the area of the bog, from the 10-perch drain to the 34-perch drain, on either side of the embankment, was divided into squares or ramparts of 4 perches area each. The drains of those squares were continually widened and sunk, and the spoil thrown on the ramparts. When the spoil became dry it was wheeled, together with an 18-inch lift of the ramparts, into the embankment in which the material was firmly trampled and chopped, and while all the dry ramparts were so disposed of a new set were being similarly prepared by sinking the drains. The formation of the canal thus proceeded until the navigation was opened. Great quantities of clay were then boated for the lining of the bottom and sides, soling the trackways, and covering the whole surface of the banks, as well to give weight and strength, as to secure them against fire and waste in summer. The material being dry and light, the surface was set on fire many times, and was liable for the same reason to be carried away by the winds; the banks were, however, perfectly retentive.

Previously to the opening, when the water had been let in temporarily, a breach occurred, the reconstruction of which (we had the direction of it) cost 10,000*l.* in securing the embankment. This was done by wheeling dry bog material into the breach, firmly ramming it into its place, and incorporating it thoroughly with the broken sides. Forty years have elapsed since this was made good, and no similar disaster has since occurred.

Piling has sometimes been had recourse to in making up such breaches; but it is a great mistake to drive piles in a bog embankment, as they disunite the particles, and open a way for the water to escape, thus increasing the evil they were intended to remedy. Vallancey in his work on canals bears testimony to this fact, and his views were derived from high authorities, such as Castellus, Belidor, and others.

It is necessary to observe that the Edenderry Canal was made through the centre of a deep basin; the lowest tap practicable being 15 feet above the adjacent river, the Boyne. It is therefore obvious that an improper site was chosen.

We thus see the necessity of ascertaining in the first instance the depths of the bog, the level and nature of the substratum; and it may be laid down as a general rule that shallow cuttings and embankments in deep wet bogs are to be avoided; that the level at which marl is found, or near it, ought not be selected for the bottom of a canal; and that perfect drainage should be carried to such an extent and depth, as to give stability to an area adequate to the sustainment of a secure navigation.

At the desire of the Institute we shall give a brief account of our process of making a canal through deep soft bog, for which purpose we shall make choice of the Ballinasloe Canal, the most recently, and we may be permitted to say, skilfully executed, from the experience previously acquired, and the most difficult of any in which we have been engaged, with the exception of that of Edenderry. Before our time, the Grand Canal was carried through three short reaches of bog in the county of Kildare with great difficulty; the water was forced into the canal before a sufficient sectional area was obtained; and it was by dredging, at a great expense and loss of time, that an imperfect navigable depth of canal was subsequently had: and so clumsy were the operations then carried on, that when all the locks were built and the gates hung, one of the locks (the 20th) being at the commencement of one of those bogs, and an aqueduct at its termination, it was discovered, on the opening of the navigation, that a mistake of 4 ft. 6 in. had been made in the bog level, which was remedied by building an intermediate lock of the required fall.

The Ballinasloe canal is 15 miles in length, 12 miles of which are through bog, averaging from 26 to 46 feet in depth, and bounded on two sides by large rivers—the Shannon and the Suck.

Kylemore bog having been the wettest, softest, and the most difficult to execute, we shall describe our mode of proceeding in that locality. The length of this bog in the line of the canal is 3,100 yards, terminating at either end in ravines between it and the adjacent bogs, leading from the upland to the river Suck, which lies some distance north of the line of canal. The drainage of this lot was carried through those ravines with considerable difficulty and expense, there being no intermediate lateral tap.

Operations were commenced by making a drain in the centre line of the canal throughout its entire length, 5 feet wide at top, and 1 foot wide at bottom, and 3 feet deep where practicable, (Plate XIII., figs. 7 and 8, H.) In situations—and they were numerous—where the fluidity of the bog would not admit this depth, it was sunk about 2 feet; and in some places not more than from 1 foot to 18 inches. At 30 feet from the centre, on each side, drains of like dimensions were made, which lined out the limits of the top opening of the canal A A, allowing 9 inches to the foot slope, assuming that the subsidence of the bog surface would increase the slopes to 18 inches to the foot, and give the required breadth at bottom and top of canal when complete. At 4 perches, and at 10 perches from the centre on each side, drains B B, C C, parallel to the foregoing, were made, of like dimensions, making seven in all, including the centre drain; these were crossed at right angles from the 10-perch drain north of the centre line, to the 10-perch drain south of it, D D. At 10 perches distance from each other, and in the intervals of these crossings, other crossings E, were made from the 4-perch drain north, to the 4-perch drain south, reducing the intervals longitudinally within these latter crossings to 5 perches. All of those drains were worked by slight sinkings, keeping the top openings, as at first, to 5 feet, until the bog acquired sufficient consistence to allow deeper incisions into it. The centre drain and the verge drains were most worked, and the

4-perch drains next, and after these the 10-perch drains; the cross drains in all cases were kept to the depth to which the parallel drains had been sunk.

After some time, when the spoil of the sinkings of the centre drain and of the verge drains accumulated to an inconvenient height, and that the ramparts F G, became consolidated, which the pressure of the spoil, aided by drainage, speedily effected, one of those ramparts, say F, was excavated and wheeled out beyond the 10-perch longitudinal drain north, C; after which the centre drain and verge drain were boldly sunk, and the spoil cast in upon the excavated rampart. The parallel drains were then sunk; concurrently with these the cross drains were also deepened; subsequently to these operations the rampart G, was excavated and wheeled out beyond the 10-perch drain, south side, and the cross and parallel drains consecutively sunk, as on the north side.

In this state of proceedings it became necessary to excavate and wheel off the spoil of the cross drains, situate between the verge drains and the 10-perch drains to a short distance beyond the 10-perch drains on each side, in order to admit of their being widened and deepened boldly; the top openings increased to 6 feet, and the depth to that of the parallel drains, the spoil of which was cast back from the verges in order also to their being widened and sunk, but in a less degree than those already mentioned. The proximity of the river Suck, running nearly parallel with the canal for its whole length, afforded opportunities of floating off immense quantities of spoil in time of flood, which considerably accelerated the progress of the work.

The effect of this system of drainage was to cause the whole mass of bog, comprehended between the 10-perch drain north and the 10-perch drain south of the centre, to subside, subsidence commencing at the centre and verge drains which were unceasingly operated upon daily, and decreasing gradually to the 10-perch drains, which, with the intermediate drains, were less frequently sunk. This rotation being performed, ramparts were prepared in the manner before described, and when consolidated were excavated and wheeled off to the prescribed distance from the centre on each side, and the process of drainage between the verge drains and the 10-perch drains proceeded with as before, all these operations being constantly repeated until the required depth was attained. It was then found that the surface of the bog, originally 26 feet above bottom at the verges of the canal, had subsided on an averge 20 feet, it having in many places sunk to within 4 feet, and in some few places, where the bog was very soft, to the actual level of bottom.

The slopes were then ranged and dressed—the centre drain straightened and sunk throughout below the level of the bottom of the canal, which was thus kept dry and firm to resist the collapse of the sides—the bottom cleared up, the cross drains E and D, from the canal to the 4-perch drains on either side, filled up to the level of the bottom of these 4-perch drains B B, and when the former were, at their entrance into the canal, below the top water line, which occurred in many places, shoots of sufficient capacity were inserted for the full breadth of the trackways, to prevent any accumulation of drainage or surface water in the parallel or cross drains, which would, if this precaution were omitted, or the passage of the water through those shoots impeded, cause great derangement by carrying in the sides, producing the subsidence of the trackways and forcing up the bottom, a common occurrence from the cause here assigned, evidences of which are visible in the work referred to. The sides or banks were then slowly and carefully raised with the lightest and dryest of the spoil to the required height. In soft places, where the surface of the bog had sunk to the level of the bottom of the canal, fascines of heath were laid under the light dry spoil of which the bank was formed; the tap-drains were then closed, and the water, for the purposes of navigation, *rapidly* let in—a precautionary measure of much importance, in order to prevent the rising of the bottom and collapse of the sides, which would have inevitably taken place if it had been slowly admitted. A soling of clay 10 feet broad and 1 foot thick, with 6 inches of gravel, was then laid on to form the towing-path.

We may here observe, that throughout the whole of the execution of this reach of canal, 3,100 yards in length, none of the numerous drains with which it was traversed attained a greater depth, at any time, than about 4 feet, except at the margins of the bog, terminating in the ravines at either ends; here the drains were sunk to 6 feet and upwards; the work was three years in hand, and had two years more been employed in the execution, two-fifths of the cost would have been saved.

It may reasonably be asked, why a top opening of 54 feet was assumed for the canal in 20 feet cutting, requiring, when complete, a bottom breadth of 24 feet, and slopes 1½ to 1, which, by these data—viz., 20 × 3 + 24, would give a top opening of 84 feet; and why an extent of 10 perches on each side of the centre line of the canal, should be adopted as the limit within which the drainage was effected? To these queries we reply, that we had ascertained previously, in the performance of similar undertakings, that subsidence would result from drainage in proportion to the depth and fluidity of the bog; and that if the top opening were prevented from narrowing by the closing in of the sides, the breadth at top would be transferred to whatever point the subsidence of the surface would rest at. We also had previously ascertained in the instances which came under our observation, that the near deposit of the spoil to the opening, pushed in the sides by the incumbent weight, contracted the opening, closed the centre and verge drains, forced up the bottom, and thus deranged the whole system of drainage; hence it was, that distances of 10 perches from the centre line, on either side, were fixed as the nearest places of deposit of the spoil, as well as the least breadth to which the drainage operations should extend; and the system adopted fully answered our expectations. Where, for example, the surface had sunk to within 10 feet of the bottom of the canal; the height at which the banks were formed (being 4 feet above water line, to allow for ulterior subsidence), the opening at top was transferred to that level where it became the proper breadth with slopes of 1½ to 1, and where the subsidence was greater or less, which necessarily occurred from the unequal depths and composition of the bog, and that the slopes were too prominent or too flat, or that contraction had ensued from unskilful or negligent working; these irregularities, from which slopes in clay cuttings and embankments are not exempt, were easily rectified, and the saving was of great value, both with respect to time and cost of execution. Had the top opening been made in accordance with the specification—namely 84 feet in breadth, the cubical quantity contained in a lineal perch would amount to 840 cubic yards; whereas with a 54 feet top opening for the same length, and a subsidence to within 10 feet of bottom, the cubical contents would be 607 cubic yards, making a saving of 233 cubic yards in the sectional area, which upon the length of the lot, (486 perches) amounts to 113,238 cubic yards, beingmore than 30 per cent., independently of the vast reduction by drainage.

The extent to which the system of drainage was carried—namely, 10 perches on each side of the centre, was for the purpose of consolidating a space through which the necessary sinking for the formation of the canal could be made, which it would have been scarcely possible to accomplish, without first having brought a sufficient breadth of deep flow bog into a dry firm state, capable of affording facility in the execution and the requisite security to the navigation.

Canals may be made through shallow and dry bogs with great facility and cheapness by the ordinary process applicable to other soils; care being taken in dry bogs, which may not be shallow, that the bottom level of the canal be not remote from the gravel line beneath the bog, which a judicious distribution of lockage would enable the engineer to fix at a proper level; otherwise the canal will be costly in its maintenance, and defective in its navigation, from the tendency of the banks to subside and the bottom to collapse; and if by accident the water should run off, serious derangement would inevitably be the consequence by the falling in of the trackways and the swelling up of the bottom. Moreover, fixing the bottom level of the canal considerably above the gravel line would be greatly opposed to the reclamation of the bog.

We have thus endeavoured with the aid of the accompanying diagrams, to give practical information on subjects presenting difficulties which an engineer in this country is frequently called on to contend with; and as the principles laid down are the results of actual experience, we feel assured of their correctness, and do not hesitate to recommend their adoption.

Dover Breakwater.—The formation of this breakwater, under the superrvision of Messrs. Walker and Burges, is proceeding satisfactorily. It begins near the Look-out house, and is to run out to sea, in cants of about 800 ft., to form a harbour. About 200 feet is executed, and 100 feet will shortly be added. The outer faces are of Bramleigh Fall stone, backed up with Portland stone. The stones measure about 80 cubic feet each. The space between the two walls is filled in solid with concrete. Large blocks of hard and dry concrete are prepared, ready to use as they get out more to sea, and two diving-bells are in daily use. There is a steam-crane for landing the stone from the ships, and the mills for grinding lime and brick-earth are also worked by steam-power. Messrs. Lee, of Chiswell-street, are the contractors.

LIFE OF GEORGE STEPHENSON.

(*Concluded from page 173.*)

XVII. THE LOCOMOTIVE STRUGGLE.

In laying down a railway between Liverpool and Manchester, a new question was opened of what should be the working power—horses, fixed engines, or moving engines. The early starters of the undertaking[1] brought forward the locomotive, then new, being moved to it by George Stephenson. The papers James laid before Mr. Sandars were drawings of Stephenson's engine, and from that time the struggle was no less for a locomotive engine than for a railway. This was a bold step. There was no locomotive running nearer to Liverpool than at Leeds, and there only Blenkinsop's engine. The step was so bold, that there were not wanting those who wished for fixed engines, or even for horses, on the railway.[2] Thus among those who were most earnest for a railway, there was great strife as to the way in which it should be worked.

In the first prospectus,[3] as already said, the use of the locomotive was taken up as a needful branch of the undertaking. In the second prospectus, it was acknowledged that objections had been made before the House of Commons to the use of the locomotive: "Another and a more plausible objection was founded on the employment of the locomotive engine. It was contended, in the *first* place, that this new and peculiar power was incompetent to perform the task assigned to it; in the *second* place, that it was unsafe; and *lastly*, that in its operation it would prove a public nuisance. By the evidence, however, it was proved that it was perfectly competent to perform all that was proposed to be accomplished; and, before the evidence was closed, the counsel for the opponents of the bill admitted it was *safe*. Upon the third point of objection, the committee are confident such improvements will be made in the construction and application of this effective machine, as will obviate all objection on the score of nuisance; and as a guarantee of their good faith towards the public, they will not require any clause empowering them to use it,—or they will submit to such restrictions in the employment of it as parliament may impose, for the satisfaction and ample protection both of proprietors on the line of road and of the public at large."

In the report after passing the act made the 22nd May 1826, the directors say: "Before concluding this report, the committee will say a few words upon the locomotive engine—a power for the conveyance of goods and passengers which they look forward to as one highly advantageous both to the company and the public. They have never doubted that the ingenuity of the country would be exerted to construct an efficient and unobjectionable machine for this purpose; and they are able to state, that they have already received a proposal from an engineer of eminence, to furnish an engine that shall comply with the clause in the act, compelling the consumption of smoke,—the engine proposed not to be paid for, if it do not answer the objects of the company."

In the report of 27th March 1828, to the second yearly meeting,[4] the directors say: "The nature of the power to be used for the conveyance of goods and passengers becomes now a question of great moment, on whatever principle the carrying department may be conducted. After due consideration, the engineer has been authorised to prepare a locomotive engine, which from the nature of its construction, and from the experiments already made, he is of opinion will be effective for the purposes of the company, without proving an annoyance to the public. In the course of the ensuing summer, it is intended to make trials on a large scale, so as to ascertain the sufficiency in all respects of this important machine. On this subject, as on every other connected with the execution of this important task committed to his charge, the directors have every confidence in Mr. Stephenson, their principal engineer, whose ability and unwearied activity they are glad of this opportunity to acknowledge."—No particulars of this engine have been given.

Although Mr. Sandars and his friends were staunch for the locomotive, the board were not all of the same way of thinking, for some powerful men set themselves against it, and wished for fixed engines. Out of doors, most of the engineers of that day were against the locomotive; so that it was by no means settled Stephenson should have his own way. Then, too, many beset the board with plans of their own. The treasurer says[5]: "Multifarious were the schemes proposed to the directors for facilitating locomotion. Communications were received from all classes of persons, each recommending an improved power, or an improved carriage; from professors of philosophy down to the humblest mechanic, all were zealous in their proffers of assistance; England, America, and continental Europe were alike tributary. Every element and almost every substance were brought into requisition, and made subservient to the great work. The friction of carriages was to be reduced so low that a silk thread would draw them, and the power to be applied was to be so vast as to rend a cable asunder. Hydrogen gas and high-pressure steam—columns of water and columns of mercury—a hundred atmospheres and a perfect vacuum—machines working in a circle without fire or steam, generating power at one end of the process and giving it out at the other—carriages that conveyed every one its own railway—wheels within wheels, to multiply speed without diminishing power,—with every complication of balancing and countervailing forces, to the *ne plus ultra* of perpetual motion." Goldsworthy Gurney was very active.[6]

This is a lively painting by one who well knew what was done, and it shows the power of skill and knowledge brought to bear whenever a great undertaking is in hand. Many of the plans may have been whimsical—many utterly foolish—most fruitless; but the end of all this work has been to make the locomotive in the shortest time the best-finished engine we have. The engine, with its springs, buffers, fenders, safety-valves, whistle, feed-pumps, blast-pipe, axles, is the work of a thousand minds,—each giving more or less, but all helping towards the same end. Nor is this to be lightly set aside, for it gives a warning to us in other cases. The first sketch of an engine is the work of one man, fraught with many faults,—built on some great plan, but wanting in the means of rightly carrying it out. Trevithick builds a locomotive, which blows up for the want of safety-valves, which will not turn round and will not run, or which wants crowbars to help it along. The mind of one man is not enough to work out any great undertaking: however great a man's mind may be, whatever his powers, he is helpless alone; it is only by the help of others he can bear himself through. Independence may be wished for, may be sought after, may be tried for,—but the world is so made that no one has power but by the means and help of his fellow-men. On the other hand, we ought never lightly cast away any new undertaking, merely because it cannot be forthwith made to work; if the ground of it be good, there is wit enough in the world to bring it into working trim.

We have seen that in 1828 Stephenson had been so far backed, that he was set to make a locomotive; but the other side were untiring in their endeavours to put him down. In October 1828, two of the directors[7] and the treasurer were sent to Darlington and the neighbourhood of Newcastle, to see on the spot the working of the locomotive and fixed engines. Mr. Booth says (p. 69): "The deputation returned with a fund of information; but of so mixed, and in some respects of so contradictory a nature, that the great question as to the comparative merits of locomotive and fixed engines was as far from being settled as ever. One step was gained. The deputation was convinced, that for the immense traffic to be anticipated on the Liverpool and Manchester line, horses were out of the question."

The ground was narrowed to locomotive and fixed engines. The next step was, as the directors and Stephenson differed, to name two engineers to make their report on the two plans: but to choose such was to choose enemies of the locomotive. Mr. James Walker was chosen as a leading London engineer, and Mr. John Urpeth Rastrick as a northern engineer. On the 12th January 1829, they went to a meeting of the board at Liverpool, before setting out; and on the 9th of March they sent in their reports.[8]

These reports are printed together,—first that of Mr. Walker, next that of Mr. Rastrick. It seems that on the 10th of January, they met at Stourbridge, where Mr. Rastrick was building a locomotive for America. On the 12th, as said, they were at Liverpool; on the 13th they went with Stephenson along the line of railway; and on the 14th were at Manchester. They acknowledged the line was "very superior to anything that had yet been done."[9] On the 15th, Stephenson went with them to the Bolton Railway, then made under his direction. There they saw a locomotive, made by him in his best way; and they say they had from Mr. Peter Sinclair, the secretary of the company, a report, "which proved the great power which the engine is capable of exerting."[10] There was no lock-up safety-valve to this engine.[11] Spring safety-valves had been introduced since 1824, and wrought-iron tyres instead of cast, and the engine set upon a spring carriage. Mr. Walker says

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[1] Mr. Sandars's Letter.—Mr. Sylvester's Report.

[2] Booth's History, p. 67.

[3] MSS. book of Prospectuses belonging to Mr. Booth.

[4] MSS. book of Prospectuses belonging to Mr. Booth.

[5] Booth's History, p. 67.

[6] Edinburgh Review, October 1832.——Answer to Lardner, 1832, p. 12 and 23. (In Library of Institution of Civil Engineers.)

[7] Stephenson and Locke's Report, p. 6, says three directors. These were Messrs. James Cropper, John Moss, and Adam Hodgson. George Stephenson, with Messrs. Robert Stephenson and Locke, likewise made a report.

[8] Booth's History, p. 69

[9] Walker's Report, p. 2.——Rastrick's Report, p. 4

[10] Walker's Report, p. 2

[11] Walker's Report, p. 17.

every new engine Stephenson made, differed in some respects from the one preceding it, and bears witness to the great improvements made.[12] The cast-iron tyres were worn out on the Darlington Railway in ten weeks, while a set of wrought-iron tyres on the Killingworth was twelve months in use.[13] It was thus, and in such small things, the locomotive was yearly brought into better working.

On the 16th of January, at Leeds, Messrs. Walker and Rastrick saw Blenkinsop's engine; on the 17th, 18th, 19th, and 20th, they were at Darlington, and on the Stockton and Darlington Railway; on the 21st at Sunderland, and on the Hetton railway. Part of this had formerly been worked by locomotives, but latterly they had been given up, and fixed engines were used instead. From the 22nd to the 29th, the weather being snowy, Messrs. Walker and Rastrick were at Newcastle, and met Nicholas Wood and Mr. B. Thompson of Ayton, the great upholder of fixed engines, which they saw on the Brunton and Shields Railway.[14]

On the 20th February, Messrs. Walker and Rastrick met at Oxford, and stayed until the 24th, going over their several reports.

Mr. Walker's aim was to overrate the cost of the locomotive, and underrate the cost of the fixed engine; and he did not allow[15] the locomotive gave any greater accommodation to the public. It is worth saying, that the Liverpool and Manchester Railway was laid out for the locomotive, as it was then understood, for Mr. Locke told Mr. Walker there were thirty roads crossing the railway on the level.[16] These the latter thought were inconvenient for the stationary system, and ought to have been altered.

Mr. Walker says decidedly on the question of comparative safety, "As a general answer, I should say that the stationary is the safer, chiefly from the locomotives being necessarily high-pressure engines, and accompanying the goods or passengers upon the way."[17]

Mr. Rastrick says: "I am decidedly of opinion that 15 miles per hour on a railroad may be travelled in perfect safety both to goods and passengers:"[18] but then he speaks of stationary engines. He thought, too, that locomotives weighing more than 8 tons could not be conveniently used to get a speed of more than 10 miles per hour. He ends this part by saying: "It was the decided opinion of Mr. Nicholas Wood, when we saw him at Killingworth, that no locomotive engine should travel more than eight miles per hour; and his opinion, from the great experience he has had in the use of them, is entitled to the greatest respect: and I am perfectly of his opinion, so long as the engines are made of such great weight; therefore, the great desideratum must be to make powerful engines of the least weight possible. Indeed, if we are to come down to eight miles per hour, and from that perhaps to six, I should say that the Liverpool and Manchester Railway was a complete failure —all the golden hopes held out of expedition and dispatch would completely vanish, and the public would be most grievously and bitterly disappointed. Therefore, we are of opinion that ten miles per hour is the speed you ought to travel at."[19]

Nicholas Wood, it has been already seen, was always behindhand with Stephenson, and it suited the opponents of the latter to set Wood up against him, though it seems strange the maker and worker of the locomotive should be held as of less weight than he who only saw the working. Mr. Rastrick again sets Wood against Stephenson at page 53, decries the work of tho *Lancashire Witch* engine on the Bolton and Leigh Railway, and says of it, "That it is, however, an experiment of any value for determining what the regular work of a locomotive engine might be, that is to travel ten or twenty miles right a-head, will, I should hope, not be asserted. Experiments of this nature are more likely to do harm than good, as they lead the public to expect much greater performances from the locomotive than can ever be realised."—At page 72, Mr. Rastrick hints that although Chat Moss then seemed firm, it must sink and give way under the locomotives.

Of these reports it is enough to say that each cleverly carried out the work assigned to it: Mr. Walker's has a specious assumption of candour which might deceive many,—Mr. Rastrick's shows a wish to set aside Stephenson, and to put up himself and Nicholas Wood against him. Mr. Rastrick was ready for whatever might happen; and although he and Mr. Walker preferred the stationary engine, yet if the locomotive were used, then he and Mr. Walker had schemed an engine which was to set aside Stephenson's.[20] Mr. Rastrick was one of the engineers thought of for laying out the railway when the Messrs. Rennie were displaced. Stephenson, however, had the preference.

The report of Mr. Walker was answered by Mr. Robert Stephenson and Mr. Locke, in a pamphlet named, "Observations on the Comparative Merits of Locomotive and Fixed Engines, as applied to Railways, compiled from the Reports of Mr. George Stephenson." This answer showed so fully the emptiness of Mr. Walker's assertions, as materially to damage the party who had set him on. It is now useless to go into all the bearings of a dispute, on which time has given a judgment which cannot be disputed, against all the assumptions and forebodings of Messrs. Walker and Rastrick, and in favour of the course adopted by George Stephenson.

XVIII. RAINHILL.

In the third yearly report, of 18th March 1829, the directors only say that they have received the reports of Messrs. Walker and Rastrick, to which their consideration shall be given.

Messrs. Walker and Rastrick's reports, however decisive in their terms, would not bear investigation; and their prompters seem to have been so far discomfited, that the board at length settled on the use of the locomotive. Mr. Richard Harrison had long thought that a reward, to be offered by the company, would be the best way to get at the knowledge of the best locomotive; and his brother directors took up his plan, and, on the 20th of April, agreed to give 500*l.*[21] The opposition directors had still sufficient influence to trammel the competition, and, acting on Mr. Rastrick's suggestion, they particularly limited the weight of the engine. Some were not without hopes Stephenson would not be able to make an engine to fulfil the conditions, or to carry the day.

The conditions, given forth on the 25th April 1829, were—1st, the engine should consume its own smoke; 2nd, an engine of six tons should draw twenty tons at ten miles an hour with a pressure of not more than 50 lb.; 3rd, for two safety-valves, one beyond the reach of the engine-man; 4th, the engine to have springs and six wheels, and to be not more than fifteen feet high to the top of the chimney; 5th, the engine with water not to weigh more than six tons, and if less would be preferred on its drawing a proportionate weight—and an engine weighing only four and a half tons might be put on four wheels; 6th, for a mercurial gage, showing the steam pressure above 45 lb. to the inch, and to blow out at a pressure of 60 lb.; 7th, the engine to be sent to Liverpool not later than 1st October; 8th, the price of the engine not to be more than 550*l.*[22]

The time was afterwards made the 6th of October; the ground was chosen at Rainhill, a flat on the railway, two miles in length, and nine miles from Liverpool. The judges were Mr. Nicholas Wood, Mr. Rastrick, and Mr. John Kennedy of Manchester—none of them likely to be too favourable to Stephenson. On the morning of the 6th, the ground at Rainhill was crowded with many thousand people, and among them several of the first engineers of the day.[23]

Five engines had been named, but only three came up; and each of these was tried on a day by itself, Stephenson having the first day for the *Rocket*. This was a four-wheel engine, weighing, with water, four tons and a quarter; the load to be given to it was 12¾ tons, making a whole load of 17 tons. Shortly after the first locomotive was tried on the Killingworth Colliery Railway, it is said, the means was found out of raising the heat of the fire, by carrying the steam into the chimney, where it escaped in a perpendicular direction up the middle, after it had done its work in the cylinders.[24] This was likewise followed in the *Rocket*. Gurney says he was the first to start this way of getting a draught. In 1828, an engine was made at Darlington, with a double fire-tube;[25] but the *Rocket* was able to present a still greater surface to the fire, Henry Booth, the treasurer of the railway company, having suggested to pass tubes through the boiler.[26] The originality of this suggestion has been contested, but never disproved. Frequently before this it had been proposed to pass the water through thin tubes in contact with the fire, and which did not succeed; but Booth's plan was to pass the fire or heated air through the tubes placed in the water. Booth proposed this to Stephenson, who approved it; and they agreed to build an engine and compete for the prize. It was fixed that Robert Stephenson and Co., of Newcastle, should build the engine. Afterwards, Stephenson wished his son Robert should have a share in the adventure, and accordingly he had a third, the two other shares being held, as said, by Booth and George Stephenson. To Henry Booth the world is therefore

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[12] Walker, p. 18

[13] Walker, p. 19.

[14] Walker, p. 4.

[15] Walker, p. 25.

[16] Walker, p. 27.—Rastrick, p. 44.

[17] Walker, p. 28.

[18] Rastrick, p. 28.

[19] Rastrick, p. 49.

[20] Rastrick, p. 54.

[21] Booth, p. 71.

[22] Booth's History, p. 64; Stephenson and Locke's Report, p. 72; Ritchie on Railways, p. 24; Whishaw's Railways of Great Britain; Lardner on the Steam-Engine, p. 244.

[23] Booth's History, p. 74.——Stephenson and Locke, p. 64.

[24] Stephenson and Locke, p. 6.

[25] Stephenson and Locke, p. 17.

[26] Stephenson and Locke, p. 65; Ritchie, p. 283; Lardner, p. 351; Fifth Yearly Report of the Directors.

much indebted for this great step in the progress of the locomotive, no less than for his other railway inventions.

Through the disgraceful patent laws of this country, Henry Booth had no protection for this invention, and no reward. The invention was at once taken up by every engine-builder throughout the world, and applied to thousands of engines. It is needless to say that the English parliament have never given Booth one penny. It is not our way in this country to reward deserving men, unless we cannot help it.

Accidents happened to Braithwaite and Ericcson's *Novelty*, and to Hackworth's *Sans Pareil*, so that further time was lost. On the 8th, the *Rocket* had its last trial; on the 10th the *Novelty* had one trial, and on the 14th another; and on the 13th the *Sans Pareil* was tried. These two latter met with several mishaps, though the *Novelty* promised well. Thus the *Rocket* carried the day. By way of an end, the *Rocket* made two trips at "the astonishing rate of 35 miles an hour."[27]

The *Rocket* engine was for some time worked on the railway, but in 1837 sold to James Thompson, Esq., of Kirkhouse, Cumberland, the lessee of the Earl of Carlisle's coal and lime works. It there worked for five or six years on the Midgeholme tramway, and carried an express with the state of the poll, when Major Aglionby beat Sir James Graham. It did a speed of nearly sixty miles an hour. It was lately in the yard at Kirkhouse.[28] If we had in this commercial and manufacturing country a national museum, as they have at Paris, of Arts and Trades, then the *Rocket* engine would perhaps be preserved in it, as it deserves to be.

The result of the struggle was decided in favour of Stephenson, and on the 25th March 1830, the directors reported they had six locomotives on the line, and four others being built—two by Robert Stephenson and Co., and two by Braithwaite and Ericsson. Of the *Novelty*, they say that on the 26th January, they had witnessed a fair experiment with it, and "the performance was such as, in the opinion of the directors, to justify their ordering two larger engines on the same principle, which will enable them to obtain for this machine the most complete and satisfactory trial."[29]

In 1832, it was said the locomotives were so costly, the directors were going to give them up and use horses. The directors thought it needful to answer this in their report dated 23rd January 1833. On the 24th July they report that Mr. John Dixon, the company's resident engineer, had substituted brass tubes for copper, thereby making a great saving.

The success of the locomotive was very much owing to the staunch and steady endeavours of Mr. Sandars and his friends, who fought its battles for so many years.

XIX. STEPHENSON'S OTHER WORKS.

As the Liverpool and Manchester Railway, and the Locomotive struggle, stand forth as two of the greatest things in the latter half of Stephenson's life, so it seems right to give to them more room. They took, however, but a share in his works.

In 1824, he was employed on a line from Birmingham to the north, since known as the Grand Junction, and made by Mr. Locke. It was then called the Liverpool and Birmingham Railway.[30]

He was afterwards employed on a London and Birmingham line, in which his son Robert succeeded him, and carried it out.[31]

Another early line was one from Chester to Birmingham. Of this he said,[32] "He remembered the time when he had to accompany some directors of a line projected from Chester to Birmingham; and on coming to Nantwich, to get the consent of some landowners, they told them, when they came into the house, the canal proprietors had been before them; and it appeared, that to poison their minds, the canal proprietors had told these landowners, that if a bird flew over the district when the locomotive passed, it would drop down dead. [Laughter.] Judge his disgust, when he knew that the locomotive would give such benefits to England and the world at large." This was the beginning of the Chester and Crewe railway, which he made.[33] He likewise made, in continuation of the latter, the Chester and Birkenhead Railway.[34]

In 1830, the Manchester and Leeds Railway was first proposed.[35] The committee applied to Mr. Walker and to Stephenson. The plan of the latter was preferred. In 1831 the act was asked for and lost. In 1835 the plan was again brought forward, and a new survey made, in which Mr. Francis Whishaw assisted, and likewise Mr. Bidder. In 1836 the act was obtained.

Stephenson surveyed and constructed the York and North Midland Railway.[36] This brought him into friendship and partnership with Mr. George Hudson, and they afterwards engaged in the Claycross Collieries and Limeworks.

In 1830, Stephenson was engaged in several undertakings, but his reputation was contested in many of the pamphlets of the day, on the ground of want of experience.

From this time till 1835, he was busily engaged in railways, till in the latter year of speculation he was at the height of employment. Many of the plans failed, and have been long since forgotten.

In 1835 he was employed on the Birmingham and Derby.[37] At this time were his London and Brighton Railway,[38] the Maryport and Carlisle Railway,[39] and the North Midland Railway.[40]

The Whitby and Pickering Railway was a small work of Stephenson's in 1832.[41]

Except the London and Brighton line, the others were worked out by him. He was likewise engaged on the Morecambe Bay or West Cumberland Railway.[42]

The Manchester South Union or Trent Valley was planned by him,[43] and also the Newcastle and Berwick Railway. The High Level Bridge at Newcastle was one of his greatest designs, and he lived to see it far advanced. It will be surmounted with a statue of him. He surveyed a South-Western Railway from Bristol and Exeter to Hook Pit,[44] and the Manchester and Birmingham Railway.[45]

Robert Stephenson had been from time to time taking a greater share in the engineering business, until at length, in 1840, George Stephenson withdrew altogether.

He had before this been invited to Belgium with his son, to give his opinion on the Belgian government railways, and King Leopold conferred on each the cross of his order of knighthood.

George Stephenson now had considerable wealth, and large profits from his engineering practice and locomotive factory. He was a great coalowner at Claycross, and in Leicestershire, near the Leicester and Swannington Railway;[46] and it was very much owing to his exertions that the working of coal[47] and lime in the midland counties has become so extensive. He was in favour of bringing coals by railway to London, but his plans have not been fully carried out.

At Tapton, near Chesterfield, in Derbyshire, was the seat of his abode in latter years, and he gave much time to the improvement of his house, grounds, and garden. His name sometimes appeared as a director of railways, or as a consulting engineer, as in the case of the Norfolk Railway, the Ambergate and Manchester Railway, and the Whitehaven Junction Railway; but his own property took up most of his time. He was chairman of the Norfolk Railway, and director of the Leicester and Swannington Railway.[48]

His after-life was one course of triumphs. On the 18th June 1844, he was at the opening of the Newcastle and Darlington Railway at Newcastle, when his health was given by the Hon. H. T. Liddell, M.P., son of Lord Ravensworth. Stephenson's speech in answer has been often referred to, and is most interesting.

In 1845, Mr. Hudson moved for and obtained four several votes of 2,000*l*. each, for a service of plate and a statue on the High Level Bridge, from the Midland Railway Company, the York and North Midland Railway, the Newcastle and Darlington Railway, and the Newcastle and Berwick Railway.

In 1847, he was invited by Sir Robert Peel to meet a party of

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[27] Stephenson and Locke's Report, p. 79.

[28] Carlisle Journal; Leicestershire Mercury, August 19, 1848.

[29] See likewise Booth's History, p. 84.

[30] Report on the Liverpool and Birmingham Railway, Aug. 1824, by George Stephenson. (In the Library of the Institution of Civil Engineers.)——A Statement of the Claim of the Subscribers to the Birmingham and Liverpool Railroad to an Act of Parliament, in Reply to the Opposition of the Canal Proprietors. London: Baldwin, 1825. (This is dated 20 Dec. 1824, and contains the Prospectus.)——Aris's Gazette, Dec. 13th, 1824, &c.——Whishaw's Railways of Great Britain, p. 157.

[31] Beware the Bubbles. London, 1831, p. 35.——Probable Effects of a Railway between London and Birmingham. London, Roake and Varty, 1831.——Conveyance upon Canals and Railways Compared, by Detector, 1831.——Remarks on London and Birmingham Railway, by Investigator. London, Richards, 1830.——Answer to Investigator, by C. H. Capper. Birmingham, 1831.—(All these are in the Library of the Institution of Civil Engineers.)

[32] Speech at Tamworth.

[33] Whishaw's Analysis, p. 49 ——Whishaw's Railways of Great Britain, p. 55.

[34] Whishaw's Analysis, p. 47.——Whishaw's Railways of Great Britain, p. 51.

[35] Whishaw's Analysis, p. 158-163.

[36] Railways of Great Britain, p. 437.

[37] Whishaw's Analysis, p. 10.

[38] Whishaw's Analysis, p. 129.

[39] Whishaw's Analysis, p. 177.

[40] Whishaw's Analysis, p. 188.——Whishaw on Railways, p. 367.

[41] Whishaw on Railways, p. 428.

[42] This was planned in 1836, by the author of this. Mr. Sandars, a most intimate friend of Stephenson, says that he was fond of quoting it as one of the most important undertakings in the country, and was very anxious for the reclamation of the lands in Morecambe Bay and the Duddon.

[43] Whishaw's Analysis, p. 168.

[44] Whishaw's Analysis, p. 226.

[45] Whishaw's Analysis, p. 332.

[46] Whishaw's Analysis, p. 230.

[47] Whishaw's Railways of Great Britain, p. 184.

[48] Railway Post-Office Directory for 1847 and 1848.

scientific men at Tamworth, and on the 30th June of that year, was present when Sir Robert raised the first sod on the Trent Valley Railway, originally surveyed by Stephenson. On his health being drunk, Stephenson made another autobiographical speech.

XX. DEATH OF STEPHENSON.

He now married again, and the lady survives him.—On the formation of the Institution of Practical Engineers at Birmingham, he became the President, and took much interest in its proceedings. From prejudice against some of the members, he refused to belong to the Institution of Civil Engineers—one of the instances of the extent to which he gave way to his personal feelings.

One of his last acts was promoting a chancery suit against the Directors of the West Flanders Railway, seemingly on very slight grounds, and which his son gave up in a very liberal manner.

He had now lived to see his son Robert a member of the House of Commons, and engaged in an undertaking (the great tubular bridge) which will give him as lasting a reputation as that of his father. Another pupil, Mr. Locke, he likewise saw in the House of Commons; and other pupils holding such high professional rank, that he was justly looked upon as the father of a great school of engineering. He was in the full strength of life and health, and busy in the world, when he was stricken down by death. He was taken with fever, it is said, brought on by too long stay in one of his hothouses. On the Tuesday, Wednesday, and Thursday, the fever ran very high; but on the Friday he was better. Mr. Condell, a surgeon of Baslow, attended him day and night. On the Saturday morning early, he again became worse, and at noon breathed his last.[49] This was on the 12th August 1848, and he was then sixty-eight years old; so that his time of life was neither too short for the world nor himself.

He was buried the next week in Trinity Church, Chesterfield; all the shops in the town of Chesterfield being shut, and hundreds crowding in to pay their last tribute to him. The funeral procession included the Mayor and Corporation of the town, the clergy and gentry, the clerks and agents from Lockaford and Claycross collieries, the carriages of many gentlemen and the mourners, Messrs. Robert, G. R., and R. Stephenson, Hindmarsh, and Langlands. On the coffin-plate was engraved,

George Stephenson,
of Newcastle upon Tyne,
died at Tapton House,
August 12, 1848, aged sixty-eight years.[50]

George Stephenson married first in the year 1800, at Killingworth. His wife died in 1803, shortly after the birth of his only son Robert. Stephenson next married Miss Hindmarsh, daughter of a respectable farmer in the neighbourhood of Killingworth, and who had been his first love, but the match had been broken off by her kinsmen as he was then only a poor working-man. He lived happily with her for many years.[51]

Stephenson's tastes and habits, when alone, were simple. In his latter years it was his greatest delight to ramble about birdnesting or nutting.[52] He was never fond of reading, but learned much in talking with the men of bright wits who were his fellows. His mind was fruitful in resources, and it was a rich treat even to the imaginative to listen to him. In this he was much like Watt, and gave proof that mechanical genius is akin to the highest intellectual efforts of the poet and the philosopher. The American metaphysician, Emerson, listened to Stephenson in silence and delight.[53]

At home he gave much time to his dogs, cows, and horses; rabbits, and birds; vines, melons, pines, and cucumbers. Every day he took a long ramble watching the nests he carefully guarded in his trees. On his hothouse he had set his pride, and having taken up with the idea that the great principle of vegetation was to give as much light and heat to the soil as may be, he believed and said he should grow pines at Tapton as big as pumpkins. This he held forth at a dinner of the North Derbyshire Agricultural Society.[54] It is asserted, his attention to these hothouses hastened his death.[55]

It is said of him by one who knew him, "Never was a proposition made to him for the mental and temporal improvement of his workmen in his collieries, of whom he had upwards of 1,000, but it met with his immediate attention and consideration, with a deep feeling towards their welfare which could not be surpassed."[56] When applied to for assistance, he ever endeavoured, instead of giving temporary relief, to find constant employment for the applicant.[57]

To those who applied to him for countenance for new projects he was not always so considerate; he was wrapt up in his own schemes and looked upon others with ill-will. His feelings towards Brunel were shown with a warmth and bitterness unbecoming, and it extended to all the supporters of the atmospheric system. The locomotive was his cherished idol, and woe to those who interfered with its worship. A very coarse scene took place when Mr. Hudson brought before him a plan of Mr. F. W. Beaumont, the engineer, for common road locomotives; and many more might be quoted. His temper was too apt to give way, unless he had the field wholly to himself.

Sometimes, however, he would relax. The writer in the *Derbyshire Courier* relates, "A certain individual in humble life had conceived a design he wished to have a patent for, and made application to Mr. Stephenson, that he might gain his patronage in order to give weight to the undertaking. Mr. Stephenson made some inquiries relative to the nature of the project, and having heard a few words in reply, said, 'Oh! I understand it altogether; it will do very well.' The party, overjoyed with this approval, said, 'Before I leave you will you be pleased to tell me your charge?' 'Oh!' exclaimed Mr. Stephenson, 'I make no charge; but I tell you what you must do, you must send your instrument down to my works, and I will attach it to them, and prove it; and I will do more—I will put it in the papers for you, and invite the public to come and examine it at work, and afterwards purchase it myself.'"

This he did, and sent a letter to the London daily papers, stating that he had tried a new steam-gage by Mr. Smith of Nottingham, and recommended it strongly.

The writer first-named tells a story however of him in another style. "A gentleman who had thought of doing away with the hills and valleys of railways, sent a friend to introduce his plan to Mr. Stephenson, who, after having heard some little about it, interrogated his visitor as to where the proposer himself was. 'I have left him outside; he was afraid to come in lest you should get the secret out of him.' 'Why! have you left him by himself?' 'Yes.' To this he answered, 'You must not leave him by himself long, or you will soon have to get some one to take care of him.'"

His plainness of mind and speech as often verged on simplicity as on coarseness, and he ever had more respect for the man than the coat, an example more uncommon in those who have risen from the ranks than it is even among those of higher birth. He was never ashamed of his own works and of his fellow-workmen, and was most proud that he had been a working-man, and not a lazy man. On one occasion, he came in contact at an hotel with a gentleman and his wife, whom he entertained for some time with his shrewd observations and playful sallies. At length the lady became curious to know the name of the stranger with the sharp eye and unostentatious demeanour. "Why, madam," was his answer, "they used to call me George Stephenson. I am now called George Stephenson, Esq., of Tapton House, near Chesterfield. And further, let me say, I have dined with princes and peers, and commoners—with persons of all classes, from the highest to the humblest;—I have dined off a red herring when seated in a hedge bottom, and have gone through the meanest drudgery; I have seen mankind in all its phases, and the conclusion I have arrived at is this—that if we were all stripped, there's not much difference."[58]

He was proud of his varied insight into mankind, and at the dinner at Newcastle said, "I have dined in mines, for I was once a miner; and I have dined with kings and queens, and with all grades of the nobility."

His energy, ingenuity, and perseverance have been already spoken of, but a few words more may be said. After leaving Callerton Colliery, he went to Walbottle Pit as brakesman, waiting on the engine while drawing the coals up from the pit. Thence he went to Willington ballast-crane, likewise as brakesman. Here, at the age of 22 or 23, he began to learn to read. From Willington he went to Killingworth, still as brakesman. At this pit were three brakesmen, who took the night shift by turns. The night shift lasted eight or ten hours; and as there was little work to be done in that time, only drawing up and letting men down, the brakesman's time hung heavily on his hands. Stephenson, however, made the most of his time, and in these night shifts began learning to reckon. When he had worked his sums on a slate, he sent them off next morning to a schoolmaster in the neighbour-

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[49] Chesterfield Gazette, August 19, 1848.

[50] Derbyshire Courier.

[51] Eliza Cook's Journal, p. 66.

[52] Leicestershire Mercury.

[53] Leicestershire Mercury.

[54] Leicestershire Mercury——Derbyshire Courier.

[55] Herapath's Railway Journal, Vol. X., No. 480, p. 867.

[56] Leicestershire Mercury.

[57] Derbyshire Courier.

[58] Derby Reporter.

hood to be set right; and who, in turn, sent him new questions to answer. For this the learner paid fourpence a week. He likewise in the night shifts mended the pitmen's clocks and watches, for which he was paid, and cut out the pitmen's clothes. He further taught cutting-out to the pitmen's wives; and to this day there are some of them at Killingworth who work by his patterns. He made shoes by the engine-fire, sometimes giving them to his poorer kinsmen. Over the door of his house at Killingworth stands a sundial, set up by himself, and to the last day of his life he was proud of it. Not long before his death, while going over the line of the Newcastle and Berwick Railway, he drew a professional friend somewhat out of his way to have an admiring look at the sundial.[49] All this time he was deeply studying the steam-engine, and exerting his mechanical ingenuity. Such a degree and variety of mental labours is seldom gone through by the hardest student in a college.

Statues were voted to Stephenson by the northern railways as already shown, and by the Grand Junction Railway Company, in 1846. Gibson is employed on the latter work.

On his death, the greatest sympathy was shown throughout the country by its representatives in the press. The notice of his death in the railway newspapers and some of the provincial newspapers appeared surrounded by a mourning border; and several short memoirs appeared from the hands of those who had known him. These have been here made use of. The Presidents of the Institutions of Civil Engineers and of Practical Engineers likewise paid a public tribute to his merits. Before the latter an *éloge* was read by Mr. Scott Russell. Robert Stephenson was chosen to succeed him as President of the Institution of Mechanical Engineers, held at Birmingham. Mr. Hudson, then presiding over several railway meetings, expressed the sense the shareholders felt of his loss. The Liverpool Board of the London and North Western Railway passed a special resolution of condolence, which they sent to his son. Lately, an engraving has been published from the full-length portrait, by Mr. Lucas, representing him standing on Chat Moss. Seldom was a man more honoured in his life or on his death.

Stephenson had been employed in France, Belgium, and Germany, as well as at home, and had received great honours; only it will be seen from the government of this country did he receive no honours. It is perhaps enough thus to speak of the system which, in all its bearings, so improperly performs the duties of national gratitude towards men of learning and knowledge. The Royal Engineers, as government *proteges*, are better looked after; and Stephenson saw Drummond, Reid, Gipps, and Denison, with many others, receive honours which the government had at its disposal, but not for meritorious civilians.

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[49] Quoted by the writer of an interesting sketch of Stephenson in Eliza Cook's Journal.

ARCHITECTURE,—ROYAL ACADEMY.

[SECOND NOTICE.]

Of designs for churches there are so many that they impart somewhat too great a sameness of character to the assemblage of drawings generally; more especially as they are one and all in the Gothic style. Upon the whole, they justify Mr. Ruskin's remark that there are now many who can show quite as much or even more ability than Mr. Pugin, who, as far as he is at present distinguished at all, is so only by his excessive affectation and pedantry. There is one design of his, by-the-by, which we have not yet spoken of—viz., No. 1057, which shows the tower and spire of St. George's Catholic Chapel, Lambeth, as intended to be finished; in which as a composition we can perceive no great merit or beauty,—and certainly should that portion of the structure be carried up to such a preposterous height, it must have the effect of dwarfing the church itself, and making the body of the building appear diminutive in comparison with it. There seems, indeed, just now, to be quite a rage for lofty spires; which, if not always disproportioned to the structures themselves, are frequently so disproportioned to the funds that the design suffers greatly in other respects, both externally and internally. In fact, just as a portico used to be some years ago, a spire is now made an *ad captandum* feature, and as making full amends for whatever deficiencies there may be in regard to all the rest. Thus, instead of a commodious and well finished-up structure being provided in the first instance, to which a spire can be added at some future opportunity,—or should that never be done, will still be satisfactory in itself,—an ostentatious spire is often attached to a small, and perhaps also mean-looking, body, which can hardly be afterwards adequately improved, except by taking down and rebuilding. "What can be worse," says Mr. Talbot Bury (in Part II. of *Architecture*, in Weale's Rudimentary Series) "than to see the body of a church shorn of all mouldings, to lavish an unnecessary amount of enrichment on a tower?" Yet, that is now frequently done, contrary perhaps in some cases to the better judgment of the architects themselves, merely in compliance with the want of judgment and one-sided notions, either of committees who cannot be got at so as to be reasoned with, or individual employers who will not listen to reason, or to any arguments against their own whims. Some other remarks of Mr. Bury's apply to several designs in the present exhibition, as when he tells us that "the only requirement of an architect of the present day (so far as the erection or restoring of churches is concerned), seems to be a knowledge of the varieties of details of Gothic buildings, which he is allowed to put together in any way he likes; for according to the views of certain societies, they must of themselves produce a good building." Again, he observes: "The details of cathedrals, royal chapels, palaces, and princely mansions, are borrowed to disguise hospitals, schools, asylums, training colleges, and even workhouses. This dishonesty in the expression of a building, and the ignorant introduction or bad execution of useless ornament, seems to be (now) sanctioned by custom, and is daily perpetrated:—success stimulates the empiric to proceed in his career, and the public taste becomes infected by his productions."

Instances of the species of disguisement reprobated by Mr. Bury are met with here: what at first sight show like lordly-looking Elizabethan mansions, turn out to be intended for hospitals, or other charitable institutions; while villas congregated together under the title of a "Terrace," are made to look very much like a range of almshouses. On the other hand, colleges—at least, training colleges, which might without impropriety be of some importance with respect to mass, and to regularity of structure, are cut up into a series of low straggling parts, merely tacked together, without the slightest regard to architectural *ensemble*. Such productions might rather be called *accidents* than designs, for the several parts—no single one of which, perhaps, has much merit in itself—might be transposed *ad libitum*, or they might all be shaken up together, and scattered out afresh, and the composition would be just as good as ever, if not better. It requires no art to produce that sort of picturesqueness which is almost sure to be occasioned by mere irregularity and incongruity; it being no more than what often shows itself very decidedly where not the slightest pretension is made to architecture, to design, or to artistic effect, but where, on the contrary, the several parts and features taken by themselves are decidedly ugly. Yet, that species of the picturesque ought to be left to the painter; it no more belongs to the architect than does that which arises from decay. Where we know that buildings have grown up piece-meal, by fresh patches added to them from time to time, irregularity does not offend; but to *design* a building so as to appear at the very first only a mass of "shreds and patches"—and of architectural tatters, as some of the things we here behold, do, particularly one design for a Training College, which requires to be trained itself,—is not a little preposterous.

By some it will be thought that our own pen requires to be *restrained*, for we have been indulging in a strain of general, yet not quite uncalled-for remarks, instead of noticing or even pointing out any designs in particular; although, were we gifted with the same talent for expeditious criticism as some are, we might ere this have passed in review the whole of the architectural subjects, by merely extracting titles and names from the catalogue—as was done, for instance, by the *Illustrated News*,—which mode of criticism those readers who prefer it will there meet with. One of the very few which deserve to be particularised for merit of design is No. 1015, "The Private Chapel and Cemetery recently erected at Carnsallock, Dumfries, for the late Right Hon. Sir Alexander Johnston," E. B. Lamb. Regarded merely as a drawing, there are others far more striking and captivating at first sight, being set off by all the artifices and allurements of showy colouring, *staffage* or figures, and pictorial effects. The structure itself, too, is but a small one, and the front of it here shown consists of very little more than a doorway incorporated with a window over it, and a gable,—the fewest and simplest features possible, yet which are nevertheless made to produce a most happily-conceived, and happily-treated *ensemble*. Mr L. is evidently more ambitious of setting precedents than of following them; and although that would be presumptuous and unsafe in many, in him it is neither the one nor the other; because he invariably displays far more than ordinary artistic *forte*, and shows himself capable of adhering faithfully to the genuine spirit of the style he adopts—be it Gothic or any other—without the slightest taint of servile imitation. This is high praise, but in his case not excessive, because amply merited; and we only regret that we cannot extend it to many other things which, being of greater magnitude, and affording much greater scope for design, ought accordingly to have manifested talent proportioned to the occasion.

For aught we know to the contrary, many of the designs here exhibited have been selected from among a number of others sent in at competitions for the respective buildings; and if such be really the case, we are bound to suppose—at least, until there be proof to the contrary, that they were in each instance, the best offered; yet few of them show particular talent. In fact, there is a striking sameness both as to quality and ideas in subjects belonging to the same class, which causes them to appear "made to order" in compliance with some one of the prevailing fashions of the day, among which Tudor and Elizabethan come in for an ample share of favour. Of such style, No. 1037, "New Schools, &c., recently built in the district of Christ Church, St. George-in-the-East," G. Smith, shows a good application. There is also something good in No. 1049, "Design for an Elizabethan Villa," C. W. C. Edmonds; for which, however, "mansion" would have been a more appropriate designation than "villa." Indeed, we almost wonder that the latter term is not altogether repudiated as foppish and outlandish, by the admirers of our "good Old English" tastes and fashions.

In any other style than mediæval and Old English there are scarcely any designs at all, except "The Assize Courts at Liverpool," which drawing we spoke of last month; and No. 1108, "The Great Hall of the Euston Station," P. C. Hardwicke, a cleverly executed interior, and not devoid of considerable scenic effect; yet, at the same time marked by oversights and defects in its design that might easily have been corrected or avoided. In our opinion, the ceiling is too much decorated,—so much so as to cause the lower part of the apartment to appear bare and unfinished, while the large carved brackets or trusses which support it are out of keeping with the order below, and take off considerably from its importance, more especially as the columns themselves are shorter than they needed or ought to have been; for strange to say, the pedestals on which they are raised are made higher than the railing between them, which produces a very awkward and disagreeable effect. No. 1091 ought to have shown us at least a handsome specimen of modern design, it being according to the catalogue for a Building for the Vernon Gallery, but for which information we should never have suspected that it was intended for a picture gallery at all. We will here bring our remarks to a close,—somewhat abruptly, perhaps, but as it happens, time does not permit us to say more.

ON THE PADDLES OF STEAMERS.

On the Paddles of Steamers—their Figure, Dip, Thickness, Material, Number, &c. By THOMAS EWBANK, Esq., City of New York. [From the *Journal of the Franklin Institute.*]

The world is awakening to the propulsion of steam-vessels, and nations are about to compete with each other in increasing their speed. Steamboat racing is too congenial with the age to be repressed; its spirit, so far from having been laid by legal exorcisms, or confined, as heretofore, to lake and river craft, has now seized the ocean for its theatre, and laughs outright at adjurations. Engineers and naval constructors, animated with the ambition of Olympian competitors, are preparing for a series of Atlantic chariot races, compared with which, the whole Naumachian spectacles of old were despicable puerilities.

Impressed with the interest of a contest unexampled in the annals of mechanical science, and one so characteristic of the progress of civilization, the following experiments were undertaken with a view of eliciting facts that seemed imperfectly known. Speculations on propelling abound. I am not aware that a series of experiments similar to these, limited and imperfect as they are, has been prosecuted. If any such are recorded, I have not met with them.

Experiments on variously formed Paddles, made on the Harlem River, New York, in 1845 *and* 1848.

For this purpose, the boat, fig. 1, was employed. It was 12½ feet long, and 3½ feet across the middle. A wrought-iron shaft, 1 inch square, with a crank, extended across the gunwales, and turned in bearings bolted to them. The ends of the shaft stretched 14 inches over the sides of the boat. This prevented the wheels, which were secured on their extremities, from throwing as much water into the vessel as if they had been nearer; and afforded a better opportunity of observing the action of the blades. A person seated at one end of the boat readily turned the wheels, in either direction, by alternately pushing from, and pulling towards him, two upright rods, which moved in joints at the bottom of the boat, and were connected to the cranks by horizontal rods.

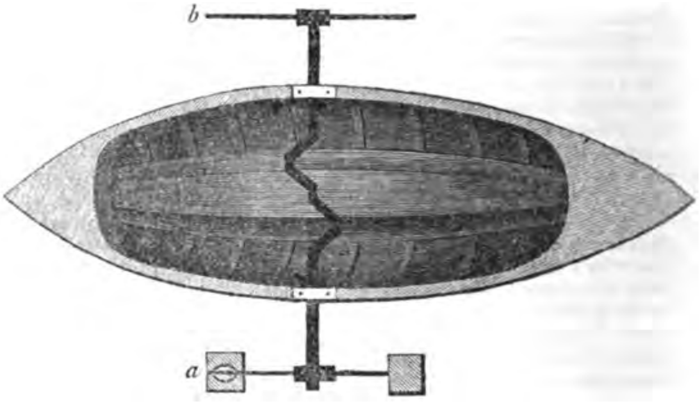


Fig. 1.

The wheels were very light, and of the simplest construction. One is shown at fig. 2. Eight slender arms of $\frac{5}{16}$ square iron, have their inner ends cast in the central piece. They extended 20 inches from the centre, and thus made a 40-inch wheel. To stiffen them, and transmit any strain upon one to the whole, they were braced tightly together by the wire *o*, *o*, *o*, which was wound round each arm, and retained by slight notches at the corners. The various blades or paddles were cut out of stout sheet iron. Square sockets, to slide over the arms, were riveted to them; by which means they were readily adjusted and secured at uniform distances from the axes. All were of the same area—49 inches.

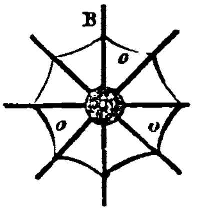


Fig. 2.

To test the qualities of the boat, and get her into working trim, blades, 7 inches square (fig. 3), were fixed on the arms of both wheels, and several excursions, up and down the river, made with them. Their dip was 7 inches, or rather more, for their upper edges were half an inch below the surface. They were next removed from one wheel, and left on the other, as the standard by which to compare the effects of different shaped ones.—They were distinguished as No. 1. Nearly all the rest were formed from them: *i.e.* by removing portions from one part, and adding them to others, as will be seen in the following diagrams. In this way there was no danger of making, through mistake, one set of blades, of larger, or of less, superficial surface than others, since no calculation of their areas was required.

Fig. 3.

In all the figures, the paddles are supposed to sweep through the water in the position they are represented in, the lowest sides being those which descend lowest in the fluid.

Fig. 4,—formed by cutting off the lower angles of fig. 3, and transferring the pieces to the upper ones, making a right-angled triangle, with sides 10 inches, and hypotenuse 14 inches. (By mistake, the upper corners were cut away, so as to leave the area of these blades 48 square inches, instead of 49.) Eight of these were fixed on the wheel (see *b*, fig. 1,) to compete with the same number of fig. 3, on *a*, both having 7½ inches dip.

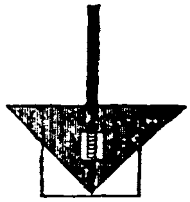


Fig. 4.

It will be obvious that, as both sets were attached to the same shaft, if one proved more efficient than the other, the boat would be turned from a straight course, and be inclined, more or less abruptly, to the weaker or less efficient set. The result was, that those marked fig. 3 overcame fig. 4; and though only in a small degree, yet quite sufficient to establish their superior effect on the vessel's progress. As we were not always out of the influence of tides and slight breezes, each experiment embraced excursions in various directions on the river. Once or twice, the boat went straight as an arrow, but eventually the square paddles got the better of the triangular ones. These dipped into the water with little noise, and threw it off behind from their points.

Most of the experiments were made in smooth water, and, except slight currents—aqueous and aerial—under the most favourable circumstances. Two persons occupied the boat, and the greatest care was exercised in preserving the shaft in a horizontal position. When results were doubtful, the experiments were repeated, and generally several times.

The *same* paddles (fig. 4) were next attached to the arms in the position represented at fig. 5, the upper side being, as in all other instances, 13 inches from the centre of the axis. Through repeated trials, they overcame the test paddles, fig. 3, and in a rather more marked manner than fig. 3, surpassed fig. 4. They entered the water silently, but observers on shore thought they raised more water behind, but did not raise it as high as fig. 3. Their points were nearly three inches lower in the water than the lower edges of fig. 3. The boat described a circle of 400 feet, and another of 600 feet.

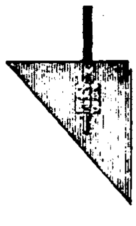


Fig. 5.

The same blades were next tried as fig. 6. From the experiment fig. 5, it was inferable that, if inverted, the effect of the blade on the boat would be augmented, as a larger portion would have a longer sweep through the water. Such was the fact, and to such a degree, that first two, and then four, were removed from the arms, when the remaining four were found equal to the eight of fig. 3. The plates were next raised, till their lower edges were on a level with those of No. 1. In that position, two inches of their upper extremities were above the surface of the river; but, notwithstanding, they had a decided advantage even then, over the square ones.

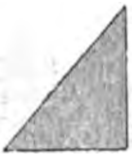


Fig. 6.

Lastly, the same blades were turned into the position of fig 7, (being fig. 4 reversed). The boat was turned on No. 1 under all circumstances, describing circles from 80 to 150 feet in diameter. Four of them equalled eight of No. 1. They were thought to throw off more water behind than their competitors, which, from the greater extent of their extremities, is probably true.

The next form tried was fig. 3, placed in the position of fig. 8. These turned the boat round against the test ones, in circles varying from 50 to 200 feet. We then tried six of them against the other eight, when there was little observable difference in the results. Four were found superior, but three were unequal to them. These, of course, entered the water without jarring, and threw it off at their points. Mr. B. thought they threw up more than fig. 3.

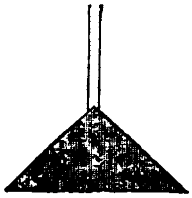


Fig. 7.

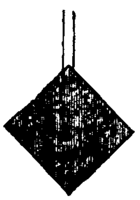


Fig. 8.

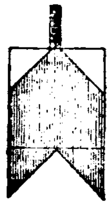


Fig. 9.

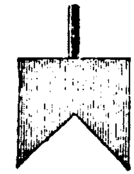


Fig. 10.

Fig. 9 were formed by removing the upper corners below, as in the figure. These seemed to have the advantage of fig. 8, but as light winds troubled us, we felt some hesitation in pronouncing them better. Four were superior to eight of No. 1. It was supposed that a slight accession of resistance to the lower ends, sweeping through the water, might be derived from opposing currents meeting in the forks, but we had no means to ascertain it, if it existed.

Fig. 10—cut out of plates eight inches square, with one-fourth, (minus a superficial inch) removed, as shown in the figure. After several excursions, these were thought to exhibit a very slight advantage over fig. 3; but from subsequent tests, they seemed to be balanced. We, on another day, reversed them, as

Fig. 11, which had a decided preponderance over their competitors.—Six predominated slightly over the latter, and four were thought nearly equal to them. There was a difference of opinion on the last point—some thinking they were quite as effective as the opposing eight.


Fig. 11.

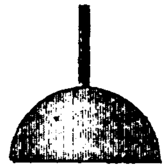


Fig. 12.

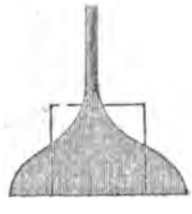


Fig. 13.

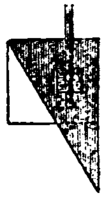


Fig. 14.

Fig. 12 was a semicircle. Mr. B. undertook to test these. They turned the boat in circles varying (from light winds and tides) from 30 to 150 feet. Four were thought sometimes equal, and sometimes superior, to eight of fig. 3. It is demonstrable that these blades are less effective, though in a very small degree, than those marked fig. 7, and, when reversed, more powerful than fig 4.

Fig. 13,—formed as in the figure, but not tried, as it was evident their value would be nearly that of fig. 7, probably a shade above them, but too minute to be detected, except in perfectly still water.

Fig. 14,—a right-angled triangle, 7 inches across the top, and ending in a point nearly 14 inches below it. These were, as might have been anticipated, more effective than those of fig. 3. "Everything about them," observed Mr. B., "shows their superiority." They, of course, entered the water without jarring.

The same were attached to the arms in the position of fig. 15, and were unable to compete with fig. 3. The latter had a slight advantage over them.

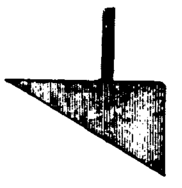


Fig. 15.

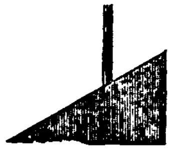


Fig. 16.

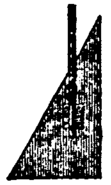


Fig. 17.

They were next reversed, as fig. 16, when they proved as effective as figs. 7 and 12.—four being equally so as the eight opposed to them.

They were finally changed to fig. 17, when the boat was turned so rapidly, as to make it difficult, with a wide oar, to keep her in one direction. Four were removed, and then she described a circle in less than 50 feet. Two more were taken away, leaving only a couple to act against the eight on the other wheel, and to which they proved equal.

From these experiments, it appears that, with equal areas, and equal dip, triangular blades may be rendered twice as effective as ordinary rectangular ones. This is made manifest by figs. 7, 12, and 16,—*four* of the former equalling eight of the latter. And this, too, while the propelling surface of the smaller number was only half that of the greater; for the four were as long in making a revolution, as were the eight. Hence, the speed of a boat may be increased by diminishing the number of her paddles—a fact still further elucidated by fig. 17.

There can, I think, be little doubt, that the greater the velocity of a steamer's wheels, the fewer (within certain limits) should be the blades; and that, at the rate at which some of our boats go, the number might be reduced with advantage. Some have three, others four, and in more than one vessel, without any load on board, I have seen six submerged at each wheel. In these cases, is it not evident that each blade, on entering, plunges, not as it ought, into water undisturbed, but into that which preceding ones have already broken up, and set in motion towards the stern? It would seem that one in the act of plunging, another sweeping under the shaft, and a third leaving the surface, are all that are necessary to be kept up; and that a greater number, as regards the speed of a boat, is positively injurious. Yet, under a vague idea of attaining a higher speed, the number of paddles has frequently been nearly doubled.

Snow, as every person knows, causes the wheels of land locomotives to slip upon, instead of rolling over the rails. They revolve as usual, but their carriages make little progress; hence much of the power spent on them is expended to no purpose. So it is with paddle wheels. A boat never progresses in the ratio of their revolutions, because of the yielding medium in which, and against which, they act. They slip always—a result inevitable when massive solids wade through fluids. The distance between the Atlantic steamers' docks, in Liverpool and New York, has been calculated at 3,023 miles, but their paddles, in each trip, pass over a space varying from 5,000 to 8,000 miles. In steamers unaided by sails, the disproportion is often greater. Now can this be modified, by giving the paddles a better hold on the fluid they sweep through? The experiments, figs. 5, 6, 7, 8, 9, 11, 12, 14, 16, and 17, furnish replies to the interrogatory.

The moral of the foregoing experiments is this:—As the propelling power of a paddle is greatest at its lower or outer extremity, and diminishes to nothing at the surface, so its face should enlarge with the dip, and be nothing, or next to nothing, above.—Let *d*, fig. 18, represent the end of an ordinary blade, or paddle. Its upper part barely touches the water, and only for the moment it is in the position shown. But suppose it were immersed to the line *c*, *c*,—say four or five inches—it would even then be no sooner under, than above the surface again, so brief would be its immersion. The lower edge, in the meanwhile, would sweep along the extended curve there delineated.

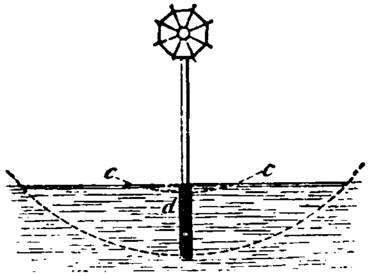


Fig. 18.

Of what use, then, to make the upper part of a blade of equal extent with the lower? Why accumulate surface where it is of little avail, and withhold it from where it is most wanted?—expending materials and power without any adequate return, if not at an absolute loss. The quantity of water carried over a wheel, is certainly greater by ordinary, than it would be by triangular, paddles. The popular form and position of paddles are unphilosophical, if viewed simply as propellers. Embrace the same area in any other outline—in a circle, ellipse, square, pentagon, hexagon, octagon, or other polygonous figure, and the propelling properties would be increased, and the jar arising from their striking the water also diminished.

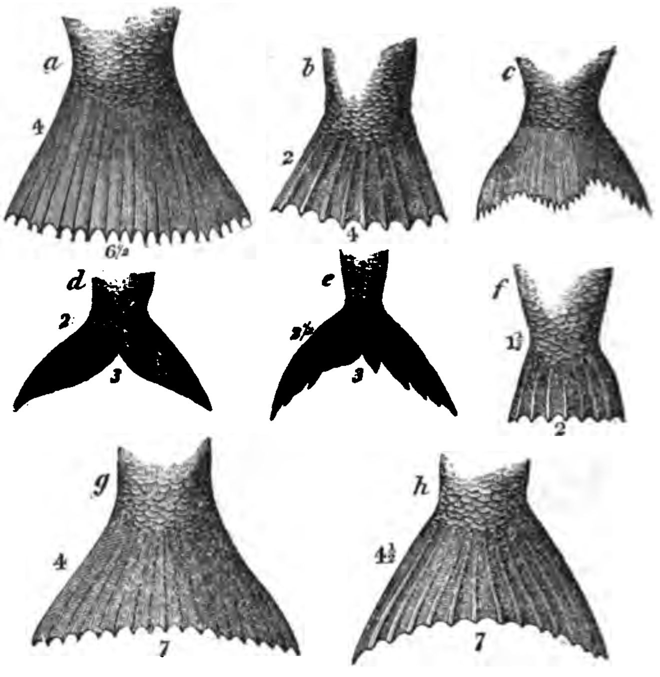
If the long paralellogram be preferred, because of the ready application of wooden planks, then is the principal sacrificed to an accessory—the greater to the less. If triangular, or other improved blades, require the adoption of plates of metal, would it be wise to reject them on that account?—But of this by-and-bye. We shall see that thick wooden blades ought to be condemned on account of defects inherent in them.

But what is this expansion of the lower part of a paddle, and contraction above, but Nature's own plan? In the tails and fins of fishes, in wings of birds and insects, and especially in the palmipeds, she has nowhere sanctioned a rectangular propeller. All are inclined to equilateral, scalenous, or isosceletic triangles, or are made up of them. Nor does she ever unite the levers that work them to their sides. The junction is invariably at an angle, and the reason is apparent—that the largest surface may have the longest sweep.

With this view, the bodies of fishes taper down to meet the blades; retaining only sufficient muscle to work them. The other day, I had an opportunity of sketching the following. I am ashamed to acknowledge that, till then, I was ignorant of the exact forms of these natural propellers, although most of them had passed under my observation on a thousand occasions. Too many of us spend no more thought on the infinitely curious and instructive mechanisms submitted by the Creator to our inspection daily, than does the ox on the vegetable glories he feeds on. The sentiment applies not more to religious than to physical truths—"Light shineth in darkness, and the darkness comprehendeth it not." We grope, as if blind, for that which is patent before us.

The general outlines and proportions are given in the annexed figures; the dimensions, of course, vary with the age and growth of individuals. The figures denote the width and length of the expanded tails—the latter being taken from the termination of the body, as shown by the curves, which reach more or less into the tails—that is, to strengthen them where strength is most required.

Fig. 19.



a—Cod. *b*—Black Fish. *c*—Sea Bass. *d*—Porgy. *e*—Mackerel. *f*—Flounder. *g*—Striped Bass. *h*—Salmon.

I confess I had no idea of meeting with figures so closely allied to the artificial ones which I had found most effectual as propellers. With the exception of the first two, the whole approach to equilateral triangles.

In the absence of a more extended acquaintance with the minuter aqueous and sub-aqueous organisms, the nearest of natural analogues to steam-vessels seem to be the principal swimming-birds. These glide through two elements at once. Their long and heavy bodies, adapted to float gracefully on water, are provided with organs of propulsion, placed far behind their common centres of gravity—the cause that makes them such awkward travellers on land. When a gale blows in the direction they wish to pursue, like human navigators they take advantage of it; they spread their wings to catch it, and are driven onward then, as steamers are, by both wind and paddles.

The reciprocating action, and the expanding and collapsing features of their aqueous organs of progression, are supposed to be unsuited to the magnitude, materials, and velocity of artificial ones. Perhaps they are; but may not their contour be perfectly applicable: since, when open, and in action, the circumstances of the two bodies propelled—the bird and the boat—are not essentially dissimilar? Now, there is a marked adhesion to the triangular form in the webbed feet of birds; showing that, in the judgment of the Creator, such an outline is the best for the purposes of their propulsion. Nor does it appear that this outline has, in any material way, been modified to meet other exigences. In the feet of water-fowl it is almost identical with the tail of the sea bass. The legs, or rods, that wield these ornithologic paddles, are invariably united to them at their points, or angles, and clearly for the reason already stated.

Fig. 20.

Fig. 20 represents the foot of a petrel. It is a type of all the swimming-birds' propellers. Few, except professional naturalists, could distinguish between it and the same organ in geese, ducks, gulls, swans, the albatross, cormorant, diver, flamingo, &c., &c. Although natural paddles are submerged when at work, and those of our wheels emerge into air to repeat their strokes, I doubt if a more efficient form could be given to the latter than the above. The cuspated extremity would obviate the jar consequent on straight-edged blades striking the water.

If I had a new boat to fit propellers to, they should resemble figs. 7, 6, or 17; or I would rather make them like half the foot of a swimming-bird, as fig. 21, in the margin,—the perpendicular sides being next the vessel, that the greatest strain might be nearest to the power. Such blades would not be raised out of the sea by a vessel's rolling, nor, when submerged, be subject to excessive strainings, as common ones are. They would produce no concussion, or but little, on dipping, and would be twice as effective as the same area employed in the current form and fashion.

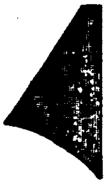


Fig. 21.

If the principle were required to be adopted in the present paddles, it could be done at a trifling cost. I would remove portions from the upper sides and attach them below, somewhat after the manner shown at figs. 22, 23, 24, and 25.

Fig. 22.

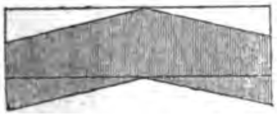
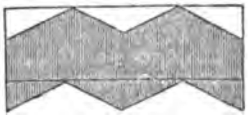


Fig. 23.



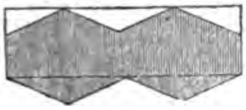


Fig. 24.

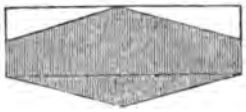


Fig. 25.

The portions *might* be removed by curved instead of straight lines.

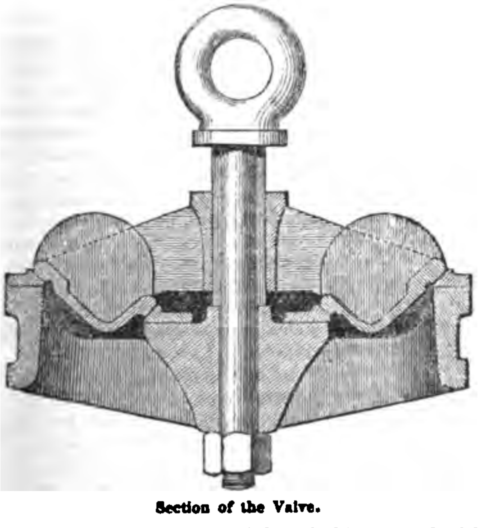
If I used blades similar to fig. 7, I would vandyke their lower edges as at fig. 23, point them as at fig. 25, or fork them as at fig. 22.

(To be continued.)

DOUBLE-ACTION PUMP FOR WATERWORKS.

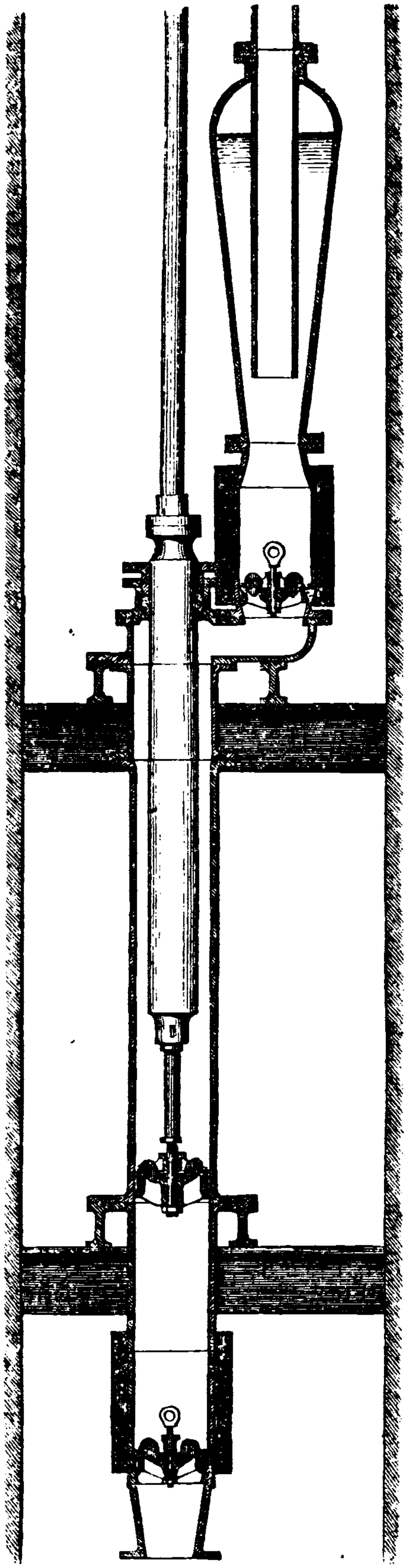
Sir—Having seen a description of an "Improved Pumping Engine," in Part 141, page 165, of your *Journal*, and seeing it there stated that an advantage is gained, "partly by the construction of the pump-valves, and partly by the use of a new kind of pump, lately registered by Mr. Thompson, Messrs. Simpsons' manager," we are led to believe that the public are to take both valves and pump "as new inventions." We think the following remarks will put the matter in the proper light.

The accompanying engravings show the arrangement used by us for some years past.



Section of the Valve.

We were aware that the principle of this pump had been considered to be the invention of Trevithick, but the arrangement of a bucket and plunger working in one cylinder we thought to be new at the time we used them. In this it appears we were wrong, for upon referring to page 281 of "A Description and Historical



Section of Direct-Action Pump at the Waterworks, Trafalgar-square.

Account of Hydraulic and other Machines for Raising Water," by Thomas Ewbank, published in 1842, we there find, that "in some pumps both a solid and a hollow piston are made to work in the same cylinder. Such was the arrangement that constituted the single-chamber fire-engine of Mr. Perkins. A plunger worked through a stuffing-box; its capacity was about half that of the cylinder, consequently on descending it displaced only that portion of the contents of the latter. The apertures of discharge were at the upper part of the cylinder, and a single receiving one at the bottom. From the lower end of the plunger a short rod projected, to which a hollow piston or sucker was attached, fitted to work close to the cylinder, so that when the plunger was raised, this piston forced all the water above it through the discharging apertures."—And in the same page: "Such pumps are more compact than those with two cylinders, but they are more complex, less efficient, and more difficult to keep in order and repair. The friction of the plunger and sucker is much greater than that of the piston of an ordinary double-acting pump of the same dimensions; and the latter discharges double the quantity of water: for, although double-acting, the effect of these pumps is only equal to single-acting ones."

Some of the latter remarks are undoubtedly right, and we in some cases prefer the double-acting pump; and when two of the double-acting pumps are employed, fixed on each side of the main centre of the working beam of the steam-engine, we conceive it impossible to devise a more efficient arrangement for raising water from a few feet below the ground, to any reasonable height.

At the Waterworks at Trafalgar-square (erected by us in 1844), and also at Ramsgate, the water has to be raised from a considerable depth below the surface of the ground, by *direct-acting* engines, without balance-beams; consequently, had we not employed the plungers in the working barrels of the pumps, to counterbalance the weight of the pistons, pump-rods, &c., by displacing a quantity of water in their descent, the whole of the power required for lifting the pistons and pump-rods would have been wasted.

We are, Sir,
Your obedient servants,
Easton and Amos.

Grove, Southwark, 14th June, 1849.

THE PUBLIC WORKS OF ENGLAND.

No. I.—Canals.

It may seem somewhat strange, that while canals of the greatest magnitude had been undertaken on the continent, England contented herself with scouring and deepening her rivers until the middle of the last century. The necessity, it must be owned, was not so stringent as in France. Yet the development of commerce in this country, long before the time we have mentioned, was sufficient to render almost necessary some better means of inland navigation than those afforded by our natural water-courses. It is true that the great southern towns, lying as they did either on large rivers or by the sea, did not require canals to the same extent as the cities of the northern and midland districts. As soon, therefore, as industry and enterprise had begun to assume importance in those parts of the island, the idea of forming canals to the various centres of manufacture followed as a matter of course; and in the year 1720 we find the first definite proposal for the execution of one of these important undertakings ever made in this kingdom. At that time the means of effecting a communication between the east and west seas, through the estuaries of the Aire and Ribble, had attracted the attention of the enterprising men of Yorkshire and Lancashire. Various schemes were set on foot for carrying this project into execution, which resulted in an act being obtained, in 1720, for the undertaking which has since ripened into the Leeds and Liverpool Canal.

Before, however, any practical progress was made towards the completion of this scheme, the Duke of Bridgwater commenced the execution of his own magnificent canal, under the supervision of Mr. Brindley. All other projectors now appear to have held back until they could witness the result of this work; and, consequently, scarcely anything was done in the way of inland navigation between 1737 and 1761, during which 24 years the *Bridgwater Canal* was being carried through every obstacle and discouragement, by the indomitable genius of its engineer, to a triumphant completion. The history of that great work is too well known to be repeated here; but the more than doubts expressed concerning it, and the prophetic warnings of inevitable failure which were uttered on all sides during its progress, prove how little was at that time understood in this country respecting that class of undertakings; and they prove, too, how extremely slow is the first growth amongst us of that very enterprise which we are afterwards destined to work out into such splendid development. The canal cost 220,000*l.*—an enormous sum at that time, and from the purse of a single individual. It is said that the Duke of Bridgwater had to live for many years upon 400*l.* a year, in order to pay for it. The recompense has been no less remarkable Long since the annual income netted by means of the canal was valued at 130,000*l.*, and notwithstanding the completion of a whole network of railways through the district it traverses, that return, it is believed, is at present considerably exceeded.

One single canal was commenced during the interval above mentioned; and which, having been completed before the Duke's, has the honour of being the first work of the kind executed in England. This was the *Sankey Canal*, running from the mouth of the Sankey Brook, in the Mersey, to St. Helen's. It is, however, little more than an improved edition of the long-used river navigation, as the brook is all along a feeder to the canal, which was by the side of it. Its length is not more than 12 miles, the fall about 78 feet, with eight single locks and two double ones, so that this first of our canal enterprises was no great work. Mr. John Eyes, of Liverpool, was the engineer.

The opening of the Bridgwater Canal gave a new impetus to this branch of enterprise. The Louth Canal got its act in 1763, little more than a year after the opening of the Bridgwater. The greater part of this canal is on a continuous level, very little above the sea, running from the Humber, near Tetney Haven, to the River Ludd. The length is but 14 miles, and the original estimate 16,500*l.* It was so defectively constructed, notwithstanding the facilities of the county, that the whole affair, after 28,000*l.* above the estimate had been raised on loan, was assigned to a single man, Mr. Chaplin, to manage in his own way. This was the result of a too stringent economy in starting. It took a long time to get public companies to understand their own interest. The Louth Canal is now a useful work, as far as it goes, and very beneficial to the town of Louth and the neighbourhood.

The next canal attempted—in fact, the third opened in the country—was, like the Bridgwater Canal, the speculation of a single man. In 1764, Sir J. H. Duval cut a canal through the solid rock, for the purpose of connecting Hartlepool Harbour, in the county of Durham, with the sea. The canal is but 300 yards long. The next canal was likewise a private undertaking, projected and executed by a single man. Mr. J. Rymer made a canal from his coal and lime works to the tideway in Kidvelly Harbour. He obtained his act in 1766. Long after, in 1812, a company undertook to improve and extend the canal, construct tramroads in connection with it, &c., from which resulted the present *Kidvelly Canal*, with its branches and adjuncts.

Thus, out of the four canals first executed, three were strictly private. In 1766 the first really important public canal was commenced, the *Staffordshire and Worcestershire.* This work was engineered by Brindley himself, to proceed from the Severn, at Stourport, to the Trent and Mersey navigation, near Heywood, in Staffordshire. Its rise is considerable, as upon the top level it runs for 10 miles at a height of 294 feet above the Severn at Stourport, and of 352 feet above low-water mark at Runcorn. In length it is almost 47 miles, and it cost 112,000*l.*, including a variety of accessary expenses in clearing away shoals from the bed of the Severn. The trade on this canal is immense.

The *Trent and Mersey Canal* was commenced in 1766. It was suggested by the Duke of Bridgwater, with whose water communication it is at one point connected, and was executed up to the time of his death by Mr. Brindley. The original estimate was 130,000*l.*, but it cost 334,000*l.* Little wonder, for it comprises 127 aqueducts and culverts—one of the former over the River Dove being very extensive—91 locks, and 6 tunnels. The famous Harecastle Tunnel, 2,880 yards long, is situated on the summit level of this canal, whose total length is 93 miles.

The next undertaking in chronological order is one of the noblest works in the kingdom. The *Forth and Clyde Canal* was begun in 1768. This canal, commencing in the Forth at Grangemouth Harbour, passes within two miles of Glasgow, and thence into the Clyde, being the first realised attempt at connecting the two great seas of our island. Its length is 35 miles, and the greatest rise 155 feet. By the recent improvements it has undergone, sea-borne craft, drawing 10 feet water, are able to navigate through it, between the Irish Sea and the German Ocean. The locks are 74 feet long by 20 wide; they are 39 in number. On its course are 33 drawbridges, 10 large aqueducts, and 33 smaller ones. Among its many reservoirs is one that covers 70 acres, with a depth of 22 feet at the sluice. The first idea of this undertaking dates as far back as the time of Charles II.—that monarch having taken preparatory measures for cutting a channel in the same direction for the passage of ships of war. The design was calculated to cost 500,000*l.*, but was far too magnificent for the impoverished exchequer of the Stuarts. In 1723 a fresh survey and estimate was made by a good engineer, Mr. Gordon, but nothing more was done until 1764, when Lord Napier employed Mr. Maskell to make a report, the result of which was, that the celebrated Smeaton was engaged to undertake the work according to the present plan. Sundry difficulties, as usual, arose—the chief being the enormous enhancement of the cost. The estimates fixed this at 147,337*l*, but when this had been expended, and between 70,000*l.* and 80,000*l.* additional borrowed, the projectors found that only about half the length had been, though with much rapidity, completed. Disputes then occurred with the engineer, amidst which the works stood still, but being presently recommenced, the canal was brought to within 6 miles of the Clyde, when its further progress was again stayed by the want of funds. An act passed in 1784, alleviated this difficulty, by enabling the proprietors to borrow money from the Scotch Barons of Exchequer, out of the forfeited estates, and with this assistance the work was completed in 1790. The whole stock amounted at last to 519,840*l.*—considerably beyond the sum estimated by Charles II. for his ship canal, and which, if mentioned at the beginning, would have stifled the project in its birth.

As a collateral assistance to the navigation of the Forth, the *Borrowstoness Canal* was commenced in the same year with the Forth and Clyde. It is a level canal, about 7 miles long, and cost 21,000*l.*, the original estimate having been 5,000*l.* In the same year Brindley commenced the *Coventry Canal*, running from the Trent and Mersey to Coventry. The project appeared a failure for some time, as the requisite capital was not forthcoming. But the Trent and Mersey Company took the matter up in 1782, and the works were begun in earnest; it was finished in 1790, and forms, with the Ashby-de-la-Zouch and Oxford Canals, which communicate with it, the longest canal line in England, being upwards of 70 miles, exclusive of branches. The length of the Coventry Canal is somewhat short of 38 miles, with very few locks, and a level at the highest of 81 feet. The expense was about 90,000*l.* Brindley's great object was to connect, by canal navigation, the ports of London, Liverpool, and Hull. The last link in this great chain was that grand undertaking, for the time, the *Oxford Canal*. This work was commenced in 1769, beginning from the Coventry Canal at Longford, and extending to the Thames at Oxford. The whole capital authorised to be raised for this purpose was upwards of 300,000*l.*—the original estimate being 178,648*l.* The length is 80 miles, carried at the summit level at the height of 387½ feet above the level of the sea. It has three aqueducts, the one at Brinklow nearly 300 feet long, and two tunnels, the longest, at Fenny Compton, being 3,564 feet. The level, at its commencement at the Coventry Canal, is no less than 74 feet above the surface water of that channel, and rises from thence to the summit level about 75 feet. On the whole, this is one of the most important canals in the kingdom, as forming the connecting link between the inland navigation of the northern and southern districts.

In the 20 years that followed, up to 1790, the number of canals executed in the country was 17—few of them of equal importance with the preceding. Brindley projected the *Chesterfield Canal* in 1769; it was carried on under his direction and that of his brother-in-law, Mr. Henshall, till its completion in 1776, at a cost of 150,900*l.* Its length is 46 miles, with 65 locks, and one very extensive tunnel, 2,850 yards long, near Harthill. Mr. Grundy had proposed another plan, which would have saved 5 miles, and between 20,000*l.* and 30,000*l.*, but Brindley's experience was preferred. The undertaking was a very successful one; but the most important of Brindley's later suggestions was the *Ellesmere and Chester Canal*. The famous aqueduct over the Dee is on this canal carried at a height of 125 feet above its bed, on 19 pairs of stone pillars, 52 feet apart. Several others of the great specimens of canal works in the kingdom were of his undertaking. It runs from Ellesmere Port to the Montgomery Canal, a distance of 61 miles, with numberless collateral branches. During the progress of this canal the greatest possible difficulty was experienced in raising the money. The shares at one time were sold at 1 per cent. of their original value. The whole cost was nearly 400,000*l.*

The *Thames and Severn Canal*, another of Brindley's projects, was commenced in 1783. The longest of the tunnels—the Tarleton Tunnel—is on this canal; it is 2⅜-miles long. It runs from Stroud to Cirencester, with a length somewhat above 30 miles. The original estimate for this work was 190,000*l.*, the actual cost above 500,000*l.*; one of the largest excesses in canal history—and the more strange, as there are no branches. It has 42 locks. A union between the Thames and Severn, by means of the Avon, was another of Charles II.'s projects.

The other canals executed during the period alluded to were the *Basingstoke*, about 40 miles long, cost about 186,000*l.*; the *Erewash*, running from the Trent to Langley-bridge, about 12 miles, cost 23,000*l.*; the *Cromford*, from the Erewash to Cromford, 18 miles, on which are one or two of our finest aqueducts, cost 86,000*l.*; the *Bradford*, 3 miles long, cost 9,000*l.*; the *Dudley*, of which the original plan was a length of 13 miles, at a cost of 12,000*l.*, but the expense of cuts and connecting branches amounted to somewhere about 150,000*l.* additional; the *Market Weighton*, 11 miles long; the *Andover*, 22¼ miles long, cost 65,000*l.*; the *St. Columb*, 6 miles long; the *Shropshire*, a canal of 7 miles from the furnaces at Coalbrook Dale to the Severn; the *Stourbridge*, and three private canals—one executed by Sir J. Ramsden, near Huddersfield, another by Sir N. Gresley, near Newcastle-under-Lyne, and the third by Lord Thanet, a short affair, near Skipton Castle.

After 1790 a violent impetus was given to canal speculations. Between that date and 1795 no less than 43 canals were planned, and acts relative to 15 new undertakings were passed in 1793—the largest number of any year in history. The dates of the first acts, relative to two of the most important undertakings in the kingdom, the *Grand Junction* and the *Kennet and Avon*, belong to this period, being passed, the one in 1793, and the other in 1794. The first of these, one of the most spirited enterprises of the kind, begins at the Oxford Canal, near Braunston, to the Thames, at Brentford—a course of 90 miles. The undertaking was the last step in Brindley's grand plan of inland communication throughout the country. We had attained already a complete water connection between Liverpool, Hull, and London; but the old river communication, with its tortuous course and manifold disadvantages, still existed in a most important part, that between Oxford and London; and it was to make the canal communication complete that Lord Rockingham, in 1792, employed Mr. Baines to make the survey for the present canal. The first estimate was 600,000*l.*; but, as usual, cuts and extensions required the raising of a further sum of 550,000*l.*, making this one of the most expensive undertakings in the kingdom. The length is above 90 miles. There are 98 locks and two tunnels, with several deep cuttings; one near Bulbourne 3 miles long and 30 feet deep for the greater part of the way. There are, besides, several embankments—in fact, this, on the whole, came nearer to modern railway enterprise than any work previous to the commencement of the iron age. From the summit level at Tring to Harefield-park, a distance of about 21 miles, there is a fall of 300 feet—the height of the summit part being 380 feet above the Thames at Limehouse. The Paddington branch, which is a continuation of the Grand Junction, is for 34 miles quite level; the water-course for 20 miles, from Paddington to Uxbridge, requiring but a single lock. The greater part of this canal was completed in about 10 years.

The Kennet and Avon Canal.—The most important water link between the west and east of the southern counties in England, was commenced in 1794. It runs from the Avon, at Bath, to the Kennet, at Newburn; and, as the former river runs on to Bristol, and the latter to the Thames, a communication is effected between Bristol and London; in fact, between the Irish Channel and German Ocean. It completes moreover the water circuit from the northern districts round the island, and passes through or near several of the most important towns in the south. The original estimate 570,000*l.*: but a further sum of 702,000*l.* was required to be raised under four successive acts, to complete the undertaking. The engineering difficulties were in some parts very great. In Somerset and Wiltshire, the country through which it passes is very rugged. At one place, near Devizes, a fall occurs of 239 feet in 2¼ miles, requiring 29 locks. The length is 57 miles, and the whole rise 210 feet, with 31 locks, and the fall 404½ feet, with 48 locks. The expense per mile (22,315*l.*) makes this one of the most costly canals in the kingdom. As a property this undertaking has been most injured by the Great Western Railway. The company were only enabled to compete with the railroad for the carriage of heavy goods, by charging half their prices when they enjoyed the monopoly. The railway at first only professed to carry light goods, and thus disarmed the opposition of the canal, but it has ended, as might have been anticipated, in carrying everything. One or two of the aqueducts on the canal are of beautiful structure, the Dundas aqueduct especially, which is situated about 4 miles from Bath.

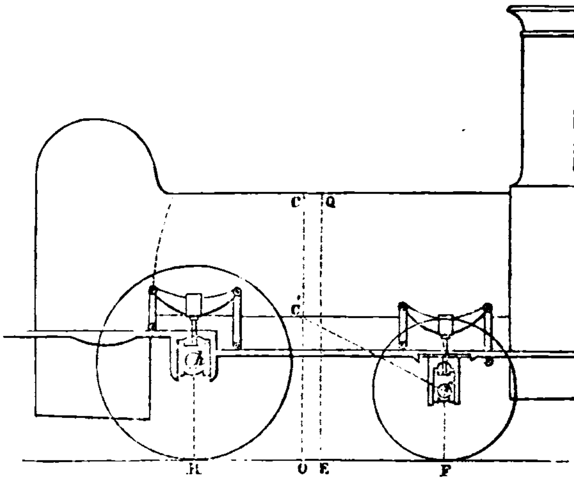
The number of the works now undertaken prevented the commencement of new designs, and besides the continental disturbances began to be seriously felt. From 1795, to the end of the century, only four canals were commenced—the *Grand Western*, the *Dorset and Somerset*, the *Newcastle Junction*, and the *Aberdeenshire*. All these, though very useful works, were but of secondary importance. The first-named, running from the Exe to Taunton, cost about 330,000*l.*—the length is about 35 miles. The second was never executed; the third is a very trifling affair; and the fourth only goes to the length of 19 miles: 36 canals have been commenced in the present century, the principal of which are the *Regent's* and the *Caledonian*. The larger undertakings were often abandoned, at least in their chief points, which was the case with the *Bridgwater and Taunton*. The Caledonian, as will be seen, does not pay at all. The *Grand Surrey*, the original subscription for which was 45,000*l.*, but which cost above 300,000*l.* additional, pays a very trifling per centage. The *Edinburgh and Glasgow*, the *Macclesfield*, and the *Grand Union*, are the three other of most importance. Enterprise was, however, busy about the old lines—most of which received important improvements in this period.

All the undertakings here enumerated have been completed by private persons, either singly or in association. The only work actually undertaken by the government has been the Caledonian Canal. Watt first surveyed this line, but it was carried into execution by Telford. It cuts completely through the Scotch islands, commencing at the foot of Ben Nevis, and running through three Scotch lakes to Inverness. The length of the whole is above 60 miles; but very little more than 23 of this is canal, the remainder being being lakes. The original intention was to facilitate the transport of Baltic timber, but the traffic has turned out far below the original expectation. The cost to the government has been above 1,000,000*l.*; and in 1842 the expenditure for wages and maintenance actually exceeded the receipts; the former being 2,090*l.*, and the latter 2,038*l.* We must add, indeed, that 576*l.* of the charges are put down as extraordinary expenditure in building boat-houses, &c.; but, even so, the surplus would have been very little more than 500*l.* There are 28 locks on this canal, of which a chain of eight, called Neptune's Staircase, alone cost 5,000*l.* The works of the canal are of first-rate order, and the channel of enormous breadth and depth, as being intended for ship navigation. The width at top is 110 feet; at bottom, 50; depth, 20 feet; the locks 172 feet by 40. All this explains the cost, together with the nature of the country through which the canal passes; but it is an instance of the failure of government undertakings, as far as mere profit is concerned. Vessels of upwards of 160 tons often pass the canal.—*Daily News.*

THE CENTRE OF GRAVITY OF A LOCOMOTIVE ENGINE.

In all investigations as to the effects produced by the locomotive engine, it is absolutely necessary to determine accurately the position of its centre of gravity. As the ordinary method of ascertaining this point by calculation is both tedious and unsatisfactory, I am induced to give the outlines of a mode which has suggested itself to me, and which, with careful application, will, I find, give an accurate result. The annexed engraving represents a four-wheeled engine, whose axles are 7 feet from centre to centre. Having first carefully ascertained the total weight of the engine, the weight on each pair of wheels must be obtained by repeated trials on a good weighing machine. Suppose these weights are found to be respectively H=9 tons, and F=7 tons; the position of a vertical line CC′O, passing through the centre of gravity, can be found by the equation $x = \frac{fd}{t}$, where x = distance of the line CC′O from *h*H; f = 7 tons, the weight on the front wheels; d = 7 feet, the distance between the axles; and t = 16 tons, or total weight of the engine.

Having thus found the line CC′O, it must be chalked upon the barrel of the boiler. Assume for a moment that C′ is the position of the centre of gravity: draw the line C′*f*. If now the front wheels be placed on the weighing machine, and the hind part of the engine raised until the insistent weight indicated is equal to 16 tons, it is evident that the point C′ will be in a vertical line passing through the points C′ and *f*. By suspending two plumb-lines in a plane at right angles to the road on which the engine stands, and intersecting the point *f*, whenever the whole weight of the engine is thrown upon this point, the line CC′O will be intersected by the plumb-lines in the point C′.



Could the above method be practically applied, it would be the most simple way of arriving at a knowledge of the point; but as it would be dangerous both to the engine and machine thus to dispose a weight of (in some instances) thirty tons, it has only been mentioned that the following plan may be more readily understood:—On an inspection of the figure, it will be seen that the line EQ is equidistant between H and F, and in this line the centre of gravity would have been situated had the weights on H and F been respectively 8 tons. The front wheels having been again placed on the weighing machine, two plumb-lines must be suspended as before, but in a plane passing through the line EQ, which may be termed the line of equipoise. It is evident now that if we lift the engine behind, the plumb-lines will intersect the line CC′, whenever the weight indicated by the machine is equal to 8 tons, and the centre of gravity will be situated in their intersection. In this operation, compensation must be made for that portion of the total weight which tends to move the front wheels forward. The amount of this force can be easily calculated, but it is better in practice to compensate it by passing the lifting rope round a pulley, so that its direction may be in a right line with the framing of the engine when lifted.

I have used a four-wheeled engine to exemplify my mode of proceeding, because it is the simplest; but a six-wheeled engine can be treated in the same way, when the lines CC′O and EQ have been found. If h, m, and f represent the weights on the hind, middle, and front wheels, and d the distance between h and m,—a point y must be found, by the equation $y = \frac{md}{h+m}$, where the weights h and m may supposed to be concentrated: if D be put for the distance between y and f, $\frac{D}{2}$ will be the position of the line of equipoise. Again, if t be put for the total weight of the engine, $x = \frac{fD}{t}$ will be the position of CC′O, the vertical line passing through the centre of gravity.

R. M.

The High Level Bridge on the Tyne, at Newcastle, on the York and Berwick line of railway, will, it is expected, be opened on the 1st of August. The key of the last arch was driven home on the 7th ult., by the Mayor of Gateshead, Mr. Hawks, of Hawks, Crawshay, and Co., the contractors for the ironwork. The first pile was driven on the 24th of April, 1846, in presence of its designer, Mr. R. Stephenson, M.P.; and the first segment of the first arch was placed so lately as the 10th of July last. The ironwork rising to a height of 120 feet above the bed of the river, much caution was called for, and from the careful and expensive arrangements therefore made, there has been neither loss of life nor limb in the fixing of the six massive arches, many of the castings of which weighed from 10 to 12 tons each. The cost of the bridge when completed is estimated to be 243,096*l.*; the viaduct through Gateshead and Newcastle, 113,057*l.*; land, compensation, &c., 135,000*l.* total, 491,153*l.*

REGISTER OF NEW PATENTS.

ELECTRIC TELEGRAPHS.

Frederick Collier Bakewell, of Hampstead, for "*improvements in making communications from one place to another by means of electricity.*"—Granted December 2, 1848; Enrolled June 2, 1849.

This invention consists, in the first place, of methods of copying, by means of electricity, written or printed characters for telegraphic communications; and, secondly, of modes of breaking and renewing the electric circuits with different stations, so as to correspond only with the place required.

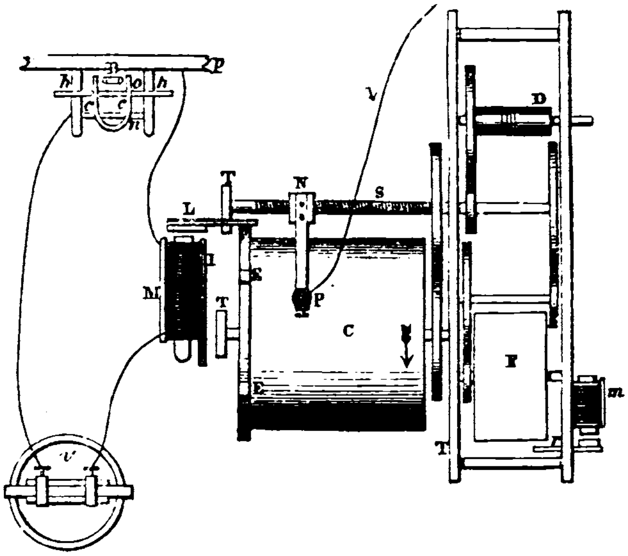
To carry out the first part of the invention, two or more instruments are made as exactly alike as possible, so as to give equal motions to a cylinder on each instrument.. Parallel to the cylinder is a screw, which carries a traversing nut from end to end as the cylinder revolves. To the nut an arm is attached, at the end of which there is a metal style or point that presses on the cylinder, and is insulated from the rest of the instrument. The point is connected with one of the poles of the voltaic battery, and the cylinder with the other. On to the cylinder of one of the instruments the message to be transmitted is attached. The message is written on tin-foil with varnish or other non-conducting substance, and the electric circuit is completed whenever the point is resting on the tin-foil, and is interrupted when the point rests on the varnish writing. On the cylinder of the receiving instrument paper, saturated with a solution which electricity will easily decompose, is placed; and as a similar metal point presses upon it, whenever the electric circuit is completed, by passing from the point to the paper, a mark is made. Thus, by the revolution of the cylinders, and the traversing of the nuts, spiral lines very close together are drawn on the paper; but the circuit being interrupted when the point of the transmitting instrument rests on the varnish, those parts remain white. In this manner, if the transmitting and receiving instruments be moving exactly together, the point of the former, by passing several times over each line of writing, will cause the marking point to produce the forms of the letters on the paper, the writing appearing white on a dark ground, constituted of numerous fine lines.

It is essential that the corresponding instruments should move synchronously. To effect this, the patentee employs electro-magnets, to regulate at certain intervals the continuous rotations of the cylinders. Several methods by which this may be done are noticed, but the mode preferred is to use pendulums actuated by clock-work, which at each vibration strike against moveable wires or fine springs, that serve to bring the electro-magnets into action, by completing the circuit with local voltaic batteries, one of which is attached to each instrument. The electro-magnets being thus brought into action at each beat of the pendulums, they are made to regulate the instruments, by causing a detent fixed to the keepers to press against projections in the cylinders. The movement of each cylinder is made rather faster than the resulting motion required; and the distant instruments are regulated to keep together by retarding their movements in a slight degree each time that the electro-magnets are put in action by the pendulums. As a means of ascertaining whether they are moving synchronously, a strip of paper is placed at right angles to the lines of writing on the transmitting instrument; and this produces a corresponding white mark on the paper, by which the operator is enabled to tell with great exactness whether the pendulum of his instrument is vibrating faster or slower than the other, and he can thus adjust it to correspond. The starting of the two instruments is contrived by means of an electro-magnet, put in action by the electric current transmitted along the connecting wires. The keeper of the magnet presses against the fan of the receiving instrument, and when the circuit is momentarily interrupted by the starting of the transmitting instrument, the keeper falls back and liberates the fan.

To copy print with these instruments, a portion of the printers' ink may be transferred to tin-foil by pressure, or the foil may be printed on from types. In copying small print, or small writing, the cylinder of the receiving instrument should be larger than that of the transmitting instrument, and the screw of the traversing nut coarser, so as to produce a magnified copy of the original.

The patentee describes a variation in the mode of copying, by using several points instead of one, so that several lines of writing may be copied at the same time, the electricity being conducted rapidly from point to point in succession. The rapidity with which the copying process may be carried on may be inferred from the size of the cylinder and the rapidity of its revolutions. The diameter of the cylinder appears from the drawings to be about six inches, and it is stated that it may be regulated to make thirty revolutions in a minute, and that seven times traversing over each line of writing is sufficient for copying distinctly. On a cylinder six inches diameter, about one hundred letters might be written in a line, and that would amount to more than four hundred letters per minute, with a single wire. In consequence of this rapidity of action, the patentee says that the copying telegraph affords peculiar facilities for establishing a system of stated transmissions and deliveries throughout the day; every half-hour being named as the interval between the communications with each town in the circuit.

Fig. 1.



The annexed woodcut (Fig. 1) represents a plan of the copying instrument. I, I, represent the frame containing the train of wheels for giving motion to the cylinder C; D, the drum from which the weight is suspended; and F, the fan which prevents acceleration. S, the screw on which the nut, N, traverses, carrying the point P; M, the regulating electro-magnet; L, the keeper and the connecting lever which presses against the projections E, E, to retard and regulate the motion of the cylinder. To the clock-plate *p*, from which the pendulum B (seen in section) is suspended, there are fixed ivory brackets *h*, *h*, which support platinum wires *c*, *c*, fixed to a cross wire *o*, that slides easily on the brackets. The wires from the voltaic battery *v*, are connected with the clock-

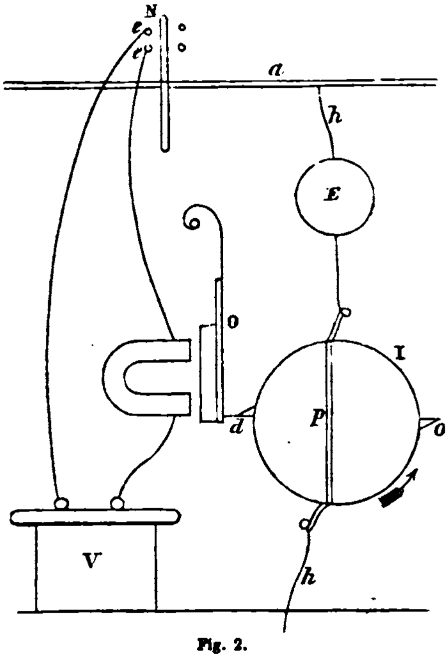


Fig. 2.

plate and with the platinum wires. so that each time that the pendulum strikes against *c*, *c*. the connection is made, and the magnet acts. V, and Y, are the wires connected with the distant instrument and with the decomposing voltaic batteries.

The second part of the invention is carried into effect by causing magnetic needles that are deflected by the electric current in the main telegraph wire, to bring into action separate voltaic batteries and electro-magnets at each station; by which means the return circuit through the earth is interrupted, and the station next in succession is placed in circuit. Fig. 2 shows this arrangement, which is repeated at each station. *a*, is the main wire; N, a magnetic needle, that may be deflected to the right or left in the usual manner; *e*, *e*, are the ends of fine platinum wires, so arranged in connection with the wires from the voltaic battery V, that when the needle is deflected, the electric circuit is completed, and the electro-magnet is brought into action. The wire *h*, *h*, connects the main wire with the earth, and in the position shown the electric circuit is completed through the telegraphic instrument E. I, a wheel actuated by clock-work to make a revolution in about four minutes, and the electric connection is made through it by the wire *p*. When the magnet is brought into action, it withdraws the detent *d*, and, by setting the wheel in motion, it breaks the connection until half a revolution has been made, and it rests on the opposite pin *o*. In this manner, all intervening stations may be thrown out of circuit until the one required is attained. Modifications of this arrangement are shown, by which the communications with branch lines may be opened and closed at will.

The patentee claims,—

1st, The arrangements described and shown for copying, at a distance, written or printed characters by means of electricity.

2nd, The employment of electro-magnets for regulating the continuous movements of distant instruments, either with or without the application of pendulums.

3rd, The use of preconcerted marks on the transmitting instrument to serve as guides in regulating the receiving instrument.

4th, The arrangement for breaking the electric circuit at distant stations by means of local voltaic batteries and local electro-magnets, brought into action by magnetic needles deflected by the electric current transmitted through the main wire; also the mode of renewing the circuit by the mechanism described.

RAILWAY WHEELS.

WILLIAM WHARTON, superintendent of the carriage department of the London and North-Western Railway Station, Euston-square, Middlesex, for "*improvements in the construction of vehicles to be used on railways, or on other roads and ways.*"—Granted December 15, 1848; Enrolled June 15, 1849.

The improvements relate, first, to the construction of wheels of vehicles used on railways or other roads. The construction of the wheel is as follows:—Into the boss, or nave, the ends of curved wrought-iron spokes are cast, or in some cases the nave may be made of wrought-iron; the spokes are connected to a wooden felloe, and to the tyre, by countersunk bolts and nuts; and between each pair of spokes, wedge-shaped pieces of metal are placed, and connected together by a bolt, passed through a hole formed therein,—the lower extremity of the bolt having a thread, a corresponding thread being formed in the hole in the wedge, into which the bolt takes; and by turning round the said bolt in one direction by a spanner, the wedge-shaped pieces will be made to approach towards each other, and compress the curved sides of the spokes, and thereby cause that part of the spoke in contact with the felloe to be pressed forcibly against it; and such pressure will be transmitted from the felloe to the tyre; and in this manner a solid and substantial wheel is formed.

Another form of construction of wheel consists in having the cast-iron boss or nave of the wheel formed in two parts, the tyre being connected to the boss or nave in the following manner:—The boss or nave has holes formed therein, through which bolts are passed, in a radial direction from the centre of the wheel, the bolts being employed for the purpose hereinafter-mentioned, connected to the boss or nave by countersunk bolts and nuts, passed through holes formed in the parts of the nave and block, the outer extremity of each of the blocks being securely connected to a ring of wrought-iron, formed with two flanges, by means of countersunk bolts passed through holes formed in the tyre, the ring, and block; and there is a hole formed through the centre of each block, and fitted with a short tube of metal, for the purpose of connecting these last-mentioned parts together by means of a split key, passed through a hole in the end of the bolt. Wedge-shaped pieces of metal are placed between each pair of wood blocks, and connected thereto, and to the boss or nave, by a bolt and nut; or the bolt may be either cast into the nave of the wheel, in which case, there would be a nut upon its other extremity; or the said bolt may be screwed into the nave of the wheel instead of passing through it, by turning round the bolt by means of a spanner. The wedge-shaped piece will be forcibly pressed against and between each pair of blocks, and as each of these wedges is successively tightened, it will be obvious that each block will be compressed. The grain or fibre of the wood blocks must be placed radiating from the centre of the wheel, and in this manner a solid and substantial wheel is formed. It should be observed, that the wedges may be easily tightened from time to time by the means before described, should the shrinkage of the wood blocks require it.

Another modification of the wheel first described is as follows:—In this case the wooden felloe is entirely dispensed with, the spokes being in close contact with the tyre of the wheel, and connected thereto in a similar manner to the former wheel.

Another part of the invention consists in constructing wheels for common roads upon the principle described with reference to wheels to be used on railways. The difference consists simply in making the tyre of the wheel for common roads flat instead of flanged, and the nave must be formed to suit the axle upon which it is to be placed; in other respects, the arrangement and construction of the wheels are similar to those before described.

THE BRITANNIA TUBULAR BRIDGE.

The great engineering exploit of the month has been the floating of one of the large tubes to its place across the Menai Straits, and which was to have taken place on Tuesday, 19th ult., but owing to some slight failure in one of the capstans, it was deferred until the following day, when it was completed at half-past nine o'clock in the evening. The perilous work had to be accomplished within 90 minutes, and if it had exceeded that time the chances were that the tube would have been wrecked; however, so well were the movements directed, it was accomplished in 85 minutes, leaving five minutes to spare.

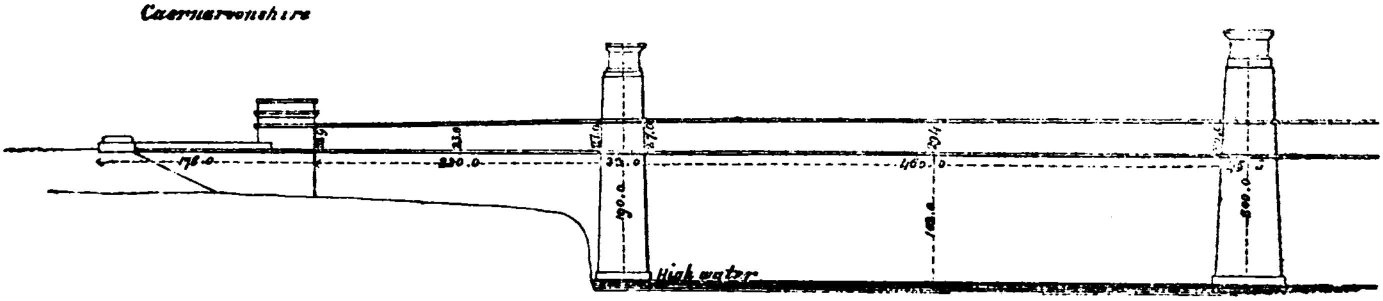
The cables that were used to guide the pontoons were twelve inches in circumference, and said to be three miles in length; there were about 300 men employed at the capstans, moorings, &c., besides steamers engaged to tow the leviathan tube. It was floated obliquely, and one end brought against the centre pier, then gradually swung round, its face to the space between the piers. The swinging the other end round to the tower on the Anglesea side was a work of great risk and anxiety; fortunately, such was the nicety of the arrangements, and the rapidity of the directing movements, that the final step was perfectly successful, and, by the vigorous action of a gigantic implement like a vice, the tube was clenched at its extremity, and in an instant held fast. On this occasion, in addition to Mr. Stephenson and Captain Claxton, Mr. Clarke, Mr. Brunel, and Mr. Locke were on the tube, rendering valuable and unceasing assistance throughout the perilous process.

The next operation, that of elevating the tube to its permanent position, will be accomplished as soon as possible. This is to be done by huge hydraulic presses, similar in design to those described in the *Journal*, Vol. XI., 1848, p. 87 and 217, but of a larger description, commensurate with the size of the works, one cylinder alone being almost large enough at the entrance to contain a man standing, and of the ponderous weight of 40 tons. It is the most powerful machine ever constructed. The two end tubes will then be raised, and it is expected, from the rapidity of the movements, that this great iron highway over the Straits will be ready for the passage of trains in the autumn.

The names of the gentlemen who have been continuously engaged on this great work, under Mr. Stephenson, since 1847 are—Captain Moorsom, the resident director; Mr Frank Forster, the resident engineer; Messrs. E. and L. Clarke and Wild, assistant engineers; Messrs. Nowell, Hemingway, and Pearson, contractors for the masonry, and Mr. T. E. Rawlinson, chief inspector of masonry; Messrs. Mare, of Blackwall, and Messrs. Garforth, of Dunkinfield, contractors for the iron tubes; Mr. J. Greaves, general manager of the masonry; Messrs. J. and A. Greaves, contractors for the scaffolding and stages. Mr. G. Campbell, engineer of the tube work, and Messrs. J. Morris and H. Hodgkinson, managers of it; and Messrs. Easton and Amos, who constructed the hydraulic machinery for lifting the tubes,—all of whom were present.

A very interesting description of the herculean works connected with the construction of the tubes, by an engineer resident on the spot, has just been published by Messrs. Chapman and Hall, to whom we are indebted for the accompanying engravings and descriptive account.

Origin and Necessity of the Bridge.—In 1844 the Chester and Holyhead Railway Company was formed, and it was soon perceived by their engineer that the grand difficulty of the line was, how to carry it over the estuary of the Conway and the Menai Straits. As it is impossible to make use of the chain suspension bridge for the passage of heavy railway trains, its flexibility rendering it wholly unfit for cases where a stiff inflexible roadway is required, some other mode of accomplishing the object was necessary; and the difficulty in the way of this arose from the following causes:—At both places there is a considerable traffic, carried on by vessels of large size, to avoid any interference with which, it was requisite that, in the building of the bridges, no scaffolding or centering should be used, since that, if employed, would of course obstruct the passage. In the case of the Menai Straits, Mr. Stephenson met this requirement by a design for a bridge, of two cast-iron arches, the span of each to be 450 feet; the height of the crown of the arch 100 feet, and of the springing 50 feet, from the water; the use of centering being with great ingenuity dispensed with, by connecting by tie-rods the half-arches on each side of the centre pier with each other. The site intended for this was that on which the present bridge is being erected. But the first difficulty having been surmounted, another and far more serious one presented itself. The Commissioners of the Admiralty, on this design being submitted to them for approval, insisted on a height of 100 feet above the water, not merely at the crown of the arch, but also close to the piers; thus giving but two alternatives—to retain the arched form, but increase its height by 50 feet; or, relinquishing the arched form, to construct on some entirely new method, a beam, which should depend for its stability simply on the strength of its parts; the first requirement, moreover, rendering it necessary that it should be either constructed in its ultimate position on a suspending scaffolding, or else lifted entire, and at once, into its place, after having been put together elsewhere. The latter alternative was the one chosen by Mr. Stephenson. His proposition of a tube or girder, 460 feet in clear length, strong enough not only to carry a railway train, but to bear its own weight, was received by the public, on its first announcement, with almost universal incredulity. However, though the public doubted, the railway company had confidence in their engineer; and his labours and investigations have resulted in the present tubular bridges, which, from their stupendous magnitude, the singularity of their form, and the gigantic nature of the operations by which entire bridges of such unexampled weight are transported and raised into their position, have excited more interest, both in the scientific world and the public, than any other engineering works of the present day. We have said that the arch and the chain bridge being unavailable, Mr. Stephenson was driven to adopt the third possible form—that of a beam; and we would impress on our readers that these tubes are nothing but gigantic beams; they derive no strength from any transmission of horizontal pressure to the abutments, as is derived by the arch; nor from any mode of suspension, as in the chain bridge, but resist incumbent pressure on exactly the same principles as the short plank does by which the village brook is crossed. But their form, and the method of employing the material of which they are composed, is so novel and beautiful, and so very different to those of a simple beam or girder, that we would willingly draw the attention of our readers to a few of these points before proceeding to a detailed description of the tubes themselves.



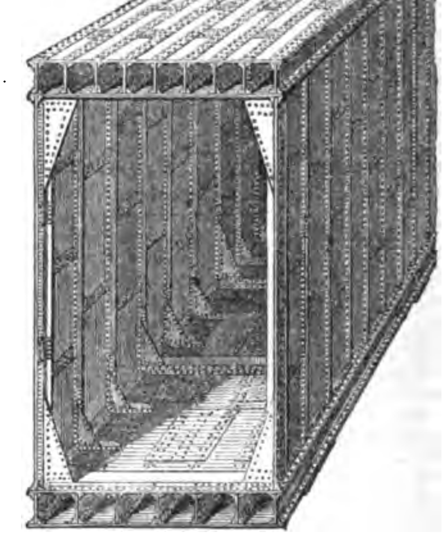
Description of the Work.—The particular spot at which the Britannia Bridge crosses the Menai Straits is exactly a mile nearer to Carnarvon than the suspension bridge; the railway, after leaving the end of the bridge, passing close under the Anglesea column. The shores are of the same precipitous and shelving character at both places, but the stream is wider here than at the suspension bridge, being about 1,100 feet across at high water. It is divided nearly exactly in the middle by the Britannia Rock, which at high water is covered to a depth of 10 feet. The rise and fall of the tide is ordinarily 20 feet, and its velocity very great, often as much as 8½ miles an hour. It is from the Britannia Rock that the bridge takes its name, the centre pier being based upon it. It and the Anglesea shore consist of chlorite schist, a very hard and intractable kind of rock, worked with great difficulty: from this and the circumstance that no cofferdam was used, and therefore few hours only could be consecutively spent on the rock, some months were passed in laying the bottom course of the tower. It was commenced in May 1846, the first stone being laid without ceremony by Frank Forster, Esq., acting engineer of the portion of the railway between Conway and Holyhead, and of the masonry, scaffoldings, &c. of the Britannia Bridge.

Construction.—The stone of which the towers are built is a hard carboniferous limestone, or marble, called Anglesea marble; it abounds in fossils, and is capable of receiving a very high polish. It is obtained from quarries expressly opened for the purpose on the sea shore at Penmon, at the northern extremity of the island, where it occurs in great abundance and in convenient strata of every thickness, from 3 feet or 4 feet downwards. The stones are split off with great dexterity by iron wedges, and wrought into shape with heavy steel picks. Some of the stones in the work are no less than 20 feet in length, and others weigh from 12 to 14 tons. A great portion of the interior masonry, however, is built of red sandstone, from Runcorn, in Cheshire. This is a very soft stone, and easily worked, but at the same time very durable, especially when not exposed. The stones in the towers are all left with a rough or quarry face, except at the angles and in the recesses and the entablature at the top. This circumstance, coupled with their immense size and height, gives the towers a truly noble appearance.

The approaches to the bridge are ornamented on each side by collossal statues of lions, in the Egyptian style. They are each composed of eleven pieces of limestone, and, although in a couchant attitude, are 12 feet in height. Their length is 25 feet, and their weight about 30 tons. Being associated with so many other large objects, their real size is not apparent. They were sculptured by Mr. Thomas, of the new Houses of Parliament. It was once contemplated to surmount the centre tower with a figure of Britannia, in stone, 60 feet in height, by the same artist; but the idea for the present is abandoned. The designs for the masonry, both for this and the Conway, were furnished by F. Thompson, Esq., of London. When the whole structure is completed, it will consist of two immense wrought-iron tunnels or tubes, each considerably upwards of a quarter of a mile in length, placed side by side, through which the up and down trains respectively will pass. The ends of these tubes rest on abutments, the intermediate portions being supported across the Straits by three massive and lofty stone towers. The centre tower, as has been just observed, stands on a rock, which is covered by the tide at high water. The side towers stand on the opposite shores, each at a clear distance of 460 feet from the centre tower. *The abutments* are situated inland, at a distance of 230 feet from the side towers. *The Britannia tower* is 62 feet by 52 ft. 5 in. at the base; it has a gentle taper, so that where the tubes enter it is 55 feet by 45 ft. 5 in. Its total height from the bottom of the foundations will be, when completed, nearly 230 feet; it contains 148,625 cubic feet of limestone and 144,625 of sandstone, weighing very nearly 20,000 tons, and there are 387 tons of cast-iron built into it in the shape of beams and girders. The land towers are each 62 feet by 52 ft. 5 in. at the base, tapering to 55 feet by 32 feet at the level of the bottom of the tubes; their height is 190 feet from high water; they contain 210 tons of cast-iron in beams and girders. The chief dimensions of the masonry, as well as of the tubes, will be seen upon the engraving, which shows an elevation of the Carnarvon half of the bridge. The scaffolding, both for the erection of the masonry and for the support of the small tubes during their construction, is of the same description as that employed at the Nelson Column, Trafalgar-square, London, and at the new Houses of Parliament. It is that known to builders as "whole timber scaffolding;" its name distinguishing it from the old kind, which was constructed in a most cumbrous manner, with round poles and cords. The timbers here are "whole balks"—logs of from 12 to 16 inches square, and some of them as long as 60 feet, and the method of uniting them is such, that when taken down the timber is uninjured—nay, often increased in value from being more thoroughly seasoned by exposure to the weather. The scaffold below the land tube on the Anglesea side is, from the form of the shore, very lofty—more than 100 feet in height at its outer end. As a piece of construction it is most admirable; and from the multitude of cross struts and bracing timbers, interlacing each other, its appearance is very picturesque. That on the Carnarvon shore is not so lofty, but is of the same excellent construction.

It will be seen presently that the weight which these scaffolds will have to support, when the small tubes are completed, is about 1,300 tons. The framing round the Britannia tower rises to the vast height of nearly 250 feet, and at this elevation stones of many tons weight are transported over all parts of the tower with perfect ease, by means of travelling windlasses, called gantries, which roll upon rail laid on the top horizontal timbers. Notwithstanding the constant and very heavy winds that it has been exposed to, this scaffolding, which looks so light and slender, has stood hitherto without injury.

The four great Tubes.—The length of one of these tubes, as constructed on the platform, is 472 feet; that is, 12 feet longer than the clear span between the towers. This additional length is intended to afford a temporary bearing of 6 feet at each end, after they are raised into their places, until there is time to form the connection between them across the towers. Our London readers will better appreciate the great length of these tubes by remembering that if one of them were placed on end in St. Paul's Churchyard, it would reach 107 feet higher than the top of the cross! The span, in fact, is much greater than has ever before been attempted, except in bridges on the suspension principle. The length of the iron arch of Southwark Bridge, in London, the largest rigid span in this country, is 240 feet. The height of the tubes is not the same at all parts of their length. It is greatest at the centre in the Britannia tower, where it is 30 feet outside, and diminishes gradually towards the ends, at which, in the abutments, the external height is only 22 ft. 9 in.; the top forms a regular arch, (a true parabolic curve), and the bottom is quite straight and horizontal. The clear internal height is, on account of the double top and bottom, less by 4 feet than the external—being 26 feet at the centre, and 18 ft. 9 in. at the extreme end. The land tubes are outside 27 feet, and inside 23 feet high at their smaller ends. The intermediate heights will be seen on reference to the figure. The internal width from side to side is 14 feet, though the clear space for the passage of the trains is but 13 ft. 5 in.; the whole width outside is 14 ft. 8 in. The general method of the construction of the tubes is readily seen. They consist of sides, top and bottom—all formed of long narrow wrought-iron plates, varying in length from 12 feet downwards, and in width from 2 ft. 4 in. to 1 ft. 9 in. The direction in which these plates are laid is not, as may be at first sight supposed, arbitrary or immaterial, but is governed by the directions of the strains in the different parts of the tube. Thus, in the top and bottom, where the strain is in the direction of the length of the tube, the plates are laid lengthwise, whilst in the sides they are run up and down. The plates, which are of the same manufacture as those used for making boilers—"boiler-plate"—are of the best quality, principally from Staffordshire. They vary in thickness from ⅜ to ¾ of an inch; some of them weigh nearly 7 cwt., and are among the largest that it is possible to roll with any existing machinery. In the sides, the plates are alternately 6 ft. 6 in. and 6 ft. 8 in. in length, 2 feet in breadth, and ½-inch thick, except at the ends, where they become somewhat thicker. They are joined together, and greatly strengthened and stiffened at the joints by T-shaped iron both inside and out, reaching from the top to the bottom, and forming a complete pillar at every 2 feet, in the same manner as the frames in a window-sash form a pillar between each two panes. It is the projection of this T iron inside the tubes that reduces the clear space to 13 ft. 8 in. The longest plates are in the bottom. They are 12 feet long, by 2 ft. 4 in. in width, arranged in double layers, each layer being nine-sixteenths of an inch thick at the centre of the large tube, and seven-sixteenths at the ends. Those forming the top are each 6 feet in length, and 1 ft. 9 in. in breadth. In the middle of the tubes they are ¾ of an inch thick, diminishing to ⅝ths at the ends. These thicknesses are all dependent on the amount of the strains in the tube, as the direction of the plates was before noticed to be. In the top and bottom will be seen the cells or flues of which slight mention has been before made. Of these there are eight at the top, each 1 ft. 9 in. square; and six at the bottom, of the same depth, but wider—viz., 2 ft. 4 in., from their number being smaller. The vertical partitions which form these cells are connected to the horizontal plates at top and bottom, and the horizontal plates themselves to the sides by angle-iron ┌, fitting into the corners, and rivetted through both. This ┌ iron weighs in the top 45 lb. per yard, and in the bottom 27 lb. The connection between the top and bottom and the sides is made much more substantial by triangular pieces of thick plate, which are rivetted in across the corners. These are technically called "gusset-pieces;" they are intended to enable the tube to resist the cross or twisting strain, to which it will be exposed, from the heavy and long-continued gales of wind that will assail it in its lofty and unsheltered situation. They will be seen on the figure, showing an end view of the tube. The rivets are placed in rows, at distances of 4 inches apart in the top and bottom, and 3 inches in the sides. They are rather more than an inch in diameter, and are put into the holes red hot, and a head formed by beating up the projecting end of the hot rivet by heavy hammers, the operation being finished by a steel tool, with a cup-shaped end, which gives the head of the rivet a round and neat appearance. In cooling they contract strongly, and draw the plates together so powerfully, that it requires a force of from 4 to 6 tons to each rivet to cause the plates to slide over each other; this resistance being due solely to the force of contraction, and independent entirely of the strength of the rivet itself. Each of the large tubes contains 327,000 rivets, and the whole bridge about 2,000,000. In all cases great care has been taken so to distribute the joints of the plates that they may never come near together; and wherever they occur, a thick plate is carefully rivetted over the joint on each side, so as to maintain an equal strength on every part. The same rule is observed at the joints of the angle-iron. The rivet-holes in the plates are formed by a machine which punches out a piece of iron the exact size of the required hole. The plates are fastened upon a sliding-table, which advances at every stroke double the required space between each rivet; two punches then descend through the plate and form the holes. In this way about 40 holes are punched per minute. Each tube contains about 10 miles of angle and T-iron, and the whole bridge 65 miles. The weight of the wrought-iron in one of the large tubes is estimated at about 1,600 tons, of which 500 are in the bottom, 600 in the sides, and 500 in the top.



REVIEWS.

The Marine Steam-Engine, designed chiefly for the use of Naval Officers and Engineers. London: Hebert, 1849.

The authors of this work are Mr. Main, Professor at the Royal Navy College, and Mr. Brown, Chief Engineer R.N. Their combined talents have produced a work of great interest to those engineers who may be engaged in our steam marine; it contains some valuable suggestions and hints that could only be given by those who have had extensive experience in the engine-room. The volume is well illustrated by numerous engravings, given in a remarkably clear manner, which cannot fail conveying to the mind correct notions of the whole of the details of the steam-engine. A few extracts from the work will better show its true value than any observations we may make in its favour.

The First Chapter is introductory, and explains the nature of Steam. The Second is an explanation of the Marine Engine, entering into a minute description of each part, from the cylinder to the grease-cups. The Third Chapter explains the different direct action engines that were introduced into the navy about four or five years since; the Fourth Chapter is on Boilers; and the Fifth on "Getting up the Steam."

Instances in which it has been found that the Steam begins to escape before the Pressure reaches the limit prescribed by the Safety-Valve.

This happens mostly with large boilers, having in consequence proportionally large safety-valves; and the explanation may be given thus. The valve being of considerable size, and the spindle in the centre, the edge of the valve is sprung off its seating, and allows the steam to pass. It becomes a question for consideration, whether it would not be advantageous, now that boilers are so large, to employ two valves instead of one.

On the Causes of Priming when first Starting the Engines.

One cause of priming at first starting the engines arises from the pressure being taken off the surface of the water in the boiler, and thus enabling the ebullition to go on with greater violence; but this is not the principal cause: the chief reason is, that many foreign substances become mechanically mixed with the water; for instance, on getting up the steam in a muddy river, such as the Thames, the mud will, by boiling, be driven up to the surface of the water, and accumulating there will prevent the free course of steam to the steam-chest, and consequently it forces up the water and mud before it. If there be any mucilage in the water, priming will also take place. Such water is formed in deep bays and harbours, especially at particular times of tide, from the mixture of seaweed and decomposing vegetable matter. There are few persons who have not noticed this fact one way or another. The cook well knows the tendency a vessel, containing other substances besides water, has to boil over at first; and in making coffee the case is remarkably exemplified: the whole mass will be observed to rise to the surface of the coffee-pot when beginning to boil; but after some time these effects are not so remarkable. Two instances of priming from this cause may be mentioned. As H.M.S.V. *Avenger*, Captain Dacres, was going into the very deep bay at Killybegs, Ireland, as the vessel came to an anchor the boilers primed to such an extent as to make it necessary to haul out the fires, so much of the water left them through the waste steam-funnel and engines: indeed, the engines were completely choked with it. Again, a short time afterwards, in Arran Bay, the fires had been banked up all night, and to supply the loss by evaporation, water from the Bay had been pumped at intervals into the boiler; and consequently when the slides were moved to start the engines (the water-surface in the boiler being suddenly relieved of its pressure), the engines nearly stopped; and at each return of the stroke it was feared the cylinder-covers and bottoms would have given way. Now this never took place at sea, unless when the fires were urged.

Some interesting facts may be stated connected with the new tubular boiler fitted to the little 10 horse-power steamer *Bee*, attached to the Royal Naval College to assist the students in gaining a practical knowledge of the steam-engine. When steaming about the harbour, it is found that the boiler begins to prime as the vessel approaches the inlets where there is the most mucilage; and also if the water be blown out of the boiler, and a fresh supply admitted, the priming afterwards will depend on the height and state of the tide when the boiler is filled. If the boiler be refilled as the tide is ebbing, especially at the time the water is leaving the mud, all hands are on the look-out to find the engine-room flooded from the escape-valves; but if it be filled as the tide is coming in from the sea, or when the water is high, the same casualties are not expected. A boiler will likewise prime as the vessel goes out of salt water into fresh, and also in going out of fresh water into the salt: the first of these cases can be accounted for from the fact, that fresh water boils at a lower temperature than salt water, and therefore as the fresh water enters the boiler previously heated, the ebullition is more violent; but the contrary case is difficult to explain; and indeed, this latter instance would almost lead one to suppose the former explanation not to be the true one. The same difficulty occurs in attempting remedies for priming; for melted tallow on the surface of some boilers will check the priming, and in others it will increase it.

We would not enter here into the real cause of priming—namely, the form and dimensions of the boiler and steam-chest, because that is a matter beyond the control of the engineer and officers of the ship; but it is very clear that if a larger steam-space were allowed, and combustion took place more slowly, and the boilers were not so contracted at the water-surface as many of our marine boilers are, we should not hear so much of priming. It is probably true that those who have the management of the Cornish engines scarcely know the meaning of the phrase.

Chapters VI., VII., and VIII. relate to "Duties to Machinery when under steam, during action, and on arriving in harbour;" and contain some valuable suggestions, from which we give the following extract:—

On the Number of Boilers to be used when not going at full Speed.

There is a common practice in our steam navy, when employed on a service in which particular despatch is not the object, to use half the number of boilers, and proceed at a speed proportionably less, in order to consume less fuel in traversing the distance. The saving thus effected depends on the fact, that the consumption of fuel *per hour* varies as the *cube* of the speed, and the consumption of fuel *per mile* depends on the *square* of the speed. Suppose, for instance, a vessel to be furnished with four boilers, and that her speed when using all four is 10 knots, her speed with two boilers would be 8 knots nearly. Let us suppose, for argument sake, each boiler consumed half a ton an hour; then, at full speed, 4 half tons, or 2 tons, would drive the ship over 10 knots, or 1 ton would propel her over 5 knots. Again, in the second case, 2 half tons, or 1 ton would send her over 8 knots. Hence we should, by this method, gain 3 knots in distance for every ton of coal: and we may set it down as a general maxim, that the slower a vessel goes, the greater the distance she will steam over with the same consumption of fuel. This is on the supposition that she meets with no strong head-winds, &c., such as to force her to use all her power. If, however, the wind or tide would have the effect of making her go astern, her rate through the water, for the greatest economy of fuel, should be at least half as great again as she would have gone in the opposite direction if no power had beeen used. Thus, if a vessel be steaming up a river which flows at the rate of 4 knots, her most economical speed would not be less than 6 knots, making good 2 knots over the ground.

But it is a question for mature consideration, whether a still further saving might not be effected by a different mode of managing the fires. Suppose, for instance, as we at first had arranged, that the vessel be going at 8 knots, using two boilers instead of four. The alteration we would propose is, that instead of using two boilers she should use three; but that the speed of the ship should still not exceed 8 knots, which she would have had with two boilers. To effect this, the engineer must do all he can to produce a slow combustion; and it is supposed by this slow combustion a considerable saving would be effected. Those of our readers who are conversant with the mode of producing steam on the Cornish system will be more likely to appreciate this; for our endeavour is to make the two methods approximate, by spreading the fuel over three sets of flues or tubes instead of two, and so allowing more heat-absorbing surface. One of the authors of this work (Mr. Brown) had lately an opportunity of trying this plan for a short time on board H.M.S. *Avenger*, though not long enough to obtain any measured results. An order had been given to go on with two boilers, and the fires in them were worked in the usual way, and kept in an active state of combustion. Shortly afterwards the order was given to proceed with three boilers, but no additional orders were received to go on faster than with the two. It was then found that it was scarcely possible to cover the fire-bars in all the boilers with fuel, the rapid absorption from the great quantity of surface was so effective in keeping up the steam. The saving of fuel was very great, but the limited time of the trial would not allow the actual quantity to be ascertained. If difficulties should arise, when using large boilers, in obtaining a small supply of steam—that is to say, if it be found that when all the fire-bars are covered too much is generated, let one or more fires in each boiler be put out, and their ash-pit doors closed, so as not to allow the cool air to enter. And in using the boilers in this way the ashes may be repeatedly burned over again, merely throwing the clinkers away.

Chapter IX. contains Miscellaneous Rules for calculating the Power of the Engine, the Screw, &c.

We wish the authors would in a future edition illustrate their rules with plain arithmetical computations, without having occasion to refer constantly to a book of logarithms. Most of the calculations could be done in simple arithmetic as easily as with logarithms; it would save the necessity of being obliged to refer to tables which are not always at hand.

A Treatise on the Law of Dilapidations and Nuisances. By David Gibbons, Esq., of the Middle Temple, Special Pleader. Second Edition. London: Weale, 1849.

Mr. Gibbons has retained the old title of his book as the one best known to the profession; but in order to make it a complete body of law for architects and surveyors, he has added to it the law of Highways and Sewers. This book was before received as the professional authority, but it is so much extended and amended, and its value has been so much increased, that its reception is incontestable. It is needless for us to say anything in its recommendation, for its character as an accurate compilation depends upon the reputation of the author, tested by the original work.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.

June 5.—Joshua Field, Esq., President, in the Chair.

The paper read was a "*Description of a Method of Rolling Bars for Suspension Bridges, and other like purposes.*" By Mr. Thomas Howard, A. Inst. C.E.

It was described that by the ordinary process of manufacture, the head, or end of the link, out of which the eye, or hole for the connecting pin, was bored, had been sometimes welded on to a parallel rolled bar, or, at other times, been hammered to the required form; both these methods were, however, objectionable, owing, in the former case, to the insecurity, and in the latter to the tediousness and expense. By the method introduced by Mr. Howard, the bars were rolled at once into the requisite form; the shingle, or faggot, was first passed longitudinally, at a welding heat, through grooved rollers, in the ordinary manner, and then, before being drawn down to the intended thickness, was carried to rollers having bosses, or increased diameters at the places corresponding to the heads to be produced, and there passed to and fro between the rollers transversely, or across the breadth of the bar, thus receiving a pressure only at the enlarged parts of the rollers, which gave the necessary increase of breadth at the heads; it was then taken to plain finishing rollers, and drawn out longitudinally in the usual manner, until it attained the required length and thickness; the heads being afterwards trimmed by machinery to the exact dimensions, and the holes drilled for the pins.

It was stated that the chains of the large suspension bridge, erected by Mr. W. Tierney Clarke over the Danube, at Pesth, which lately so satisfactorily withstood the heavy strain brought upon it by a retreating army, were constructed on this system at the King and Queen Ironworks at Rotherhithe: as were those for lifting the tubular bridge at Conway, and over the Menai Straits; and also that the links for a bridge now erecting by Mr. Vignoles, at Kieff, in Russia, were manufactured by another firm, under license to use Mr. Howard's system.

Some interesting observations were recorded of the results of the experiments for determing the strength of these bars, showing them to possess great elasticity and freedom from permanent set.

The discussion elicited some useful remarks as to proportions of the area of the body and of the head, and of the diameter of the pin, which, it was shown, had much influence on the resisting power of the heads;—the larger the pin the less being the tendency to rupture the eye.

The process appeared to be admitted as a great improvement on the ordinary mode of manufacture, and tending to give confidence to the engineer that his designs could be executed in metal, uninjured by manipulation.

June 12.—The first paper read was "*A Description of the Construction of a Collar Roof, with arched trusses of bent timber, at East Horseley Park.*" By the Right Honourable the Earl of Lovelace, A. Inst. C.E.

The roof which covered a hall of fifty-six feet long by twenty-four feet wide, was described as being sustained by four arched trusses, springing from stone corbels. The ribs of these were each composed of four layers of deals, three inches thick, bent to the required form by steam heat. All the mouldings surrounding the tracery were also bent to the required forms in the same manner, thus giving great strength and lightness, as well as performing the work with greater economy of labour. The tracery was cut out from two thicknesses, half-an-inch each, of tub-stave oak, glued together, with the fibres at right angles to each other, which facilitated the carving, and gave greater strength to the minute tracery.

The ceiling was formed of half inch diagonal boarding, and as the slate battens crossed it in a horizontal direction, the roof was strongly braced against the action of wind, and the staining of the alternate boards gave a pleasing variety of effect.

This kind of construction was first suggested by Colonel Emy, in his work on Carpentry, but he had applied it to much flatter roofs of large span, whereas Lord Lovelace's intention was to demonstrate its applicability to roofs for edifices in the Pointed and Tudor styles, and to show that great advantage would result from bending timbers rather than cutting them to the requisite forms; that the thrust of the roof might be entirely taken from the upper part of the walls, and carried far down them, and that such a construction might be adopted as would satisfy every condition of solidity, and, at the same time, admit of considerable decoration.

In the discussion which ensued, the ingenuity of the design and of the mode of execution of the roof were equally approved, and the noble Earl was deservedly complimented for the motives which induced him to bring to the Institution the account of one of his works.

The second paper was "*A Statement of Observations made on the Initial and Terminal Velocities of Trains in descending Inclined Planes.*" By Capt. W. Moorsom, M. Inst. C.E.

The observations were eighty-two in number, and were made during the ordinary passing of trains on the Waterford and Kilkenny Railway, the gauge of which is 5 ft. 3 in., over two adjoining inclines, each falling at the rate of 1 in 100 for upwards of a mile and a half, with a short intermediate level between them.

The speeds at which the descent was begun, varied from 20 to nearly 44 miles per hour, and the loads varied from 32 to 94 tons.

One of the planes presented for the greater part of its length two curves of a radius of 1¾ and 1⅛ miles respectively, and the other plane was straight for part of its length, but contained a curve of 2⅛ miles radius.

The general results in the more curved plane were, that initial velocities of 20 to 30 miles per hour, at the top of the plane, became terminal at velocities of 24 to 28 miles per hour; and on the straighter plane the same initial velocities became terminal between 29 and 31 miles per hour.

Again, on the more curved plane, initial velocities between 30 and 40 miles per hour, became terminal at velocities between 29¾ and 31⅛ miles per hour; and on the straighter plane the same initial velocities became terminal at 30¾ to 33⅛ miles per hour.

Initial velocities above 40 miles per hour were noted only upon the more curved plane, and became terminal at 30 to 31 miles per hour. There did not appear to be any constant proportion between the load in motion and the terminal velocity; but the latter appeared to be dependant more upon initial velocity than upon the weight or character of frontage of the trains.

The general practical conclusion was deduced, that the question of gauge had little or nothing to do with terminal velocity derived from gravity, and that the views generally entertained by engineers, during past years, of the great resistances experienced by trains at high velocities were borne out by the observations recorded in the paper.

The proceedings of the evening concluded with a paper by Lieut.-Colonel Harry D. Jones, R.E., M. Inst. C.E., descriptive of the Bridge at Athlone, erected under the authority of the Shannon Commissioners, from the designs of Mr. Rhodes, M. Inst., C.E.

The paper described the great difficulties experienced from the rush of water into the cofferdams, through the porous gravel stratum in which they were placed, and the ingenious modes of overcoming these impediments. The bridge, of three arches of stone and one of iron, the latter having the means of opening for the navigation, was fully described, and was admitted to be not only a beautiful structure, but to have been built for a small sum (about 24,000*l.*) considering its extent. A beautiful set of drawings, and the printed specifications for the work, illustrated the paper.

June 19.—The paper read was "*On the Employment of High-Pressure Steam, working expansively, in Marine Engines.*" By Mr. John Seaward, M. Inst. C.E.

This communication was described to be the substance of a reply, by the author, to some questions addressed to several eminent engineering firms, by the Hon. H. L. Corry, M.P., when secretary to the Admiralty. This reply was found to furnish so much useful information, and so completely to open the question of the advantage or disadvantage of using high-pressure steam, and of cutting off the steam at various portions of the stroke, that it was conceived it would be advantageously produced at the Institution, in order that the subject should be fully discussed. Unfortunately, the absence of the principal members at the floating of the first tube of the Britannia-bridge frustrated the latter expectation, but the substance of the paper appeared to be fully appreciated.

The argument was so continuous that it would be difficult to attempt to do more than to give a faint idea of it, as the limits of this account would not suffice for an abstract of it. It first reviewed the mode of working marine engines for some years past, and noticed the gradual change that had occurred, particularly the tendency to use high-pressure steam, instead of that of a pressure of about 4 lb. above the atmosphere. It then examined the system of cutting off the steam at various parts of the stroke; and as, at the same time, a remarkable augmentation had occurred in the speed of the vessels, which was naturally attributed to that cause, it inquired minutely into these several causes and effects, as well as the considerable reduction in the consumption of fuel which took place, enabling the vessels, consequently, to make longer voyages, or to carry less fuel for given distances.

In this examination, all the arguments for and against the use of high-pressure steam, and the presumed gain or loss of mechanical power in the use of the expansion principle in the cylinder, were canvassed at length; and the paper wound up with replies of the author to the three questions from the Admiralty, to this effect:—"The highest pressure of steam that we have, in any case, put upon a marine boiler of our own construction, was about 16 pounds to the square inch; but we are not inclined to repeat the experiment, as we feel assured that we can obtain equally good results with steam of a lower pressure—from 10 to 12 lb. is the usual pressure we employ in the merchant service for engines and boilers of comparative small power. The steam pressure at present employed in the service is about 8 lb. per square inch. We consider steam of this pressure to be well adapted for the exigencies of the service; we believe it is calculated to secure all the important advantages of power, economy of weight and space, in a very eminent degree; those advantages will, in some respects, be slightly increased by augmenting the steam pressure to 10 or 12 lbs. to the square inch. We strongly recommend that the steam employed in the navy should not be of greater pressure than 10 lb. per square inch, or in extreme cases 12 lb. to the square inch; any material increase to the latter pressure will be attended with considerable risk, without any adequate advantage."

In the discussion which ensued, these propositions were, to a certain extent, concurred with, but with limitations as to the introduction of other forms of boilers; and it was explained that the arguments of the paper were only applicable to condensing engines working expansively, and, therefore, left the question of the introduction of the using of high-pressure non-condensing engines quite untouched, and free for discussion at a future period.

June 26.—The paper read was "*Observations on the Obstructions to Navigation on Tidal Rivers.*" By Mr. J. T. HARRISON, M. Inst. C E.

The first part of the paper treated, in a general manner, of the circumstances affecting the deposition of materials and the action of water upon them; and in the latter part an application of these circumstances was made, in explanation of the formation of obstructions existing in the bed and at the entrance of tidal rivers.

Under the former head, the materials forming obstructions were first examined, the places whence they were derived, and the causes affecting their initial removal; cohesion, friction, the specific gravity and size of the materials, were shown to affect the question of their motion. The action of water upon these materials formed the latter part of the subject. Under this head, the character and effects of pure stream motion and forced motion, in the form of a pure wave of translation, and of standing waves, were severally considered. It was shown, that during pure stream motion the water had the greatest velocity where the channel was deep; that curves in the channel gave rise to increased depth and velocity; and an explanation was given of the deposit of materials by the water after leaving a curved channel; that the effect of a pure wave of translation was, to scour the shallows and deposit the material in the deeps; and, as its momentum was destroyed, to heap up a bank rising gradually. The effect of standing wave motion of water was shown to be the formation of a succession of deeps and shallows.

Under the latter head, the *first division* treated of the action of river water—first, in its own channel, when the subject of impediments, as piers of bridges, weirs, &c., was examined; 2nd, where it discharged into a large basin devoid of tide, under which head the formation of deltas, &c., was discussed; 3rd, when the basin into which it flowed was subjected to a rise and fall of tide, but without perceptible current.

The second division treated of the action of the sea without the entrance of the river. Attention was drawn to the effect of the situation of the entrance, with respect to the direction of the tidal wave. It was shown, that in some cases, part of this wave set directly up the river, as in the case of the Severn, &c. As a branch of this subject, the peculiarities of the tidal action, described in a communication to the Royal Society by Capt. Beechy, as existing in the Irish Sea, were commented upon, and an explanation offered of some of them. In other cases, the tidal wave setting at right angles to the direction of the river, when the wave which passed up it was generated at the entrance. The deposition of materials near the mouth of rivers by along-shore currents, and by the wind-waves, was then briefly touched upon.

The third division treated of the action of the water in entering rivers so placed, that the wave was generated at the entrance. The circumstances which affected the quantity of water entering were considered; it was shown to be limited by the width and depth of the entrance, and the rise of the tide; and again, by the degree of freedom with which the momentum generated is transmitted. It was also shown that this freedom of transmission depended chiefly on the depth of the water; and other circumstances affecting it were explained.

Under the fourth division, the removal of bars by the ebb tide was discussed; and the propriety of the water having a free motion, and not being forced over the bar, was shown. It was argued, that bars are frequently increased by a narrow or shallow channel at the entrance causing a head of water, and the consequent formation of a standing wave between it and the bar. The deeper the channel could be maintained, and the further the water could be made to flow up it, the better would be the effect of the ebbing waters upon the bar. It was shown that the deep water found within the entrance of many rivers is caused by the flood tide, and that an improvement in the bar would probably have the effect of lessening this depth, which, in many cases, would be considered a disadvantage.

The fifth division treated of the effect produced on the bed of the river's channel. The difference in the motion of the water on the flood and ebb was shown. When the tidal wave was oscillatory at the entrance, the tendency of the tidal action was to draw out to sea the material lying in the bed of the channel at the entrance, and to heap up sand-banks in the upper part of the estuary. When the tidal wave was generated at the entrance of a bottle-necked estuary, the formation of sand-banks within the entrance, with the false channels which accompany them, was explained, as being the result of the flood tidal action. The effects produced by the ebb tide were shown to be generally similar to those described as produced in rivers proper.

The sixth division drew attention to the remedies necessary for preventing obstructions; and to that end it was urged that the sources whence the materials are derived should be first attacked; the possibility of checking the progress of shingle along the coast towards the mouth of rivers, and its entrance when there, as well as the washing down of the detritus from the upper part of rivers, was discussed; and it was agreed that much might be done by groyning the coast, carrying out piers at the entrances and in the upper part of the river, by groyning the banks in some places, and allowing a free scope for the deposit of the material which is being washed down in others. The subject of piers at the entrance of rivers was then more freely entered into, and the effects produced by their being built too close together and curved were discussed. Some points which it seemed desirable to attend to in fixing the lines for confining rivers, were generally considered; and the paper ended with the expression of a hope that it might lead to discussion, and a further collection of facts, upon which alone any sound theory can be founded.

After the meeting, Mr. F. A. Carrington exhibited in the Library a beautiful model, in relief, of portions of the counties of Lancaster, Yorkshire, Cheshire, Notts, and Derbyshire, extending from Manchester to Lincoln; and the Humber, east and west; and from Leeds and Bradford to Chatsworth Park, north and south. These models show at a view the whole physical geography of a district, and are admirably calculated for projecting works of both civil and military engineering; and if they were a step in the sanitary improvements of towns, the progress would be more certain, and less costly.

The meeting was adjourned until the commencement of the next session, which it was proposed should be at an earlier period than heretofore.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

June 4.—T. BELLAMY, Esq., V.P., in the Chair.

A paper was read, "*On the Building Materials employed at Paris, and in the Valley of the Lower Seine.*" By G. BURNELL, Esq., Jun.

The author gave a detailed account of the qualities of the principal building materials used by the architects and engineers of Paris and the valley of the Lower Seine, accompanied by some statistical statements of the quantities used in those localities. In comparing these with the quantities employed in England, the most remarkable difference appeared to exist in the greater use in this country of iron, especially *cast* iron, which may be accounted for by that material being much dearer in France. The use of gypsum in France, which we call Plaster of Paris, instead of mortar made entirely from lime, for filling in the internal partitions and for forming the floors and ceilings of the rooms, was alluded to as rendering the buildings less combustible than in England. Mr. Burnell commented on the bad system adopted in building some of the modern houses in Paris, where, by using squared stones for the fronts next the streets, rubble stone for the party-walls, and timber framing filled in with plaster for the back walls,—fissures and cracks are produced in consequence of the unequal combination and the different expansive power of the materials thus applied. For the covering of the roofs, slates and tiles are used in France, but zinc is more generally applied in that country than in England,—the dryness of the climate rendering it less liable to corrode than with us; being much cheaper than either copper or lead, it is frequently employed where those metals would be applied in England. Mr. Burnell urged the necessity of more accurate and detailed investigations of the chemical properties of building materials than have hitherto been considered necessary,—he observed that "little is here known, comparatively speaking, of the chemistry of the art of building, that little having principally been gleaned from the scientific researches of the French authors."

A discussion ensued on the subject of the greater amount of resistance offered by stones when used in the direction of their natural bed.

The Report of the Council to the Annual General Meeting, May 7th, 1849, has just been issued, from which we collect the following extracts;—

The agitated state of Europe during the past year, following immediately upon the vast financial embarrassments of the year 1847, has not failed to produce a serious effect on the arts, to which a state of peace is ever favourable. The council feel that to these circumstances may be attributed the absence from this report of one feature always hitherto satisfactory,—the notice of new works of magnitude and interest, in which art and science might have acquired further development. Symptoms of returning national prosperity are however to be observed, and as these, if realised, cannot fail to operate beneficially on all the arts of design, it may reasonably be expected that a future council will be enabled to make a more favourable record than can be done on the present occasion. But notwithstanding this barrenness of matter as respects art, the fields of science have not been unproductive.

The various accidents which have occurred during the last few years in some extensive buildings in the manufacturing districts, and likewise in works connected with railways, from failures of cast-iron, have given rise to the question as to the dependence to be placed on that material; this has attracted the attention of the government and of several scientific men. A series of elaborate and accurate experiments, on a large scale, have been gone through by our honorary member, Professor Hodgkinson, and various expedients have been suggested by practical men; amongst others Mr. Morries Sterling's patent method of increasing the tenacity of cast-iron by the admixture of wrought scraps, promises important results. As iron has been largely introduced of late, and is likely to be still more extensively employed in the construction of buildings, the problems to be solved demand that the most serious attention should be bestowed upon the system of wrought-iron framings, frequently adopted by French architects and engineers, and perhaps instructive principles might be derived from a comparison of the relative values of the systems in operation in France and in England.

Fire-proof construction is becoming of more general adoption, and various schemes have been brought under the attention of the Institute at the ordinary meetings. The revival of the ancient mode of constructing vaults and arches, by means of hollow bricks, as employed in a somewhat different form in the vaulted ceiling of St. George's Hall at Liverpool, recently constructed under the direction of Mr. Rawlinson, and described by him at a late meeting,—Mr. Barrett's description of Messrs. Fox and Barrett's patent mode of constructing fire-proof floors and ceilings, and likewise Mr. Beardmore's method of constructing malleable iron fire-proof flooring, given at preceding meetings, may be enumerated;—the subject however seems to be in its infancy, and it is to be hoped that some combination may be suggested, which may unite economy with complete protection from fire in public and private buildings.

The report then refers to the attempt of establishing a benevolent fund; and next refers to the difficulty of obtaining suitable apartments to hold the meetings of the Institute, library, &c.

The report laments the loss by death of Mr. Miles and of Mr. Eginton of Worcester, both of whom have for many years been associates; and further of Mr. Paxon, a few weeks after his election as an associate, and before he had actually been admitted. We have likewise to regret the decease of our honorary fellow, the Rev. Robert Norgrave Pemberton, of Church Stretton.

The report then refers to the annual prizes, which have been already reported.

The competition for the medals of the year has unfortunately been far from satisfactory; for although the silver medal of the Institute has been deservedly awarded to Mr. Wyatt Papworth for his essay "On the Peculiarities of the Palladian School of Architecture, and a comparison and contrast of its elementary principles and details with those of Roman Art," yet the Institute have been compelled to withold the medal offered for "an Essay on Roofs, and forming the Flats and Gutters of Buildings, &c." as likewise the Soane medallion offered for the best design for "a Building to serve as a National Repository and Museum for the illustration and exhibition of the productions of the Industrial Arts," neither the essays nor the designs submitted having been deemed worthy of reward.

The designs for the Soane medallion, apparently the productions of very young men, exhibited generally a remarkable absence of the recognised elementary principles of architectural composition, together with a lamentable want of knowledge of construction; and in some cases, such glaring discrepancies between the plans, sections, and elevations were apparent, that the council felt necessitated to withhold the reward offered, lest it might be inferred that the Institute recognised as a standard of merit, productions of the class submitted this year:—in the hope of eliciting for the future more matured talent, the council have extended the limit as to the age of competitors for the Soane medallion to thirty instead of twenty-five years as heretofore.

The council have observed with deep concern the absence of that spirit of noble emulation which should stimulate the junior member of the profession to strive for distinction, in the acquisition of those prizes offered to his ambition by the Institute: he should reflect that the seal of approbation, stamped by the rewards of this body, is an honour that must accompany him through life. A medal from this Institute is a title to the respect of the public and of his professional brethren: the very energies he exerts to be worthy of that distinction, are invigorated by the praiseworthy effort to merit the approval of his seniors. The wide range of thought to be taken, the studies to be pursued, the monuments to be investigated, the elevation of ideas and of imagination, required to qualify himself for the important struggle, must have influence upon his future standing in the profession, even if not immediately successful. He should never be satisfied until he is crowned by success and has grasped those honours which the generous encouragement of his seniors holds out to his enthusiasm and perseverance. Nothing less than the utmost concentration of purpose and unwearying application can qualify a man to be an architect, and enable the laborious student to acquire the mass of learning, the perfect mastery of the pencil, that acquaintance with construction, that familiarity with the mineral and vegetable worlds and with the laws of mechanics, which are requisite to ensure future reputation and success. He should avail himself of the many motives to exertion, and the numerous sources of instruction now open to him, but which were not accessible to the less-favoured studies of his seniors, who had to struggle under every disadvantage to acquire even the rudiments of the art which they profess.

The recent political convulsions which have already been alluded to, have had their influence upon the progress of the art on the Continent. But it is satisfactory to observe that the governments of France and Prussia, amidst their violent civil contests, have recognised the moral and political importance of continuing their public monuments already in course of erection, as a means of employing the well-disposed artizans. Vast sums have been allocated by those countries to the completion of important edifices, nor has a miserable economy deprived those buildings of the embellishments to be derived from the chisel of the sculptor, or the pencil of the painter. It is however to be deplored that the horrors of war have visited several beautiful cities of Europe, and occasioned serious injury to numerous precious works of art, which it will require many years of prosperity and peace to restore to their pristine splendour.

The council refer with satisfaction to the numerous and valuable additions that have been made to the library and collection, by donations and by purchase.

The Builders' Benevolent Institution.—We wish to direct the attention of our professional readers to this excellent institution for giving relief and granting permanent pesions to decayed masters, who have been practically engaged in the trades connected with building, and their widows,—pensions not to exceed 24*l.* per annum to the males, and 20*l.* per annum to the females, payable monthly; and for giving temporary relief to deserving workmen of masters being members of the institution. By reference to our advertising columns, it will be seen that the Second Anniversary Dinner is to be held on the 18th inst., to be supported by the Earl of Carlisle, and numerous members of the profession.

Boat for His Royal Highness the Prince of Wales.—By command of His Royal Highness Prince Albert, Mr. H. G. Robinson, Captain Light, Captain Smith, R.N., and Mr. C. Manby, Secretary of the Institution of Civil Engineers, attended at Buckingham Palace, on the 22nd. ult., to present a beautiful life-boat, constructed on a peculiar principle, for His Royal Highness the Prince of Wales. The following are the dimensions of the boat:—

Length over all	20 ft.	9 in.
Ditto on the keel	17	4
Breadth at the main thwart	3	2⅜
Ditto at the back-board thwart	2	11⅜
Ditto at the rowlock	3	7½
Depth	0	11¼

She was built by Messrs. George Searle and Sons, of Lambeth, boat-builders to Her Majesty, and is constructed of bird's-eye maple, the linings, saxboards, and thwarts being of Spanish mahogany; her keel-band, stem-bend, and rudder-hangings are of bronze, the rudder of maple, with a carved yoke, gilt, and silk lines and tassels of crimson and gold colour. She is also fitted with an elegantly-carved chair, the seat of which is covered with crimson satin damask, with an elaborate pattern in raised velvet of the same colour, the back being supported by the Prince of Wales' feathers, carved in maple and heightened with gold. The rowing mat is of the same material as the cushion of the chair, and there is a small foot-ottoman of Utrecht velvet. The sculls are of mahogany, and very light. The boat, which is a "single sculling skiff," is lined throughout between the timbers with Captain Light's patent material, which gives to her all the buoyancy and other properties of a life-boat.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM MAY 24, TO JUNE 7, 1849.

Six Months allowed for Enrolment, unless otherwise expressed.

David Smith, of New York, lead manufacturer, for certain new and useful improvements in the means of manufacturing certain articles in lead —Sealed May 29.

Richard Edward Hodges, of Bycroft, Hereford, gentleman, for improvements in mechanical purchases, which are also applicable in whole or in part to projectiles.—May 29.

Edmund Grundy, of Bury, Lancaster, woollen manufacturer, and Jacob Farrow, of the same place, manager, for certain improvements in machinery or apparatus for preparing wool for spinning, and also improvements in machinery or apparatus for spinning wool and other fibrous substances.—May 29.

John Dingdale, and Edward Birch, both of Manchester, tool and machine makers, for certain improvements in constructing and propelling ships, or other vessels.—May 31.

William Goose, of Birmingham, manufacturer, for certain improved machinery for manufacturing nails. (A communication.)—June 5.

William Henry Smith, of Fitzroy-square, civil engineer, for certain improvements in breakwaters, beacons and moorings, parts of which are applicable to other purposes.—June 5.

George Simpson, of Buchanan-street, Glasgow, civil and mining engineer, for a certain improvement or improvements in the machinery, apparatus or means of raising, lowering, supporting, moving, or transporting heavy bodies.—June 5.

Samuel Dunn, of Doncaster, gentleman, for improvements in constructing tunnels, and in apparatus to be used for such or similar purposes.—June 5.

Thomas Lawes, of the City-road, gentleman, for improvements in generating steam, and in the means of obtaining and applying motive power.—June 5.

William Edward Newton, of Chancery-lane, civil engineer, for improvements in stoves, grates, or fire-places, and in warming or heating buildings. (A communication.)—June 5.

Thomas Jowett, of Burrage House, in Bingley, York, stuff manufacturer, for certain improvements in the method of stopping power looms, and preventing injury to the cloth, or fabric, in the course of being woven.—June 5

George Hinton Bovill, of Abchurch-lane, London, engineer, for improvements in manufacturing wheat and other grain into meal and flour.—June 5.

Jacques Hulot, of Rue St. Joseph, Paris, manufacturer of fabrics, for improvements in the manufacture of the fronts of shirts.—June 5.

Daniel Miller, civil engineer, of Glasgow, for certain improvements in the mode of drawing ships up an inclined plane out of water.—June 5.

Victor Hippolyte Laurent, of France, engineer, for improvements in looms for weaving.—June 5.

Osgood Field, of London, merchant, for improvements in anchors. (A communication.) June 5.

A grant of an extension of her Majesty's letters patent for the term of five years from the 27th of May, 1849, to Thomas Hornby Birley, assignee of George Bodmer, the original inventor of an invention for certain improvements in machinery for preparing, roving, and spinning cotton and wool.—June 5.

Thomas Masters, of Regent-street, gentleman, for certain improvements in the construction and arrangement of apparatus for cooking, heating, and evaporating fluids, and obtaining decoctions and infusions from certain vegetable and animal matters, parts of which improvements are applicable to certain chemical processes.—June 7.

Edward John Payne, of Chancery-lane, London, for improvements in marine vessels, in apparatus for the preservation of human life, and in moulding, joining, and finishing hollow and solid figures, composed wholly or in part of a certain gum, or combinations of certain gums; also for improvements in dissolving the aforesaid gums, and in apparatus or machinery to be used for the purposes above mentioned.—June 7.

Robert Wilson, of Low Moor Ironworks, Bradford, York, engineer, for certain improvements in steam-engines and boilers, and methods of preventing accidents in working the same.—June 7.

Bennett Alfred Burton, of John's-place, Southwark, engineer, for certain improvements in the manufacture of pipes, tiles, bricks, stairs, copings, and other like or similar articles from plastic materials; also improvements in machinery to be employed therein.—June 7.

John Edward Hawkins Payne, of Great Queen-street, Middlesex, coach-lace manufacturer, and Henry William Currie, engineer, for improvements in the manufacture of coach lace and other similar looped or cut pile fabrics.—June 7.

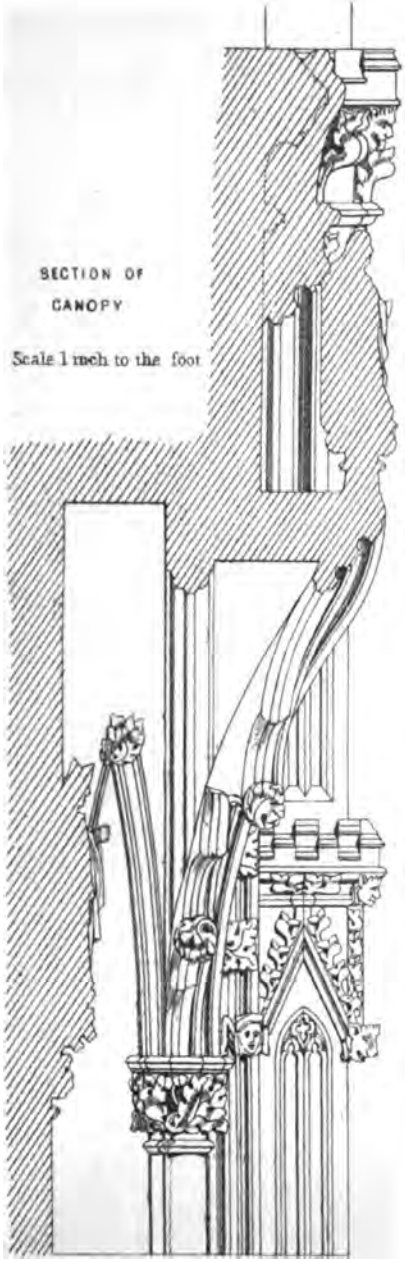
Charles James Anthony, of Pittsburgh, America, machinist, for certain new and useful improvements in the means of treating unctuous animal matter.—June 7.

William Henry Ritchie, of Brixton, gentleman, for improvements in fire-arms.—June 7.

John Houston, of Nelson square, surgeon, for improvements in obtaining motive power when steam and air are used.—June 7.

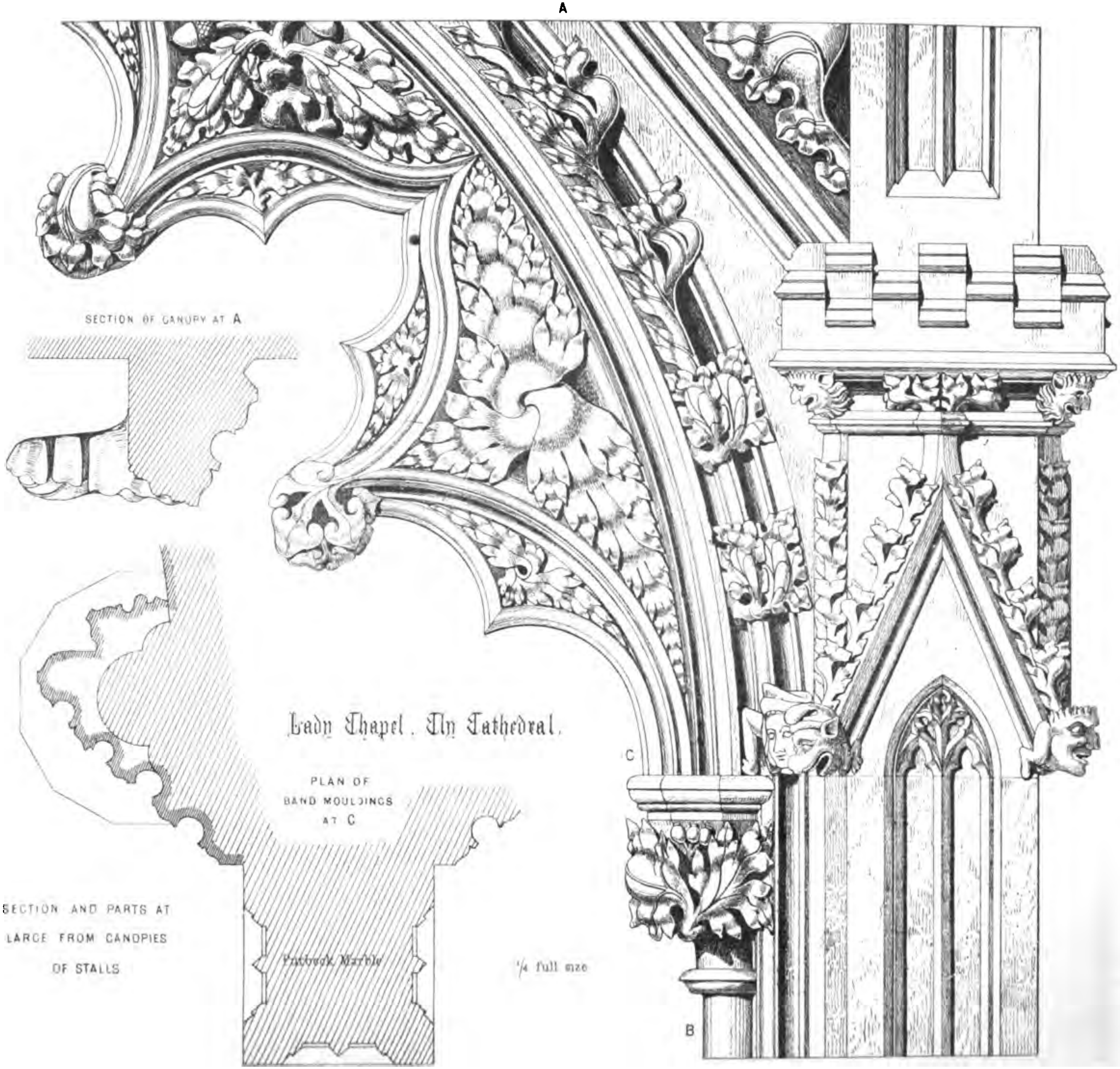
[We are compelled, from want of space, to defer the remainder of the present month's list till our next Number.]

Lady Chapel. Ely Cathedral.



SECTION OF CANOPY

Scale 1 inch to the foot

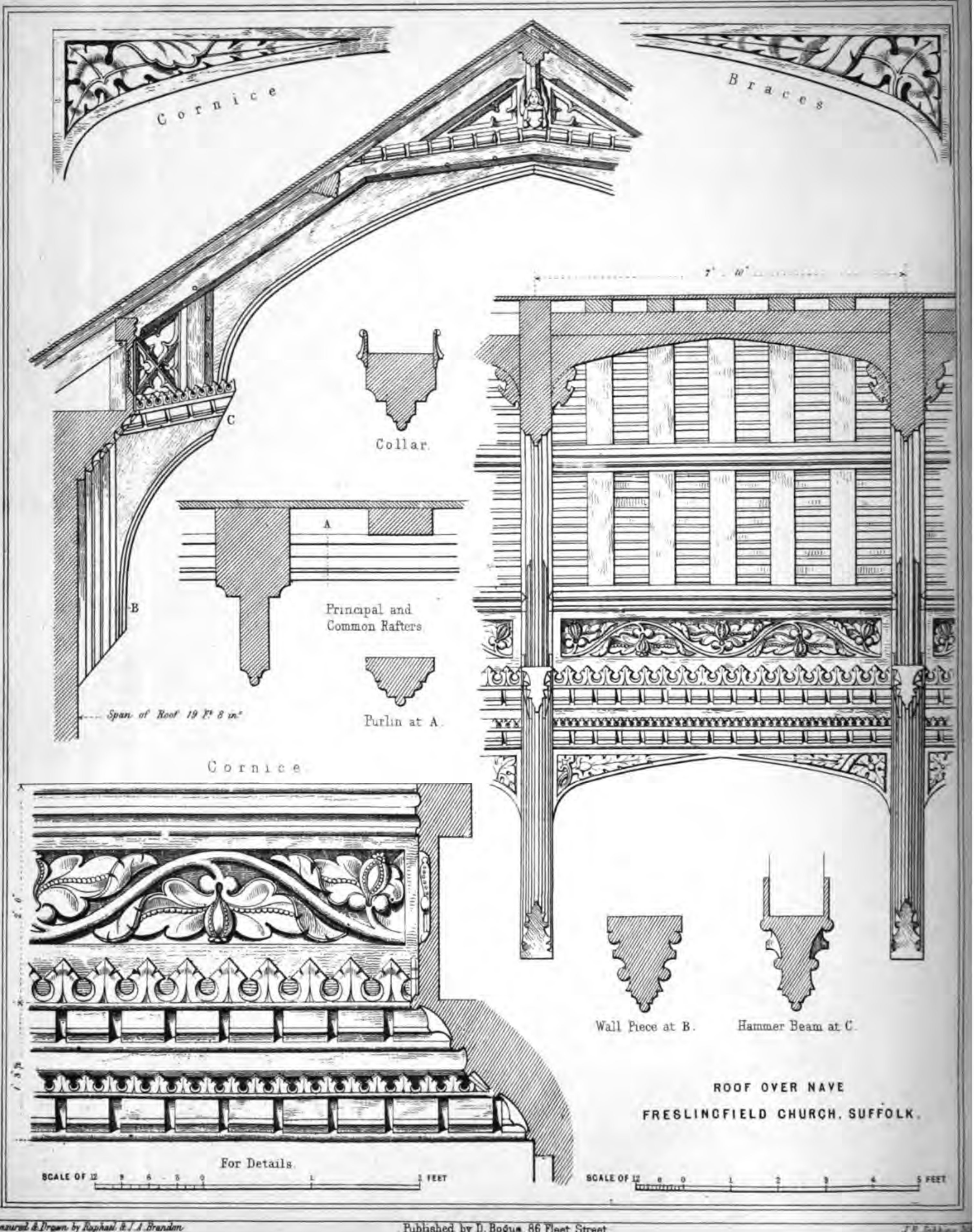


SECTION OF CANOPY AT A

PLAN OF BAND MOULDINGS AT C

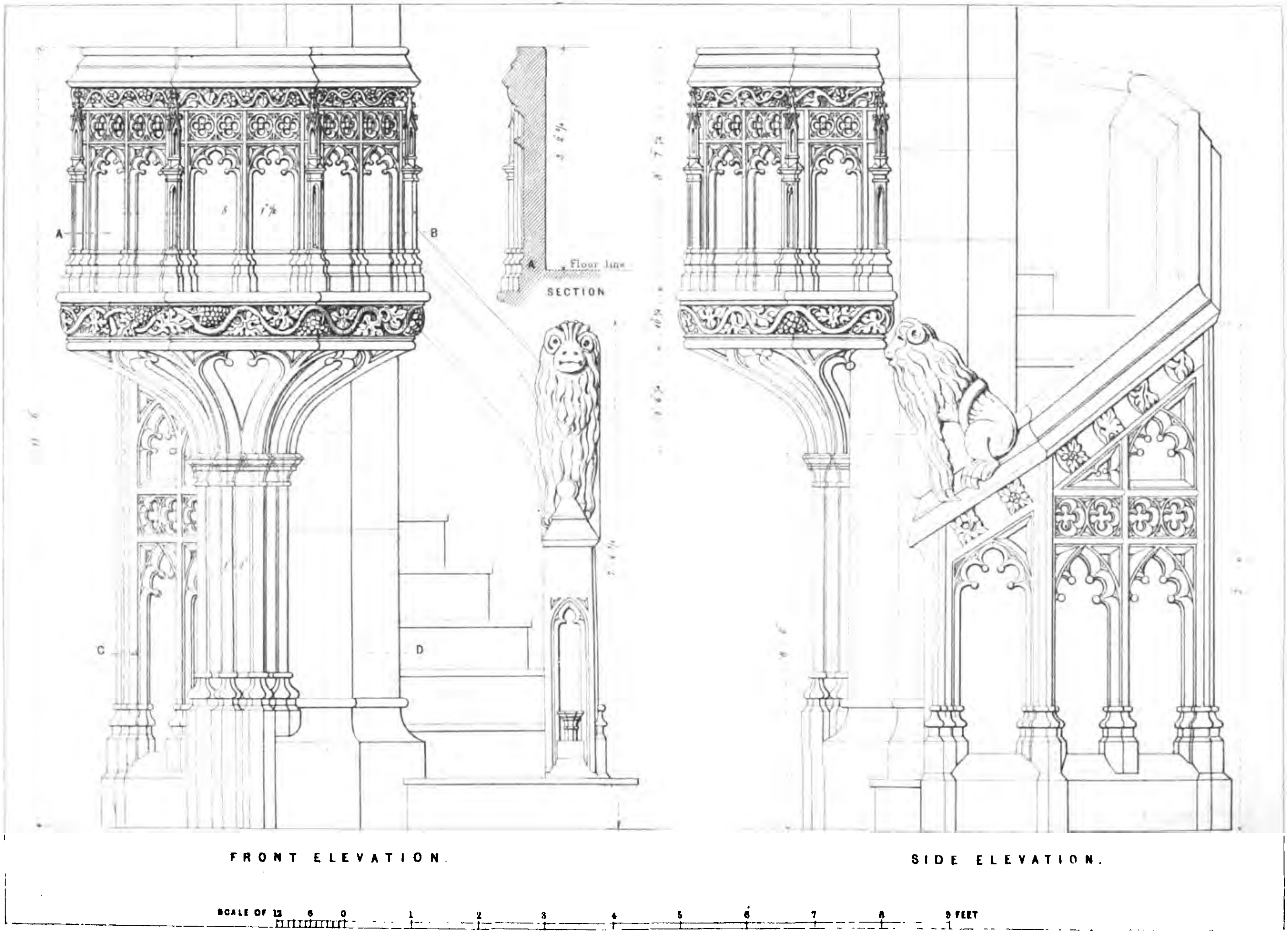
¼ full size

SECTION AND PARTS AT LARGE FROM CANOPIES OF STALLS



ROOF OVER NAVE
FRESLINGFIELD CHURCH, SUFFOLK.

easured & Drawn by Raphael & J. A. Brandon
Published by D. Bogue, 86 Fleet Street.
J. R. Jobbins



Drawn by F T Dollman.

J R Jobbins 3 Warwick Ct

Stone Pulpit in St. Peter's Church. Wolverhampton. Staffordshire.

CHURCH ARCHITECTURAL PUBLICATIONS

1. *Gothic Ornaments; drawn from Existing Authorities.* By James R. Colling, Architect. London: George Bell, 1849.
2. *Examples of Ancient Pulpits existing in England; selected and drawn from Sketches and Measurements taken on the spot, with descriptive letter-press.* By Francis T. Dollman, Architect. London: George Bell, 1849.
3. *The Open Timber Roofs of the Middle Ages; illustrated by perspective and working drawings of some of the best varieties of Church Roofs, with descriptive letter-press.* By Raphael and J. Arthur Brandon, Architects. London: David Bogue, 1849.

(*With Three Engravings, Plates* XIV., XV., *and* XVI.)

In whatever way we look at it, the extent of publication on church architecture is gratifying, for it stores up materials for the student, and, by showing the infinite fertility of resource of the mediæval architects, it very strongly suggests the propriety of adopting now the same course which they did—not the path of imitation, but of invention. Whatever may be the extent to which the inventive faculties are to be applied, it is indispensable the architect should be well acquainted with the resources of constructive art, and should be fully master of the experience of the past. For this end and so far, books are valuable; but nothing can be more injurious than to push them beyond this, and make the work of the present day the thievish copy of the work of old. Englishmen have not degenerated; and if they could apply their ingenuity in the ninth century, so can they in the nineteenth, and so ought they.

This is a cuckoo note of ours, but we have encouragement to persevere in it, because it is already listened to; and, although small, there is an evident improvement, and an evident desire for improvement, of which the architectural publications give full testimony. There are readers for them,—therefore they are bought, and more are written; the resources of illustration are brought to bear, and a class of books is now placed at the disposal of students, which formerly masters could scarcely buy. We have before us three of these publications—'Gothic Ornaments,' by James Colling, being the Fifth Part; 'The Open Timber Roofs of the Middle Ages,' by Raphael and Arthur Brandon; and 'Examples of Ancient Pulpits existing in England,' by Francis T. Dollman. All these are by architects, and all have been got up with great care by Mr. Jobbins.

The 'Gothic Ornaments' constitutes a gorgeous work, illustrated by gold and colour, giving correct ideas of the magnificence of the original examples, of which the unilluminated works afford but a scanty conception, as they give form without the chief characteristic of the mediæval architect—colour. In the present day, too, the public are better instructed, and are unwilling to take form alone as the representation of Gothic art; and the architect is compelled to go through a wider course of study, giving him a more enlarged acquaintance with art. The addiction to the study of form alone has done more than anything to keep back, in this country, the pursuit of architecture in every form. This special and restricted study, this abstinence and seclusion from the catholic pursuit of art, necessarily involved a complete neglect of *chiaro oscuro*, as well as of colour, and hence the bareness and baldness of our architectural monuments. The sculptor, who restricts himself to bas-relief, the painter who draws only cartoons, can scarcely lower himself to the tameness too prevalent in our buildings. Nothing is better calculated to remedy this than the restoration of the architect to his proper sphere,—reminding him that his is an intellectual and elevated pursuit, and that no department of art, no feature of beauty, no work of nature, is beneath him, or is unnecessary for his acquirement. Those who look back on the studies of the architectural student in the beginning of this century, which Stuart's 'Athens' might be said to satisfy, and compare them with the requirements of the present day, will see how much architecture has advanced, and will acquire the hope that if we have not already the full results, we shall not long be kept waiting for them.

Whatever some may think as to the mediæval architect being ignorant, living in what are popularly known as the dark ages, yet it may very much be questioned whether at any time then the architect was worse educated than now—if, indeed, he did not receive a more liberal and catholic training. The practitioner in architecture was a member of one of the great colleges, in which a wide circle of studies was pursued; and we may see by the works which have come down to us that he largely shared in them. So much attention has been given to Free Masons, and so much nonsense has been written about them, that the actual position of the architect has been too commonly lost sight of. Freemasons never existed before Wren's time, in the modern sense, but Free Masons there certainly were, as Free Barbers, Free Tailors, Free Cordwainers, and Freemen of every craft; and the Free Masons were in no respect distinguishable from any other guild, and there is no authentic document to show that they were otherwise. The Freemason after whom the archæologist searches was the monk, a man trained in Latin learning, and having access to the great stores of knowledge; well versed in the vernacular learning of French or English,—but, above all, cunning in music, drawing, painting, carving, building, mechanics, and husbandry, and dabbling in every art and handicraft of the day. If less book-learned, he was very handy; if he had no newspaper or periodical, he was a travelled man himself: he had been to court, to Paris, to Rome, or the Holy Land, and was thrown into society with the most intellectual men of the day. If he had read few books himself, and had access to few, yet all the stores of learning which could be spread by word of mouth were his; and a travelling monk served at once as a newspaper, a book of travels, and a digest of the library of his own monastery, and perhaps of many others. *Non multum sed multa*—what was learned was learned thoroughly. A man who had ardour enough to become a good architect was likewise well versed in other studies; and many of the names which have come down to us are those of the best scholars and greatest men of the time. The architect then was not so liable to be bullied by idle lords, and by purse-proud commoners, making a boast of their own ignorance, for he was often the chancellor or prime minister of his day. Architecture was not claimed as the mystery of a few, and was therefore not the byeword of the many. Architects will never again become prime ministers; but it will be no harm when prime ministers know something of architecture, and architects treat their profession as one of liberal ideas and pursuits. It may seem that to study bricks and mortar only is the most practical way of becoming an architect, but the experience of ages is rather in favour of the preliminary of an architect being a man of learning and education.

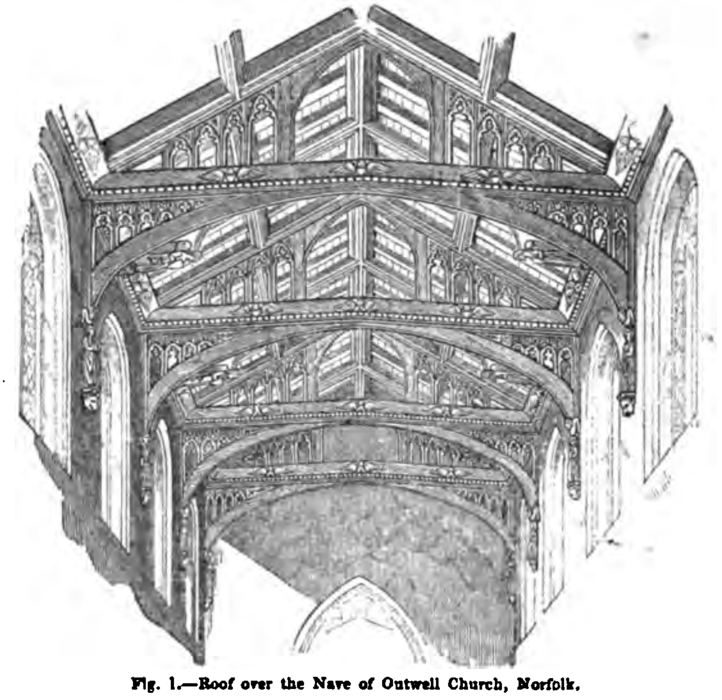


Fig. 1.—Roof over the Nave of Outwell Church, Norfolk.

We cannot transfer one of the illuminated drawings from Mr. Colling's work, and therefore we are narrowed in our selection. The one we have given (Plate XIV.) shows the details of a highly painted Stone Canopy from the Stalls of the Lady Chapel in Ely Cathedral.

What called itself classicism was all in favour of pure marble and white stone: the colouring which the Almighty has distributed throughout creation, as one of the unequivocal stamps of authentic origination, was ignored, and any attempt to use its rainbow tints was declared unclassical, unpleasing, and unsublime. It is wonderful that pictures were still allowed to be made with colours, though certainly some ingenious men did paint black and white imitations of bas-reliefs, and thereby gave the example of classicality in painting; but architecture and sculpture were completely under its domain, and at length such a thing as a painted building, or a coloured statue, was not brought forth: and had matters gone on thus, nothing else than classicality would have been seen. Polychromy has shaken the pseudo-classical in architecture, but sculpture is still fettered; and though Gibson has indulged himself with a tinge of colour, he must be a bold man who will apply the resources of art to the sublime works of the sculptor. For ourselves, we cannot see why colour is to be limited to a flat surface, nor why, because we like Madame Tussaud's well enough so far as it goes, we should not like much more a work in which the powers of sculpture and of painting are equally brought to bear. If in Baily's Three Graces the eyes had been put on, the hair of the head and eyebrows tinged, the lips reddened, and the ground distinguished by colour, we cannot see what harm would have been done. Marble may be a very good representative of the flesh,—Phidias thought ivory better; but either is a very bad representative of the hair.—Who will be the first to show that he can think for himself in sculpture?

By the example from Ely Cathedral, as by so many others, we see that the mediæval architect was neither afraid nor ashamed to overlay rich carved stonework with colour, and the bright blue and crimson given in Mr. Colling's first plate show that an effect is produced beyond that of plain white stone. Architects are now timidly beginning to put in a coloured marble column or tablet in exteriors; but what, except themselves, is to prevent all the resources of coloured stones and metals from being brought into use —and where such cannot be got, artificial colour? Many a pimping cornice might be improved by colour, and in the so-called Gothic buildings, flat panels ought to have appropriate heraldic decorations. What more foolish than a shield without charges, if a shield is to be put up?

Mr. Dollman's 'Ancient Pulpits of England' supplies a great want, for even this piece of church furniture is now becoming the subject of study. We wish he had said something about foreign works; but, at any rate, he has given us three-and-twenty English examples, some coloured and some plain, executed in stone or wood, between the years 1270 and 1533. All the examples are drawn and delineated with great care, and the dimensions marked, and are further illustrated by the details being enlarged. The engraving (Plate XV.) represents the Stone Pulpit in St. Peter's Church, Wolverhampton, Staffordshire, and is described as follows

"*Date circa* 1480.—An elaborately enriched example, attached to one of the piers on the south side of the nave. The panelled enclosure of the stairs is original; across the coping of which, at the foot of the staircase, a grotesque animal, in a sitting posture, forms a remarkable singularity in the design. The leaf ornaments are boldly carved and considerably undercut, and are very effective."

Messrs. Brandon's book is particularly important, for there is now a great demand for open timber roofs, and an acquaintance with the best constructive examples is most desirable. They have evidently given to their subject great labour and research, and they have produced a work which will be useful to the architect, whether practising church building or any other branch. The number of examples given in detail is thirty-five, mostly from Norfolk and the eastern counties, but with some others. They are all from churches.

Messrs. Brandon have given a very useful and interesting preliminary dissertation, founded on their own experience, and we wish much our space allowed us to transfer it to our pages, for it is of a character eminently practical. They class the roofs in four main divisions—1st. Roofs with tie-beams; 2nd. Trussed rafter or single-framed roofs; 3rd. Roofs with hammer-beams and braces; 4th. Roofs constructed with collars and braces, or with the latter only. As an example of the first division, we select the engraving of the Roof over the Nave of Outwell Church, Norfolk, (see woodcut, fig. 1.)

"In the churches of the middle ages, a perfectly horizontal tie-beam is of extremely rare occurrence. Where a tie-beam is used, we almost invariably find it cambered, as are also the collar-beams: even the hammer-beams will be generally found, on close inspection, to incline upwards from the walls. The disagreeable effect of a straight tie-beam was often further counteracted by having curved braces framed from its underside, connecting it with the wall-pieces; thus forming an arched support for it, as at Outwell Church, Norfolk.

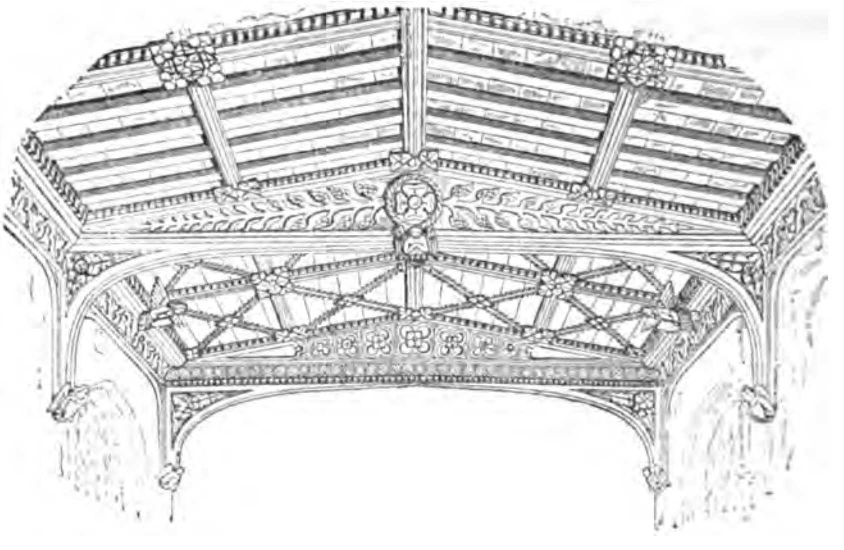


Fig. 2.—Roof over North Chapel, Wellingborough Church, Northamptonshire.

"In roofs of higher pitch, the builders still endeavoured, with varied success as to effect, to retain the arched shape in conjunction with the tie-beams. A curious specimen exists at the church of St. Mary the Virgin, Pulham, Norfolk, where the beam literally divides the arch in two.

"As the Perpendicular period drew towards a close, tie-beam roofs of very low pitch were of general occurrence; in fact, they were frequently almost flat, with no more rise to throw off the wet than could be obtained by the camber of the beams. These roofs were oftentimes profusely ornamented, as in that over the North Chapel of Wellingborough Church, Northamptonshire (see woodcut, fig. 2). In this instance, the eastern bay, as was very frequently the case, is panelled, while the others are left open to the rafters.

"*Of Collar-braced Roofs.*—These include also roofs braced together without collar-beams, the braces simply connecting the wall-pieces and principals together. This style of roof is a natural simplification of the hammer-beam roofs, among which we have already described some varieties without collar-beams, others without struts, and one without either; having found that these members could be dispensed with safely, the next transition, that of omitting the hammer-beam itself, followed very soon; indeed, in either of the before-mentioned cases, it plays a very subordinate part—take, for instance, the roof over the nave of Capel St. Mary's Church, Suffolk: the hammer-beam, with its brace and wall-piece, form little more than a continuation of the collar-beam brace; nor is it of much more importance in the roof over Palgrave Church; at Brinton it is boldly omitted: the wall-piece is tenoned into the underside of the principal rafter, the foot of which is likewise connected with it by means of the usual horizontal piece of timber, which might to distinguish it be called a wall-beam; the arched braces, which in this roof terminate somewhat abruptly, effectually bind and hold the main timbers together. It is worthy of remark, that this roof in appearance and general construction bears a striking resemblance to a form of roof that had been executed at least a century earlier—we mean the roof over Tunstead Church, the most important difference being, that in the latter the curved braces are of the same thickness as, and appear to form part of, the principal rafters; whereas, in the former they are not more than four inches thick, while the principal rafters themselves are about ten. Of course, this observation applies only to the general appearance of the two roofs, that at Brinton being more ornamental, especially in its cornice and cornice-braces, as well as being more elaborately finished.

"The next roof illustrated, that over the nave of St. Mary Magdelen's Church, Pulham, Norfolk, is one of the most beautiful of the kind that we have met with; the shape of the arch, and the general design of this roof, are far more pleasing than in the preceding example; all the timbers are well moulded, and the cornice and purlins fringed with a creating of strawberry-leaves, the former being further enriched with a double range of figures of angels and flowers alternating, and their positions in the second range counterchanged. The eastern bay of this roof is much more highly ornamented than the other parts, the mouldings of the various timbers are more elaborate, and the spaces between the principal rafters are boarded under the common rafters, and subdivided into panels with the emblems of the Evangelists painted thereon: the whole of the roof still retains traces of the colours and gilding with which it was once resplendent, the distinction between the eastern bay and the remainder of the roof being still kept up in the treatment of the colouring; the former was coloured all over, whereas the colour was only applied to the ornamental parts of the latter, such as the carvings and the more important mouldings, leaving the general ground-work the natural colour of the wood; and this was the most usual way of introducing colour in roofs, it being of rare occurrence to find the wood entirely concealed, as at Knapton and Palgrave.

Fig. 3.—Roof over Chancel of St. Mary's Church, Leicester.

"The Roof over the Chancel of St. Mary's Church, at Leicester (woodcut, fig. 3), is similar in general design to the Pulham roof, but of a much ruder construction: this roof, though a double-framed one, has no ridge-piece, the rafters being simply crossed and halved, and pinned together, as in an ordinary trussed-rafter roof."

As a concluding specimen of the work, we select a Plate which describes the Roof over the Nave of Freslingfield Church, Suffolk, (Plate XVI.)

MILITARY AND CIVIL ENGINEERING.

1. *An Essay on a Proposed New System of Fortification, with Hints for its application to our National Defenses.* By James Fergusson, M.R.I.B.A. London: Weale, 1849.
2. *Aide Memoire.* Weale.

Fortification is now commonly looked upon as a special subject, exclusively belonging to the military engineer; and it will strike some with equal surprise to see a work on fortification by a civilian, and to find it reviewed in our columns. If, however, fortification has come to be regarded as a special art and mystery, it is only of late: it was not always so, neither does there seem to be any good reason for it. In most cases, it is true, the subdivision of employment leads to the improvement of a given art; but in fortification, it may be questioned whether such has been the result, and for this very good reasons may be assigned. Whenever the subdivision of employment is carried to the extent that but few persons are engaged in a particular branch, then evil must be produced, because there is a want of emulation among the professors, a want of physical and moral force for the development of the subject, and, above all, the want of a sufficient public to criticise, to supervise, to applaud, and to reject. Such is the state into which fortification has come in this country and in some others, since it has ceased to command the sympathies and co-operation of the general world of science.

Neither in classic times nor on the revival of learning was there such restriction, and we therefore find among the professors of fortification many most eminent men of science. To say nothing of Archimedes and his ancient prototypes, Albert Durer, Michael Angelo, and San Micheli are examples of military engineering practised by men whose ordinary pursuits were of a far milder character. Fortification is at present so little of an art, and still less of a mystery, so far as any practical and useful application is concerned, that its technical acquirement does not require any extraordinary study or labour. There is, therefore, no real incongruity in a work on fortification by an architect; it is *selon les règles*, and will remind Professor Hosking of military architecture, —and we welcome Mr. Fergusson's essay because it is likely to do much good, directly and indirectly.

It is a strange beginning for an essay on any art, to assert that it is in a most unsatisfactory and imperfect state; and yet the writer has very good authority in his behalf, and it bespeaks some boldness that he should apply himself under such circumstances. Military critics have, over and over again, pointed out the defects of the bastion system, and book after book has been written with a view to its amendment, without correcting the practical vice, because all exertion has been in a wrong direction. So far from any good being done, the efforts of reformers have mostly tended to improve the flanking defense, thereby introducing greater real weakness. The merest tyro is so impressed by the state of affairs, that he is naturally tempted to design some new outwork, or to improve those of the present system.

Those who have studied fortification for naval purposes must be forcibly struck with the antithesis and opposition of principles displayed in military and naval fortification. The military man does his best to get a perfect flanking defense—the naval man goes straightforward to work, and throws his whole strength into a direct fire. It will be found, too, that where a ship comes, under fair circumstances, in contact with a land battery, as our naval annals fully show,—the ship, by bringing greater weight of metal, comes off the conqueror. The best examples of fortification, moreover, are those most in accordance with nautical principles.

Thus the great amount of ability possessed by the military engineers of Europe is neutralised, because it is exercised in a wrong direction, and because there are wanting the sympathies of the allied professions. So little is known about fortification, that it is looked on as a mystery, and there are perhaps few civil engineers in this country who know anything of it, or have any desire to know. It is, nevertheless, very much to be wished that it formed part of professional studies, because an acquaintance with it would be calculated to produce very gratifying results. In the colonies, the civil engineer is often the only practitioner; and it is of great importance he should have sufficient knowledge, in case of a sudden emergency, to provide the requisite military works of defense. In this country, too, the arrangements of our harbour works are often, in a military point of view, prejudicial, because the engineer has no regard to military purposes; whereas some attention in this respect might mitigate the defenceless state of our coasts, and provide for their defense.

So far as military engineers are concerned, they would in every way gain by fortification being taught in the engineering colleges. There would be a greater body of practitioners, and therefore better and cheaper books and periodicals; there would be a greater association of intellect, and therefore an enhanced reputation to the professors of the art. Against this good there is no countervailing disadvantage to be set, because although civil engineers would sometimes be employed on military works, yet more military works would be executed, and there would be a greater reliance on the special practitioner. One advantage, which cannot be overrated, is that there would be a greater application in military art of the boundless resources of mechanical science, for which this country is so distinguished.

As there is no need for mystery in fortification, and as the art can be readily comprehended, none of our readers need feel any diffidence in taking up Mr. Fergusson's book; and they will be the more gratified, as it is a continuous appeal to their common-sense, and the exercise of their judgment. They have not to take anything for granted,—nothing is laid down *ex cathedra;* and they proceed to a perfectly independent and impartial investigation, carried on by themselves as much as by the author.

Mr. Fergusson's great canon we take to be the weighing each scheme by the money-worth, which constitutes a practical test, admissible anywhere, but peculiarly acceptable in this commercial country. He thus gets a standard on a subject which hitherto has been without one of a satisfactory character, and he secures the sympathy and attention of all those who are interested in the national expenditure and defense.

Our writer takes the opportunity of adverting to the anomaly, which is received indisputedly by so many, that since the invention of gunpowder the art of attack is superior to the art of defense, though, as he afterwards shows, there is no reason either in theory or practice for any such notion. The besiegers and the besieged have the command of the like resources; and it is the quantity of these at the disposal of each, which must *cœteris paribus* govern the result. In simple terms, it is a fight of artillery, and, as in line battles, the relative proportion of this arm must exercise the greatest influence on the event.

Why, under such circumstances, fortification has become so ineffective that its works were virtually set aside by Napoleon in his campaigns, it does not seem very easy to explain,—and yet in reality it has arisen from increasing the flanking defenses, which are only wanted as a reserve; exhausting the resources on these works; neglecting the superiority of direct fire, and making no adequate provision against vertical fire. While the use of shells has been increasing, the construction of casemates and protected works has not kept pace with it; and now all that has to be done by an energetic commander is to burn the town with shells, and the *enceinte* falls into his hands, unbreached and unhurt, within eight-and-forty hours. The citadel of Antwerp held out, it is true, but the town was in other hands; and in the revolutionary wars now going on, a bombardment replaces a siege as the means of getting hold of a fortified town. It is very questionable, therefore, whether, in a military point of view, it is worth while fortifying towns, and the art of fortification must limit itself to intrenched camps, field works, batteries, and harbour defenses. Anything which can be shelled will be burnt, and no civil population will bear patiently this process. When, however, the houses have been burnt out, a town makes, as our writer says, a better defense for the invader than the home garrison.

We think it therefore perfectly useless to consider how an *enceinte* can be put round a town, and shall limit ourselves to consider the construction of a citadel, which will give the fairest example of the application of the several schemes of fortification.

The defects of the bastion system, as established by various authorities in the last and present century, and summed up by our author, with some additions of our own, are, that its works are

1st. Liable to be enfiladed.

2nd. They want direct fire to their most exposed parts, the salients.

3rd. Their flanking defenses are insecure.

4th. Want of combination and co-operation between the faces after the besieger has reached the counterscarp of one, which therefore becomes isolated.

5th. Their entire exposure to vertical and plunging fire from ricochet and shells.

6th. Want of security in communicating with the outworks.

7th. The advantage of position each outwork taken gives to the besieger.

8th. The insecurity and inconvenience of the covered way.

9th. The exposure of the reserve pieces to the tirailleurs in the last stage of a siege.

10th. The effect of the earthworks in damping, rotting, and forcing out the brick and stone revêtements.

11th. The necessity for a disciplined and well-trained garrison.

12th. The small real service rendered in holding out against an enemy.

13th. The moral discouragement of the soldiery.

14th. The enormous expense.

Fortifications of the first class are indeed of very little good, and cost an enormous sum, and strategists make very little account of them. They never materially delayed Napoleon's advance, and did not delay his fall, although all that he could himself suggest, and all that Carnot could do, was exerted for the improvement of the internal fortresses of France. The student cannot fail to be gratified by the sight of the cordon of first and second class fortresses on the French and Belgian frontiers; but if he sets to work to calculate how an army would be moved among them, he receives but a very moderate impression of their value, for they would only be attacked when their defense, politically speaking, was no longer possible. In fact, so strongly impressed does the strategist become with these ideas, that he is apt to conceive but a contemptuous opinion of the resources of fortification,—and none the less for knowing its little merit as a branch of instruction.

Mr. Fergusson has set himself to remedy the defects pointed out, to get a cheaper system, works that shall hold out longer if not entirely, and a superiority of material resources for the defenders.

He adopts a circular system, without outworks, with a wide wet ditch, and an *enceinte* of several ramparts, rising within and above each other. Great part of the works is casemated, and the magazines are put in greater safety. On the works is mounted a heavy armament of guns and mortars, superior on each face (of construction) to any field-train which has yet been brought out. His flanking works are kept low down, and beyond the reach of direct fire. These works he proposes to construct on a cheap and simple plan. Altogether, we think he has made out a good case, and one which cannot well be upset.

This scheme was laid by him before the editors of the 'Professional Papers of the Royal Engineers,' but, for some reason we know not, they were refused. This is rather singular, for the most valuable contributions in those volumes are on civil engineering works, and by civil engineers, and Mr. Fergusson's contribution was on military engineering. It is however stated, there was an examination by an officer of the Royal Engineers, of high attainments, who raised many objections to Mr. Fergusson's plans. This could be no sufficient bar to the publication of the paper, which, if erroneous in some details, was of professional interest. Now it has come before another tribunal, it can be ascertained that it is a work of particular merit. If the piecemeal objections of an officer of engineers are to be thus authoritative, we may at once dismiss from our studies Montalembert, Carnot, Choumara, Merkes, Bordwine, Fergusson, and every innovator. In other words, we close the way to discussion and improvement. The rejection was the more ungracious, as there is no other professional serial in which such a paper could be conveniently published. It is fortunate Mr. Fergusson's zeal and means overcame this impediment, and led him to the publication of a separate book, which, as matters turn out, is likely to prove much more influential.

Mr. Fergusson assumes that the effect of construction must, under any proper armament, give an advantage to the fortress as against the besieger. This he asserts on several grounds, as these —the former works are better constructed; they have heavier guns, more mortars, and are better covered in; they cannot be scaled. Therefore a defending force must be able to contend with a greater number of assailants. It is this condition which must be maintained permanently.

Our writer prefers wide and deep wet ditches, because they defend themselves, and because he wants no outworks. Though he provides the means of sortie for the purpose of keeping the enemy constantly on the alert, and thereby diminishing their working force, he justly deprecates sorties, as leading irreparably to the diminution of the *personnel* of the garrison. He is speaking of a normal system: of course he would want outworks to take in positions necessary for defense, and would likewise want the means of sortie in such cases, to delay their fall or to recapture them.

It is in getting rid of the outworks that he does the most good, for thereby he gets rid of a great source of harass and weakness. The outworks must be defended from the place, and the place is thereby made subservient to the outworks, instead of looking only to its own defense. More men, too, are lost in outworks than they could be in the body of the place, and thereby the strength of the garrison is impaired. Outworks can never adequately defend themselves, for so few guns can be mounted on them; neither can the place adequately protect them. Every face of the outwork becomes a prolongation of an enemy's battery, and the whole work is therefore taken in detail, and becomes a harbour for the enemy. When the French did so at Antwerp, they had achieved a success, for they got under cover. It is like unravelling a bit of knitting —one mesh loose will undo the whole. An outwork is reduced, the enemy gets up to one face, reduces that, and the whole place falls, with the smallest expenditure of means. To make an attack on two or three faces harasses the garrison, and gives other chance of success: but in truth it is hardly essential.

The author has provided for dry ditches because there are situations where water cannot be got, and he is thereby driven into greater expense; but he still resists the addition of outworks.

On a face of 400 yards, Mr. Fergusson gets so much room that he can mount 1,000 guns and mortars. This will appear monstrous to the common school, but it is the right way and the only way. What is to be done everywhere is to get the greater number of pieces and weight of metal. The system is particularly applicable in England, as we have such vast establishments; we could, in case of need, cast 1,000 guns daily, besides iron shot. The author allows for a field-train of 200 pieces being brought up, and against one face; though the largest train yet brought up against a place, and that through a peaceful country, was the French train of 144 pieces, for the siege of Antwerp in 1831. From what we saw of this we are sure it is a feat which could not be easily managed in a hostile country, and it is not likely to be paralleled for some time in the state of warfare now going on.

Assuming that 200 guns are brought up, it does not seem easy, as our author says, to bring them all, or any considerable number, to bear from the first parallel on any one face. Their effect, too, would be limited to that of direct fire; and it is difficult to contemplate what good they could do in a flat, open country, towards the reduction of the place. It must be remembered here is no enfilade work and very little chance of dismounting guns, while the besiegers' guns are exposed, even under blindages. The fire of the place cannot be reduced and silenced, and the place cannot be reduced *de vive force*. The assumption that the besieger could sap up to the edge of the ditch, and then establish his batteries and silence the fort over a sufficient breadth of rampart to enable him to effect a passage across the ditch, seems quite untenable. Indeed, by all the ordinary modes of superficial offensive works, it appears impossible to get near the place, unless by a casualty; neither does mining offer greater promise.

The author has devoted considerable space to revêtements and the details of construction, and which will be read with interest. He relies as far as possible on earthworks, and the masonry revêtement he endeavours to keep down below the direct line of fire. His revêtement, too, is not a mere retaining-wall, but is detached to a great extent from the earth body. It thus becomes a kind of fender to keep off escalade. His reasons for this cause are very satisfactory. In this, as in other details, he has followed Chasseloup, Carnot, and other authorities, but with many modifications.

Having provided for the defense against direct fire, the next point is against vertical fire; and as our author keeps a greater weight of mortars, and a sufficient cover by casemates, he may be regarded as having done his duty in this respect. He adopts casemates on the system of General Haxo, which are open in the rear (and therefore, free from smoke), drier, and better ventilated. The modifications here suggested as to these casemates are, so far as our knowledge extends, practical and valuable. He likewise introduces mortar and steam-gun casemates.

The plans for powder-magazines are ingenious, but we are far from being satisfied as to the result of the wilful or accidental explosion of one of these.

CANDIDUS'S NOTE-BOOK,
FASCICULUS XCVI.

> "I must have liberty
> Withal, as large a charter as the winds,
> To blow on whom I please."

I. Whether Mr. Ruskin's "Lamps" will much enlighten our architects, remains to be seen. What their opinion generally may be of his book I know not; but I do know—at least, have heard, that some of them scruple not to call it "very queer stuff;" and perhaps the majority of them fancy that their own little Lamp of Copyism is better worth than all his seven. Be that as it may, quite certain it is that his Lamps have enlightened the gentlemen of the public press, many of whom have now for the very first time touched upon the subject of Architecture, and have become all at once exceedingly critical upon it; speaking, if not with *dog*-matism, most assuredly with abundance of *puppy*-ism, puff included. This sudden light, it may reasonably be suspected, is derived not so much from the book itself as from the circumstance of its authorship, and from the nimbus that plays around the temples of the "Oxford Graduate;" the probability being that had it appeared with the name of plain John Ruskin, and under a less mystical title, the daily papers and the reviews would never have touched it at all, or been able to make anything of it; whereas, now, having got their cue, they go into raptures accordingly, and bestow if not very "sincere admiration"—as Mr. Ruskin himself does on the British Museum—at least, sufficiently well counterfeited admiration, chuckling, perhaps, all the while at the idea of having imposed brummagem upon John Ruskin, which he will clutch at, and pocket as fine gold. Speaking of his book, the *Morning Post* assures us that "ladies may read it;" which would seem to imply that there is so much indelicate and *paw-paw* stuff in architectural books in general as to render them very objectionable and unfit reading for ladies. No doubt ladies may read it very safely; the only doubt is, whether they can understand a writer who appears very frequently not to understand himself, at least shows himself unable to explain his meaning intelligibly, but flounders about in mere high-sounding verbiage; which, being high-sounding, has been taken by some for eloquence fraught with feeling, and—"feelosophy." As a specimen of such, the *Dublin University Magazine* quotes the following super-sublime passage: "For, indeed, the greatest glory of a building is not in its stones, nor in its gold. Its glory is in its age"—*quære*, its per cent-*age*—"and in that deep sense of voicefulness, of stern watching, of mysterious sympathy, nay, even of approval or condemnation, which we feel in walls that have long been washed by the passing waves of humanity," &c., &c.! Of course this is, or ought to be, exceedingly fine, it being evidently intended to be so; but to me, who am not one of the enlightened, it appears to be the merest babbling and gabbling,—certainly what any lady may read, but also what any "old lady" might write. I should like to have that "deep sense of voicefulness" interpreted into honest plain English; also "washed by the passing waves of humanity." By "washed," does Ruskin mean "white-washed?" And what, again, does he mean by "the waves of humanity?" Possibly it is merely owing to the thickness of my own skull; but I must confess that many of his sentences and expressions appear to me no better than the veriest jargon of tawdry sentimentalism and cant, and of the most disgusting affectation.

II. Curious, at all events, it is, that those who pretend to applaud him to the skies, give him no credit for, nor take any notice of some of his most striking and original opinions—such, for instance, as his unqualified condemnation of our English "Perpendicular" style, and "our own Tudor," which he affirms to be "an ugly and impotent degradation!" notwithstanding that it has been adopted for the new "Palace of Westminster,"—which costly edifice, by-the-by, is treated very cavalierly by Mr. Fergusson, who more than hints that we are already tired of it before it is finished.—Just now, the epithet "Detestable," which Kata-Phusin Ruskin so cavalierly applies to that style, is particularly ungracious and unsavoury. "It adopts," he says, "for its leading feature, an entanglement of cross bars and verticals, showing about as much invention or skill of design as the reticulation of a bricklayer's sieve!" What an awful thunderbolt is hurled there! Fortunate then is it, that whomsoever else it may strike, it has not *struck* any of Mr. Ruskin's own reviewers; nor have they been at all shocked by it. It is true what Mr. Ruskin says concerning that style does not amount to much in mere words, but the opinion itself amounts to nothing less than the most violent and unqualified condemnation of the style which is followed for the greatest architectural undertaking of the present age—a structure in which what he thinks constitutes the viciousness of the style has, instead of being at all moderated, been carried to the utmost excess. In one respect, perhaps, the comparison he has made holds good, inasmuch as we detect the character of a sieve in what has drained away so much money. Briefly as Mr. Ruskin's depreciatory opinion is expressed, we cannot possibly suppose that it was uttered hurriedly and unguardedly, because he himself says: "I have always spoken with contempt of the Tudor style;" and his comparison certainly does indicate contempt in the most marked manner. Had it been uttered by almost any one else, such opinion might have been disregarded and left itself to contempt; but coming from the quarter it does—from one for whom his reviewers prophecy that he will henceforth be a standard and paramount authority in matters of taste and art, such emphatic denunciation of that particular style is particularly unfortunate. Shall we say that Mr. Ruskin is decidedly in error there?—that would be awkward; because, if he has fallen into an error of such magnitude—so extensive for injustice of opinion and insensibility of taste as to condemn one entire style, one moreover that may be called peculiarly English,—what is to assure us that many other of his peculiar opinions are not equally erroneous; or how is he to be trusted as a safe guide? Besides which, to admit him to be in error there, would be also accusing his critics either of singular stupidity in not detecting it, or of flagrant violation of their duty in not warning us against it; also of want of tact, because a few remarks of a contrary tendency would have served to give some value to their praise, and would have corrected its nauseating fulsomeness, which last must, I think, be far less gratifying to Mr. Ruskin himself than to his publishers; since he himself must be well aware that the "Opinions of the Press," as they are called, can do little or nothing in securing permanent reputation for a work like his, it being on a subject on which the so-called "gentlemen of the press" know no more than their own readers.

III. What with his off-hand wholesale condemnation and somewhat flippantly-uttered abuse of the Perpendicular and Tudor styles, his extravagant praise of the Doge's Palace at Venice, and his "sincere admiration" of the British Museum,—Mr. Ruskin shows himself to be a decided nonconformist in architectural taste, and, as far as the first-mentioned styles are concerned, to go directly against the popular current. Nevertheless, such nonconformity and utter disregard of prevailing prejudices, have been somehow or other overlooked by his reviewers, either owing to their obtuseness or to their dishonesty—perhaps their cowardice. Now, I myself am—certainly ought to be—the very last to find fault with Mr. Ruskin for freely giving vent to his own opinions,—in some of which he is likely to stand quite alone; but it surely was the duty of his critics to prepare *their* readers for what must have caused some of them to make wry faces. His tirade against "that treacherous phantom which men call Liberty," must shock not a few; his sneering at the idea of anything being done for Art by "pottery and printed stuffs," will not obtain him friends in the manufacturing districts or schools of design; and his utter aversion to Railroads and Railway travelling, cannot fail to scandalise a very numerous class indeed, if we include the holders of shares. Little would it have mattered what he himself says, did not his reviewers assent to and sanction such exceedingly *outrageous* actions by their silence, instead of reprobating them, as they ought to have done,—if only to show, as they had a fair opportunity of doing, their own impartiality, and that they were not to be imposed upon by the *prestige* of the reputation previously acquired by the same writer's 'Modern Painters.' By that reputation the gentry of the press had their cue given them; they felt certain that they might praise safely—conscientiously is quite a different matter. Enough it was for them that they might, very safely to themselves, "lay it on thick;" and they have done so accordingly, *buttering* Ruskin over with their oily phrases in such manner that the butter actually drops off again. They might have spared their butter and their pains, for after all, *cui bono?*—what can toadying puff do for a work which aims at becoming influential?—and which if it ever so become, must be seconded by opinion, and very great change of opinion, in a different sphere from that of the public press, which, whatever it may be in other matters, shows itself to be in those of Architecture and Art equally empty-headed and hollow-hearted.

IV. "We want no new style of Architecture," says Ruskin, and very justly too; or did we so, we should never get one, if by a "new style" we are to understand a sudden transition to a system of architectural elements, forms, and combinations decidedly different from, and in no respect modelled upon, those which either now are or formerly have been in use. Yet such impossibility affords no argument at all for resisting, as we now strenuously do, all further extension and modification of the styles we profess to adopt. We merely think of copying them as closely as we can; and where they stop short, we stop too, through our inability to carry them on in the same spirit—or if not precisely in the same, in a congenial one. As Mr. Ruskin excellently well observes—it is in fact one of the most sensible and valuable remarks in his book—"A man who has the gift, will take up any style that is going, the style of his day, and will work in that, and be great in that, and make everything that he does in it look as fresh as if every thought of it had just come down from heaven. I do not say that he will not take liberties with his materials or with his rules; I do not say that strange changes will not sometimes be wrought by his efforts, or his fancies, in both. But those changes will be instructive, natural, facile, though sometimes marvellous; and those liberties will be like the liberties that a great speaker takes with the language, not a defiance of its rules for the sake of singularity,—but inevitable, uncalculated, and brilliant consequences of an effort to express what the language, without such infraction, could not. There may be times when the life of an art is manifested in its changes, and in its refusal of ancient limitations."—Most true: yet what with plodding servile copying, and slavish, superstitious adherence to precedent, Architecture has now, instead of an artistic, only a sort of artificial life. It is no longer permitted to grow with the growth of society, to keep pace with its advance, and with general improvement in other respects,—but is stunted, dwarfed, and crippled like the feet, or rather *pettitoes* of a Chinese lady. If we need no new style, we certainly do need, and that very greatly, much more freedom for those which we have and make use of.

V. Excellently well, again, does Ruskin point out the proper use and service of *Precedent*—namely, to guide and instruct, not to fetter and enslave, as it is allowed to do. "When we begin," he says, "to teach children writing, we force them to absolute copyism, and require absolute accuracy in the formation of the letters; as they obtain command of the received modes of literal expression, we cannot prevent their falling into such variations as are consistent with their feelings, their circumstances, or their characters. So, when a boy is first taught Latin, an authority is required of him for every expression he uses; as he becomes master of the language he may take a license, *and feel his right to do so without any authority, and yet write better Latin than when he borrowed every separate expression.*" In the same way, he goes on to observe, should "our architects be taught;" and in such way, in fact, do they seem to have been taught in former times, whereas now they are kept, or else are content to remain in a state of *schoolboyism* all their lives. Even those who may be supposed to have fully "mastered the language" of their art,—who at any rate have credit with the public for having done so, confine themselves to stereotype and therefore hackneyed forms and expressions, without venturing to show that it is in their power to vary them and impart freshness to them. On the contrary, they are but too apt to make a positive merit of what accuses them of want of artistic power, and of spontaneousness of thought and geniality of conception. So exceedingly humble is their ambition, that they are proud of showing with what admirable precision they can copy features and details, the pattern of which are taken—*stolen* is an ugly word—from other buildings or representations of them. Admitting, however, for a moment that mere copying gives us all that we now want or need ask for, an exceedingly ticklish and awkward question presents itself—namely, is it at all reasonable that mere copying—and what is more, mere mechanical copying—should be paid for at the same rate as original talent, or rather infinitely higher?—*Quo tendis?*—stop, stop in time, friend Candidus, and do not broach such an uncomfortable question as that. Consider, in by-gone times Genius was a fool, and exerted itself for fame; in our wiser and more enlightened age, mere Talent works for money alone. The substance, it seems, we cannot get, but at all events we pay liberally enough for the shadow of it, and be that our consolation.

VI. As in some other respects, Mr. Ruskin is not very consistent with himself when—although he says that we do not so much require a new style as one that should be universally followed—he recommends us to adopt for such universal purpose what would be to us altogether new. "The choice"—that is, for a style to be henceforth generally followed—"would lie, I think," he says, "between four styles:—1, the Pisan Romanesque; 2, the Early Gothic of the Western Italian Republics, advanced, as far and as fast as our art would enable us, to the Gothic of Giotto; 3, the Venetian Gothic in its purest development; 4, the English Earliest Decorated. The most natural, perhaps the safest, choice would be that of the last, well fenced from the chance of again stiffening into the Perpendicular."—Unlucky Perpendicular! how art thou flouted at, and spoken of contumeliously by Ruskin—who, of most assured certainty, will not find Charles Barry among the admirers of what one reviewer has termed "a book unique in our language." Now, for a universal style, or rather for the foundation of one that would be capable of being moulded to every one of the various architectural purposes required at the present day, the three first of those proposed by Mr. Ruskin are decidedly out of the question; and even the last is scarcely less so. It would, in fact, be utterly impossible to shape out of it a style accommodated to general usage, and which would conform to the conditions imposed by actual purpose. Is it for a single moment to be thought of as suitable for domestic and street architecture, or for secular buildings at all, in this nineteenth century? How can a style which is fit only for ecclesiastical buildings—on which account, perhaps, that and other mediæval styles are now affected for that particular class of structures, as markedly distinguishing them—be now constituted a universal style? We may adopt mediævalism for our churches, but we cannot possibly throw off *modernism* in our habitations, in our houses and our street architecture. Consequently, so long as we insist upon retaining the former, we shall never arrive at—no, nor even take a single step towards that *oneness* of style which Mr. Ruskin regards a *sine-qua-non* for the healthy condition of architecture,—and not of architecture alone, but of all the arts of design. For such desirable condition of art generally, among us, he asserts there is but one chance, "and that chance rests on the bare possibility of obtaining the consent both of architects and the public, to choose a style, and to use it universally." He himself, however, has, by what he recommends, rendered "bare possibility" a bare impossibility. Rather ought he to have said: Let us take up the system of building and construction now generally employed by us, and endeavour to work it up into one capable of answering worthily to all purposes and occasions, no matter how opposite they may be. Such was the course pursued by the modern Italian architects at the period of the so-called *Revival*, or Renaissance. The style which they then took up they employed for all purposes alike,—for both secular and ecclesiastical buildings—for both public and private ones; although not indeed with that judicious discrimination which they might have done. Yet, notwithstanding that he is of opinion an architect of talent can take up "any style that is going, the style of his day," and mould it to his purpose, Mr. Ruskin recommends us to endeavour to get an entirely new style,—one constituted quite differently from any one now in use, by modelling it upon that particular mediæval and ecclesiastical one which is now generally termed the Early Decorated English. Such being his opinion, it was incumbent upon him to endeavour at least to point out how far that style accords with existing conditions, and our present actual requirements. As he has not done so, we may reasonably question not only the propriety but the practicability of what he recommends; and which, even if practicable at all, would be no better than what Mr. Cockerell has justly called "disgraceful retrogression."

ON THE PADDLES OF STEAMERS.

On the Paddles of Steamers—their Figure, Dip, Thickness, Material, Number, &c. By Thomas Ewbank, Esq., City of New York. [From the *Journal of the Franklin Institute.*]

(*Concluded from page* 213.)

The foregoing experiments and remarks relate chiefly to the *figure* and *dip* of paddles. Other traits next solicited investigation; and, though neither prominent, nor promising any adequate reward for the requisite labour, they were thought worth attending to, since engineers will certainly be urged shortly to cast about for every means of adding, though ever so little, to the speed of steamers.

Buoyant or Displacing Paddles.

It had been imagined, that the resistance which fluids oppose to the sinking of bulky bodies in them, might be employed as an element of propulsion—that if close barrels, for example, were fastened to the arms of a wheel, their ends would act as paddles, and the force required to plunge them (equal to 62 lb. for each cubic foot of water displaced), also react favourably on the boat. To test this idea, eight square and tight boxes, 7 inches by 7, and 6 inches deep, were secured to the arms of one wheel, and set to work against the eight blades, No. 1, (fig. 3), on the other. The boxes required, very sensibly, more power to carry them round than any other tried, and were miserably deficient in pushing the vessel forward with it—certainly not equalling four of the competing blades. They produced quite a commotion in the water, carried large quantities over with them, and, could we have communicated sufficient velocity, would probably have formed a vertical ring of it. These boxes were, and should be, considered simply as unusually *thick* blades. All paddles are buoyant in proportion to their thickness.

Thickness of Paddles.

But though worthless in one respect, they were valuable in another, for they led us to the fact, or the law, that the propelling virtue of blades expands and contracts with their thickness. Thicken them till they touch each other, and they form a perfect drum, which could exert no more propelling power than a revolving grindstone;—reduce them to the thinnest plates, consistent with the strains they have to oppose, and in the same ratio that property is augmented in them.

The boxes were removed, and boards, $\frac{7}{8}$ths of an inch thick, and 7 inches square put in their places. These represented common plank paddles, and were found sensibly inferior to their metalline competitors, whose thickness was slightly less than $\frac{1}{16}$th inch. We next took away two of the latter, when no very obvious change in the boat's direction occurred. When two more were taken off, the remaining four were unable to contend with the wooden ones. These, it will be remembered, were $\frac{1}{7}$th the thickness of the boxes, and consequently inherited that proportion of their defects.

It was also very observable how much more water was raised by the boards than by the plates. It could not easily be cast off their blunt boundaries, but kept running over them, from one side to another—a fact rendered more distinct in the boxes. Nothing could declare plainer, that the sharper the dipping edges of paddles are made, the more back-water they throw off at the point where its departure is most beneficial: that is, when the re-action favours the vessel's progress—and, consequently, less is carried higher than the axis. A very little labour would impart this feature—in other words, would make their section a wedge. The resulting benefit would repay the expenditure a hundred-fold.

Compared to metal, wood approaches in its nature to sponge; water clings to it; its pores are absorbing vessels, that suck it in, and assist to retain it on the surface.

Here nature also confirms the positions arrived at. Extreme tenuity of blade is stamped with perfection by her. Hence we see it strengthened by reticulated bars in the wings of insects—by radial, angular, and tapering ribs in the fins and tails of fishes. An uniformly thick, and unsupported slab, like our paddles, is nowhere met with. We cannot imagine natatory or soaring organs, formed after such a pattern, without feeling the absurdity. The caudal propellers of fishes are necessarily thick where they join the bodies, but how rapidly is the substance diminished, and to a mere film, at their extremities, so much so, that they are often there torn and jagged, by accident or wear, as fishermen well know. There must, therefore, be some powerful reason for withholding the material—one that overbalances all inconveniences resulting from its absence; and what can it be but the thinner the blade, the more efficient as a propeller it is—the longer is its stroke, and the more effectual is the power that wields it. The same law prevails in the wings of birds; their outward boundaries are feathered off to almost nothing.

The reflection is irresistable. With what nicety and care nature perfects her propellers, and how clumsy and unfinished are ours; as if, forsooth, a vessel's progress did not depend upon them!

The last two experiments demonstrate, that the less water a paddle *displaces* by its volume, the more efficient it is; that all accumulation of material behind its acting face, beyond what is absolutely necessary to strengthen it, is injurious, and ought to be avoided. But how does this accord with the current practice? Oaken planks are universally employed, and I have heard more than one engineer assert, that the thicker they are the better! Because, said they, if their propelling property be not enhanced, it is not diminished, and their additional weight is a positive advantage, since the heavier the wheels are, the easier they work—the more uniform are their movements.

The *Gorgon*, an English steamer, had "large wheels and little power," so she used oak or pine scantlings, 5 inches by 6, or 6 by 8, for paddles. Had her managers been aware of the true effect of thick blades, they never would have adopted them with the view of economising power.

Paddle planks vary in thickness from 1½ to 3 inches. No sea steamers have them less than 2 inches. In the English vessels they are 2¼; in others, as the *Franklin*, they are 2½; in some of the largest class they are 3. The *Atlantic* and the *Pacific*, each of 3,000 tons, now building for the Collins' Line, are to have them 3 inches. The former is to have 28 blades; hence, united, they will form a solid mass, *seven feet* thick, in each wheel—just one-fifth of its diameter! They are to be 12½ feet long, by 34 inches; those of both wheels will, therefore, contain nearly 500 cubic feet of timber, and must displace that enormous volume of water at every revolution, by their submersion alone!—and, as we have seen, not only uselessly, but with a serious retardation of the vessel's headway, and waste of her motive power.

The wheels of the *Pacific* are to be 36 feet in diameter; each will have 30 blades, 11½ feet, by 3 feet; the solid contents of her paddles will, therefore, equal 517 cubic feet. Her loss from the same source will, therefore, be greater. In *every* revolution of *each wheel*, her paddles will lose 7½ feet of effective stroke, and those of the *Atlantic* 7 feet! Those of the ocean steamer *United States* are 2¼ or 2½ inches thick; they are 36 in number, but as they are "split," and attached on both sides of the arms, there are really 72. They certainly diminish the effective strokes of her blades, from 10 to 15 feet, in every turn of her wheels, startling as the assertion is.

Has the attention of engineers ever been turned this way? Or have they forgotten, that a volume of water equal to that of a boat's paddles, and every inch of material submerged with them, is neutralised as a resisting medium, as often as it is displaced by their immersion;—that water is to them what steam is to pistons—the more space the latter occupy in cylinders, the shorter becomes their stroke, because metal then takes the place of steam; the object to be moved crowds out the mover. Thicken a piston till it fills its cylinder, and the motive agent being wholly kept out, all motion ceases.

It is much the same with the paddles of a wheel. Let them fill up $\frac{1}{10}$, $\frac{1}{5}$, $\frac{1}{3}$, or $\frac{1}{2}$, of the circles they describe, and in those proportions they lose their virtue, because in the same proportion they displace, or push aside, the fluid agent on which their worth depends.

The *Atlantic* will lose *seven feet* stroke in every turn of her wheels. I leave to mathematicians to determine, how many more miles an hour she would make, if the loss were reduced to *seven inches*, by using ¼-inch iron, in place of 3-inch plank.

There are several interesting questions about paddles that yet require solutions, but as respects their thickness, there is no *mean* to seek; the thinnest is the best under all circumstances—thin, were it possible, as a lamina of mica. The only question is, What material will supply the thinnest sheets to resist the pressure they are to oppose? Plates of steel, I opine, will yet be adopted.

Number of Paddles.

The experiments of each day convinced us that, so far as propulsion is concerned, the fewer the paddles, the faster went the boat, so long as *one* at each wheel, or an area equal to the face of one, was kept in full play. A greater number in the water merely cuts it into slices, throws them into commotion and diminishes the resistance they should oppose to the blades. As a further elucidation of this fact, we tried, at the suggestion of Mr. B., four blades, 7 × 14, against the eight test ones, 7 × 7. The smaller number had a decided advantage over the greater, and the cause was visible: they had a full sweep, through an unbroken, undisturbed mass of fluid, and consequently produced, unabridged, their legitimate effects; while those on the other wheel—unusually small ($\frac{1}{3}$ or $\frac{1}{4}$) as their number was, compared to those on the wheels of steamers—following so quickly in the wake of one another, threw it into an uproar, causing eddies, whirlpools, and counter currents, and thus interfering with each other, necessarily produced inferior results.

We thought 8 of fig. 4 would be equally valuable as 24 of fig. 3, but the construction of our wheels prevented us from instituting a series of similar comparisons.

The number of paddles now employed is, generally, greater than formerly. For large vessels, 28 are usual; some have 24, and others 32. The English rule, said to be a good one, is adhered to by many American engineers, except when circumstances require a deviation. By it, there is a paddle for every foot of a wheel's diameter, which makes them stand 3 feet apart; there are boats in which they occur every 2 feet.

One object of their multiplication, is to equalise the jar of their striking the water, by increasing the number of the blows. With the same view, they are often split through the middle, lengthwise, and the inner half—that next the shaft—removed to the opposite side of the arm, as in the end view, fig. 26, thus *doubling*, in a manner, their number. All the British steamers have their blades thus arranged. The *Hermann's* 28 were thus made into 56; their efficacy was found to be reduced about 9 per cent. The value of their upper or inner halves has been ascertained to be about the same, for, when wholly removed, the lower portions have proved within 10 per cent. as effective as before. The blades of the *United States* are split, and disposed as in the figure. The true principle of breaking the jar of paddles striking the water, seems to me to be indicated in the blades 4, 5, 8, 9, 10, 14, 15, 21, 22, 23, 24, 25. Had the attention of engineers been led to it in the early days of steaming, the popular plan of avoiding the evil at the expense of a greater, would not have been sanctioned so long.

Fig. 26.

I observed the blades of the last-named steamer, a week after her recent return from Europe. *Seven* were submerged, or *fourteen*, if those on both sides of the arms are counted. She sailed on the 4th inst., for New Orleans with 8 (or 16) under water. The *Cherokee* left on the 1st inst., for Savannah, with *six* of her undivided blades below the surface. The *Washington* came in on the 6th inst., from Bremen, with *five* similar ones fully immersed on each side—four full ones and the halves of two others. The largest of our Sound and River boats have equal, if not greater numbers under. The *Vanderbilt*, 1,200 tons, has *five*, or *ten* halves, immersed in each wheel, when lying at her dock, and without passengers on board. The *Isaac Newton*, 1,200 tons, has similar wheels, and the same number of blades under water at once.

As sea steamers have little occasion to go stern forwards, the backs of the acting faces are occasionally dressed off, as shown by the outline of fig. 27. As far as the lower, or dipping, parts are concerned, this is an advantage; but, from the preceding experiments, it is seen how much more beneficially such blades would act, were those parts brought to a knife-edge, and their sections bounded by the dark part of the cut.

Fig. 27.

Arms of Wheels.

The practice of making the arms of paddle-wheels of uniform, or nearly uniform, dimensions throughout, is also wrong. They may, without diminution of strength, be reduced towards their extremities, and ought to be, since every inch of surplus material submerged in them, detracts from the work done by the blades. They should taper outwards, as Nature tapers the radial ribs in her propellers.

Coating Paddles with Materials that Repel Water.

If any substance can be found, durably to prevent paddles from being *wetted*, they would then carry over less water with them. We coated one set with grease (suet), and, while the water streamed uniformly over the faces of others, it adhered only in narrow streaks to these.

The lessons which the foregoing experiments teach us are:—

That, to render paddles of steamers more effectual, they ought to be fashioned, as far as circumstances sanction, after models furnished by Nature, so as to conform to her general practice of contracting surface when resistance is of little avail, and extending it when the latter is greatest—to give the largest portions of blades the longest strokes.

That the fewer the paddles on a wheel the better, provided *one* be always kept in full play;—and hence, that it would be more advantageous to point, or fork them, as proposed, to evade the jar of their striking on the surface, than so perniciously to split and multiply them, as the popular practice is.

That smooth and thin metallic plates should be substituted for the usual massive, water-soaked planks. (At present, perhaps, nothing better than boiler-plates, galvanised, could be adopted). That bolt-heads, nuts, cleats, straps, and every other projection, upon, or about, them, should be provided against. That the arms of wheels ought to be reduced at their outer extremities, and the immersion of all superfluous material carefully avoided. That, when wheels require balancing, or their momentum to be increased, the weights to be attached to the arms above the surface of the water.

To coat paddles, and parts that plunge with them, with varnish, or other substance that repels water, that the fluid, instead of being dragged up in volumes by them, may roll from them, as from the backs of diving birds.

Some persons smile at the idea of machinists studying nature; and such, on perusing the preceding suggestions, will deem it a sufficient reply, to remind the proposer, that steamers are not blackfish, nor paddles salmons' tails, nor petrels' feet.

But minds differently organised, think a glance into her workshops is never amiss, and that the longer the visit, the better for the visitor, since there is no art or contrivance, (and it is certain that, through eternity, there never can be one), which has not its prototype in her collections. If we find them not, it is because of inattention, or of an imperfect acquaintance with her stores. Perhaps we know not at which of her *ateliers* to inquire, or are not prepared to appreciate specimens laid before us when we enter.

It would be wrong to close this paper, without acknowledging many obligations to Mr. John Bell, of Harlem, by whose assistance the experiments were conducted; a gentleman whose judgment on general mechanics is not surpassed; and to Mr. Mott, for the use of a boat, and facilities for making the various paddles tested; to Messrs. Morris and Cummings, also.

Mr. Bell has matured a subtitute, which he proposes for paddle-wheels, consisting of two reciprocating arms on each side of a vessel. At their extremities are folding blades, or vanes, which open when sweeping in one direction, and close in the other. He dispenses with the cumbrous paddle-boxes, and leaves the deck nearly clear;—at the same time increases the sweep of the blades beyond what is practicable with wheels, by simply elevating (on framework resembling that of beam engines) the points of their suspension.

Note.—Since the above paper was written, I have seen in the *Journal of the Franklin Institute* for February, 1842, (3rd series, vol. 3, p. 102), an extract from the *Civil Engineer and Architect's Journal*, for October, 1841, by which it appears that Mr. Rennie was led, by his experiments, to substitute the diamond-shaped paddle (fig. 8) for that of the ordinary form. It is there stated that, "after a great variety of experiments, he found that a paddle-wheel of one-half the width and weight, and with trapezium floats, was as effective in propelling a vessel as a wheel of double the width and weight, with the ordinary rectangular floats." This agrees very well with my own results. Mr. Rennie states that the Admiralty had permitted him to fit H. M. ship *African* with these wheels, and he had perfect confidence in the success of the experiment; but I have not been able to find any account of the results of this trial upon a large scale.

Measures have been taken to secure by patent, the improvements developed by the preceding experiments.

ON WATER-WHEELS WITH VENTILATED BUCKETS.

On Water-Wheels with Ventilated Buckets. By William Fairbairn, Esq.—(Paper read at the Institution of Civil Engineers.)

Since the time of Smeaton's experiments in 1759, little or no improvement has been made in the principle on which water-wheels have been constructed. The substitution, however, of iron for wood, as a material for their construction, has afforded opportunities for extensive changes in their forms, particularly in the shape and arrangement of the buckets, and has given, altogether, a more permanent and lighter character to the machine than had previously been attained with other materials. A curvilinear form of bucket has been generally adopted, the sheet iron of which it is composed affording facility for being moulded or bent into the required shape.

From a work entitled 'Mécaniques et Inventions approuvées par l'Académie Royale des Sciences,' published at Paris in 1735, it appears, that previous to the commencement of the last century, neither the breast nor the overshot water-wheels were much in use, if at all known; and at what period, and by whom they were introduced, is probably equally uncertain. The overshot wheel was a great improvement, and its introduction was an important step in the perfecting of hydraulic machines; but the breast-wheel, as now generally made, is a still further improvement, and is probably better calculated for effective duty under the circumstances of a variable supply of water, to which almost every description of water-wheel is subjected. It is not the object of the present paper to enter into the dates and nature of the improvements which have taken place during the last and the present centuries. Suffice it to observe, that the breast-wheel has taken precedence of the overshot wheel, probably not so much from any advantage gained by an increase of power, on a given fall, as from the increased facilities which a wheel of this description, having a larger diameter than the height of the fall, affords for the reception of the water into the chamber of the bucket, and also for its final exit at the bottom.

Another advantage of the increased diameter is the comparative ease with which the wheel overcomes the obstruction of back-water. The breast-wheel is not only less injured from the effects of floods, but the retarding force is overcome with greater ease, and the wheel works for a longer time and to a much greater depth in back-water.

The late Dr. Robison, Professor of Natural Philosophy in the University of Edinburgh, in treating of water-wheels, says, "There frequently occurs a difficulty in the making of bucket-wheels, when the half-taught millwright attempts to retain the water a long time in the buckets. The water gets into them with a difficulty which he cannot account for, and spills all about, even when the buckets are not moving away from the spout. This arises from the air, which must find its way out to admit the water, but is obstructed by the entering water, and occasions a great sputtering at the entry. This may be entirely prevented by making the spout considerably narrower than the wheel: it will leave room at the two ends of the buckets for the escape of the air. This obstruction is vastly greater than one would imagine; for the water drags along with it a great quantity of air, as is evident in the water-blast, as described by many authors."[1]

Such were the opinions of one of our first writers on mechanical philosophy; but the evil has been subsequently much increased by attempting to form a bucket which should carry the water down to the lowest point of the fall. In these attempts, the opening became so contracted as to prevent the free admission of the water from the cistern into the buckets, and its free discharge at the bottom of the wheel.

In the construction of wheels for high falls, the best proportion of the opening of the bucket is found to be nearly as 5 to 24; that is, the contents of the bucket being 24 cubic feet, the area of the opening, or entrance for the water, would be 5 square feet. In breast-wheels which receive the water at the height of 10° to 12° above the horizontal centre, the ratio should be nearly as 8 to 24, or as 1 to 3, as shown in fig. 5. With these proportions, the depth of the shrouding is assumed to be about three times the width of the opening, or three times the distance from the lip to the back of the bucket, as from A to B, fig. 1, the opening being 5 inches, and the depth of shroud 15 inches.

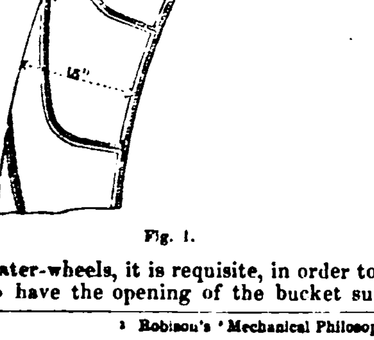


Fig. 1.

For lower falls, or in those wheels which receive the water below the horizontal centre, a larger opening becomes necessary for the reception of a large body of water, and for its final discharge, as shown in fig. 4.

In the construction of water-wheels, it is requisite, in order to attain the maximum effect, to have the opening of the bucket sufficiently large to allow an easy entrance and an equally free escape for the water, as its retention in the bucket must evidently be injurious, when carried beyond the vertical centre.

Dr. Robison further observes, "There is another and very serious obstruction to the motion of an overshot, or bucketed wheel. When it moves in back-water, it is not only resisted by the water when it moves more slowly than the wheel, which is very frequently the case, but it lifts a great deal in the rising buckets. In some particular states of back-water, the descending bucket fills itself completely with water, and in other cases it contains a very considerable quantity, and air of common density; while in some rarer cases it contains less water, with air in a condensed state. In the first case, the rising bucket must come up filled with water, which it cannot drop till its mouth gets out of the water. In the second case, part of the water goes out before this; but the air rarefies, and therefore there is still some water dragged or lifted up by the wheel, by suction, as it is usually called. In the last case, there is no such back-load on the rising side of the wheel, but (which is as detrimental to its performance) the descending side is employed in condensing air; and although this air aids the ascent of the rising side, it does not aid it so much as it impedes the descending side, being (by the form of the bucket) nearer to the vertical line drawn through the axis."[2]

These were the difficulties under which the millwrights of Dr. Robison's time laboured; and the remedy which they applied (and which has since been more or less continued) was to bore holes in what is technically called the 'start' of the bucket. This was the only means adopted for removing the air from the buckets of overshot wheels, in order to facilitate the admission and emission of the water. In lower falls, where wheels with open buckets were used, or straight float-boards radiating from the centre, large openings were made in the sole-planking, exclusive of perforations in each bucket, in order to relieve them from the condensed air. The improved construction of the present time is widely different, the buckets being of such a shape as to admit the water at the same time that the air is making its escape.

During the early part of 1825, and the two succeeding years, two iron water-wheels, each of 120-horse power, were constructed in Manchester for Messrs. James Finlay and Co., of the Catrine Works, under the auspices of the late Mr. Buchanan, and also for the same company at Deanston, in Perthshire, of which firm Mr. James Smith (Deanston) was then the resident partner. Those wheels are still in operation, and taking them in the aggregate, they probably rank, even at the present day, as some of the most powerful and the most complete hydraulic machines in the kingdom. The construction of these wheels, and others for lower falls, first directed the author's attention to the ingress and egress of the water, and led to the improvements which have since been introduced by him.

The object of these modifications may be generally stated to have been, for the purpose of preventing the condensation of the air, and for permitting its escape, during the filling of the bucket with water, as also its re-admission during the discharge of the water into the lower mill-race.

Shortly after the construction of the water-wheels for the Catrine and Deanston Works, a breast-wheel was made and erected, for Mr. Andrew Brown, of Linwood, near Paisley. In this it was observed, when the wheel was loaded, and in flood-waters, that each of the buckets acted as a water-blast, and forced the water and spray to a height of 6 or 8 feet above the orifice at which it entered. This was complained of as a great defect, and in order to remedy it, openings were cut in the sole-plates, and small interior buckets were attached to the inner sole, as shown at *b*, *b*, *b*, fig. 2. The air in this case made its escape through the openings *a*, *a*, *a*, into the inner bucket, and passed upwards, as is shown by the arrows, through *b*, *b*, *b*, into the interior of the wheel. By these means it will be observed, that the buckets were effectually cleared of air whilst they were filling, and that during the obstructions of back-water, the same facilities were afforded for its re-admission, and the discharge of the water contained in the rising buckets. The effect produced by this alteration could scarcely be credited, as the wheel not only received and parted with the water

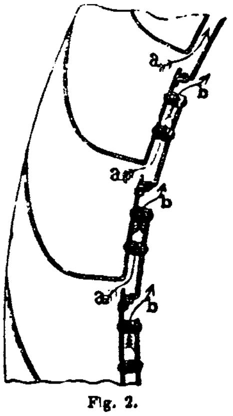


Fig. 2.

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[1] Robison's 'Mechanical Philosophy,' vol. ii. p. 598.

[2] Robison's 'Mechanical Philosophy,' vol. ii. p. 599.

freely, but an increase of nearly one-fourth of the power was obtained, and the wheel, which still remains as then altered, continues, in all states of the river, to perform its duty satisfactorily.

The amount of power gained, and the beneficial effects produced upon Mr. Brown's wheel, induced a new and still greater improvement in the principle of construction: the first wheel erected on this, which has been called the 'ventilated' principle, was one designed for Mr. Duckworth, at the Handforth Print Works, near Wilmslow, in Cheshire. This wheel was started in 1828. The improvement of the breast-wheel, with the close sole and ventilated buckets, as shown in fig. 5, followed immediately thereon.

Close-bucketed wheels labour under great difficulties when receiving the water through the same orifice at which the air escapes, and in some wheels the forms and construction of the buckets are such as almost entirely to prevent the entrance of the water, and to deprive the wheel of half its power. These defects may be easily accounted for where the water is discharged upon the wheel in a larger section than the opening between the buckets: under such circumstances the air is suddenly condensed, and, re-acting by its elastic force, throws back the water upon the orifice of the cistern, and thus allows the buckets to pass without their being more than half-filled. Several methods have been adopted for relieving them of the air: the most common plan is, by cutting holes, as before mentioned, in the sole-plates, close to the back of the buckets, or else making the openings between them much wider, in order to admit the water, and at the same time to allow the air to escape. All these remedies have been more or less effective; but they labour under the objections of a great waste of water and much inconvenience, by the water falling from the openings, down upon the lower part of the wheel, exclusive of the puffing and blowing when the bucket is filling. Other remedies have been applied, such as circular tubes and boxes attached to the sole-plates, which, extending upwards, furnish openings into the interior of the wheel for the air to escape; but these, like many other plans, have been, to a certain extent, unsucessful, owing to the complexity of their structure, and the inadequate manner in which the objects contemplated were attained. In fact, in wheels of this description it has been found more satisfactory to submit to acknowledged defects, than to incur the trouble and inconvenience of partial and imperfect remedies.

In the improvements made by the author, these objections are to a great extent removed, and a thorough system of ventilation has been effectually introduced. Before entering upon the description of this new principle of ventilation, it is necessary to remark, that in climates like Great Britain and Ireland, where the atmosphere is charged with moisture for six or seven months in the year, it is no uncommon occurrence for the rivers to be considerably swollen, and the mills depending upon water are either impeded or entirely stopped by back-water; while at other times a deficiency of rain reduces the water-power below what is absolutely required to drive the machinery. On occasions of this kind, much loss and inconvenience is sustained, particularly in mills exclusively dependent upon water as a motive power, and where a number of work-people are employed.

On the outskirts of the manufacturing districts, where the mills are more or less dependent upon water, these inconveniences are severely felt; and in some situations these interruptions arise as frequently from an excess of water as from a deficiency in the supply. To remedy these evils, reservoirs have been formed, and wheels have been constructed to work in floods; but although much has been accomplished for diminishing these injurious effects, and giving a more regular supply in dry seasons, yet the system is still imperfect, and much has yet to be done before water can be considered equal, as a motive power, to the steam-engine, which is always available where the necessary fuel is at hand. It is therefore obvious, that any improvement in the construction of water-wheels, whereby their forms and requirements may be the better adapted to meet the exigencies of high and low waters, will contribute much to the efficiency and value of mills situated upon rivers subjected to the changes before alluded to.

Ventilated Water-Wheels as adapted to Low Falls.

The first wheel constructed upon the ventilated principle was erected at Handforth, in Cheshire, in the summer of 1828; it proved highly satisfactory to the proprietors, Messrs. Duckworth and Co., and gave such important results as to induce its repetition, without variation, in cases where the fall did not exceed the semi-diameter of the wheel.

In the earlier construction of iron suspension wheels by the late Mr. J. C. Hewes, the arms and braces were fixed to the centres by screws and nuts upon their ends, as shown in *fig.* 3. The arms *c, c* passed through the rim *b, b*, and the braces *e, e*, which traverse the angle of the rim at *f, f*, are, as nearly as possible, in the position and form adopted by Mr. Hewes. This arrangement, although convenient for tightening up the arms and braces, was liable to many objections, arising from the nuts becoming loose, and the consequent difficulty of keeping the wheels true to the circle, and the arms and braces in an uniform state of tension: gibs and cotters were therefore substituted for the nuts and screws, and since their introduction into the large wheels of the Catrine Works, Ayrshire, the objections have been removed, and the arms and braces are now not only perfectly secure, but the periphery of the wheel is retained in its true and correct form. It will not, therefore, be necessary further to explain this part of the structure, as the engravings are not sufficiently explicit to give a correct idea of all the parts.

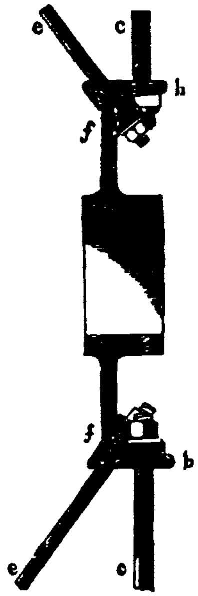

Fig. 3.

Having noticed the obstructions offered to the entrance of the water into buckets of the usual form, and the consequent loss which ensues from its retention upon the wheel, after its powers of gravitation have ceased, it may be necessary to show the means whereby those defects were removed, and also to exhibit the relation existing between the breast and the undershot wheels. These terms have, however, become nearly obsolete, as every description of water-wheel may now be properly called a breast-wheel; and in every fall, however low, it is generally found advantageous for the water to act by gravitation, and not by impulse, as during the earlier periods of the industrial arts. If the process of filling and emptying the buckets of the wheels shown in figs. 4 and 5, be traced respectively in each, it will be found, that in the event of a large body of water being discharged into the bucket at D, fig. 4, it could not be filled if the opening at *g* was closed, and the air was prevented from escaping in that direction. Under these circumstances, the air would be compressed and pent up in the bucket, and the water prevented from entering, or be blown out, as already described. Now this is not the case when they are properly ventilated, as a perfectly free passage is constantly open for the escape of the air, in the direction of *g*, and an equally free entrance is again afforded for the water at D; the passage for the escape of the air being represented by the direction of the arrows through the openings *g, g, g*, fig. 4, and also the connection of the buckets with each other by rivets and tubular blocks. When a wheel of this description is heavily loaded, a small quantity of water will sometimes escape along with the air, above the lip of the outlet *g*, into the interior of the wheel; but that is of little consequence, as it is again received into the buckets as it falls upon the wheel; and even this defect may be removed by carrying the edge of the plate higher upon the sole of the upper bucket. For low falls, the length of the tail side of the buckets will, however, be found, in practice, quite sufficient, either as regards the economy or the distribution of the water.

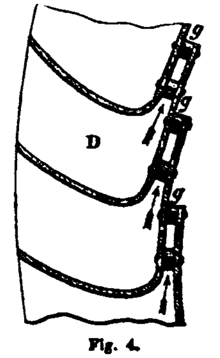

Fig. 4.

Having treated of the entrance of the water into the buckets, it is necessary to describe the facilities afforded by this constructio for its discharge. A quick and easy outlet for the water, when no longer required upon the wheel, is as important as an expeditious inlet; and it is evident that every drop of water which is carried by the wheel beyond the vertical line of the centre, is so much useless absorption of its power: moreover, in the construction of the bucket for the reception of the water, strict reference should also be had to its free and uninterrupted discharge. Another main point for consideration is the distance to which the water is carried by its momentum, or centrifugal action, when leaving the wheel; and it will be found advantageous to effect the discharge of the water as soon as the bucket passes the lower edge of the stone-breast. This discharge being seldom accomplished in time, in the old wheels, was a serious counterpoise to the power of the wheel, as the ascending buckets carried with them portions of the water to a considerable height, on the opposite side of the vertical centre. In the improved construction, this defect is obviated, as the opening which allows the air to escape, during the filling of the buckets, re-admits it with the same facility during the discharge: there cannot, consequently, be any formation of a partial vacuum, and the wheel not only works easily, but to a much greater depth in the back-water. It has also been found necessary, in order to facilitate the escape of the water, to terminate the breast at a distance of about 10 inches from the vertical centre, and always to have a depth of from 18 inches to 2 feet of water under the bottom of the wheel.

These are considerations of some value, as the abrupt termination of the breast admits of a much quicker discharge of the water from the buckets, and the increased depth of the tail-race gives room for its escape, after it has passed from the wheel. In fact, the benefits arising from this form of breast, and tail-race, are so great, that they should be strictly enforced, where it is desirable to have the full and effective use of the fall. In the erection of water-wheels, these principles should never be lost sight of; and instead of a shallow tail-race, with the water running from the wheel at a rate of from 6 to 8 feet per second, as is frequently the case with the old wheels, the current should be scarcely perceptible, and the water should always flow as steadily and as smooth as in a deep canal.

It would, perhaps, be difficult to describe with accuracy the properties and proportions of these improvements, without a long series of costly experiments upon a large scale; and in order to make the comparison perfect, the new and old forms of water-wheels should be placed in juxta-position, each having a proportionate load, and working, as nearly as possible, under the same conditions, both as to the fall and the supply of water. Under these circumstances, the great difference which exists between the one kind and the other would become apparent, not only as respects superior economy, but also the perfect ease with which the ventilated wheel overcomes the resistance of the load, and the obstructions of back-water to which wheels are subject in times of floods.

On some future occasion an opportunity may present itself for returning to this subject, when the superiority of water-wheels with ventilated buckets may be confirmed by more detailed experiments, and when the relative forms of wheels and buckets may be respectively established. For the present, it will suffice to observe, that the wheel already described will be found in practice exceedingly effective, and probably the best adapted, with certain modifications, for falls not exceeding 10 feet in height.

Breast-Wheels, with Close Soles, and Ventilated Buckets.

The preceding statements have been principally confined to the form of bucket, and description of water-wheel, adapted for low falls. It will now be necessary to describe the best form of breast-wheels for high falls, or those best calculated for attaining a maximum effect on falls varying from one-half to three-fourths of the diameter of the wheel. This is a description of water-wheel in common use, and is generally adopted for falls which do not exceed 18 feet in height, and, in most cases, is preferable to the overshot wheel. It possesses many advantages over the undershot wheel, and its near approximation to the duty, or labouring force, of wheels of the former description, renders it applicable in many situations, especially where the fall does not exceed 18 or 20 feet, and where the wheel is exposed to the obstructions of back-water. In the latter case, wheels of larger diameter are best adapted; and provided sufficient capacity is left in the buckets, such wheels may be forced through the back-water without diminution of speed. Every wheel of this kind should have capacity in the buckets to receive a sufficient quantity of water to force the wheel, at full speed, through a depth of five or six feet of back-water; and if these provisions are made, a steady uniform speed, under every circumstance of freshes and flood-waters, may be attained.

A water-wheel of this kind, of 100-horse power, was constructed for T. Ainsworth, Esq., of Cleator, near Whitehaven, about four years back, for driving a flax-mill; it is 20 feet in diameter, 22 feet wide inside the bucket, and 22 inches deep on the shroud. It has a close-riveted sole, composed of No. 10 wire-gage iron plate, and the buckets are ventilated from one to the other, as shown in the engraving, fig. 5. The fall is 17 feet, and the water is discharged upon the wheel by a circular shuttle, which is raised and lowered by a governor, as circumstances require. By this arrangement the whole height of the fall is rendered available, and the water, in dry seasons, may be drawn down from three to four feet, in order to afford time for the dam to fill, during the periods of rest, either during the night, or at meal-times.

In this wheel, the power is taken from each side by two pinions working into internal segments, and these again give motion to shafts and wheels, which communicate with the machinery of two different mills, at some distance from each other. The position of the pinion, or the point where it 'gears' into the segments, is of some importance in every water-wheel, but more particularly in those constructed on the suspension principle, which, upon inspection, will be found but indifferently prepared to resist a torsive strain, when the power is taken from the opposite side of the loaded arc of the wheel. Water-wheels of this construction, with malleable iron rods only 2 inches in diameter for their support, could not resist the strain, but would twist round upon the axle as a fixed centre of motion. It therefore becomes necessary, on every occasion, to take the power from the loaded side of the wheel, and as near the circumference as possible, in order to throw the weight of the water upon the resistance of the pinion, and that such resistance shall be at the point of the greatest velocity.

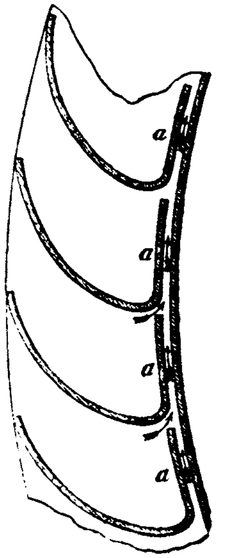

Fig. 5.

In the old water-wheels, where the power was generally taken from the axle, the whole of the force first passed through the arms to the axle, and afterwards by a pit-wheel, or some other multiplier of speed, to the machinery in the mill. Now, in the improved wheels, this is not the case, as the arms, braces, and axle have only to sustain the weight of the wheel, and to keep it in shape; and by the power being taken from the circumference, considerable complexity in the transmission of the power is avoided: a great saving is also effected when the speed required is greater than that of the wheel. It has already been shown that this description of wheel has a close sole; and on reference to the figure it will be found that the tail-ends of the buckets *a*, *a*, *a*, are turned up at a distance of 2 inches from the back of the sole-plate, and, running parallel with that part, terminate within about 2 inches from the bend of the upper bucket. The object of this construction is obvious, as the water in passing through the openings between the buckets drives the air before it, in the direction of the arrows at *a*, *a*, *a*, into the bucket above, and so on in succession, till each bucket is filled as it passes the aperture of the cistern from which the water flows upon the wheel. Irrespective of the advantages of clearing the buckets of air, additional benefit is obtained by the facility with which the water is discharged, and the air again admitted, at the bottom of the fall, during the period of the emptying of the bucket into the tail-race. This is strikingly illustrated where the wheels labour in back-water, as the ventilated buckets rise freely above the surface, and the communication being open from one to the other, the action is rendered perfectly free, at almost any depth to which the wheel may be immersed.

In breast-wheels constructed for falls of 25 feet or upwards, the stone-breast is not required, as the buckets are formed with narrow openings, and the lip being extended nearer to the back of the following bucket, the water is retained much longer upon the wheel. Under these circumstances, a stone-breast is of little or no value, when attached to a wheel with close buckets, on a high fall.

The construction of the breast-wheels, as above described, is almost exactly similar to that for the lower falls; malleable iron arms and braces being common to both, as also the axle, shroud, and segments. These, when duly proportioned and properly fitted to each other, form one of the strongest, and probably the most permanent structures, that can be attained in works of this description.

Common Breast-Wheel (not ventilated), as constructed by Messrs. Fairbairn and Lillie, between the years 1825 and 1827.

These wheels were executed upon the plan of the overshot or breast-wheel, taking the water at an elevation nearly equal to that of its height. Four wheels of this description were constructed for Messrs. James Finlay and Co., for a fall of 32 feet, at Deanston, in Perthshire, and two others, for the same firm, at the Catrine Works, in Ayrshire, on a fall of 48 feet. Taking into consideration the height of the fall, the Catrine water-wheels, both as regards their power and the solidity of their construction, are, even at the present day, probably among the best and most effective structures of their kind in existence. They have now been at work upwards of twenty years, during which time they have required no repairs, and they remain nearly as perfect as when they were erected.

It was originally intended to have erected four of these wheels at the Catrine Works, but only two have been constructed; preparations were, however, made for receiving two others, in the event of an enlargement of the reservoirs in the hilly districts, and more power being required for the mills. This extension has not yet been wanted, as these two wheels are equal to 240-horse power, and are sufficiently powerful, except in very dry seasons, to turn the whole of the mills. The water-wheels were so placed and arranged as to communicate their motion to a series of connecting cross-shafts, and by means of large spur-wheels and pinions, to transmit the united power of the water-wheels through large horizontal shafts to a cotton-mill at a considerable distance, and also by means of a pair of large bevel-wheels and shafts, to keep in motion another mill of equal magnitude, in another direction. These water-wheels are 50 feet in diameter, 10 ft. 6 in. wide inside the bucket, and 15 inches deep on the shroud; the internal spur segments are 48 ft. 6 in. diameter, 3¼ inches pitch, and 15 inches broad on the cog; the large spur-wheels are 18 ft. 2⅝ in. in diameter, 3¼ inches in the pitch, and 16 inches wide on the cog; and the pinions are the same width and pitch, but are 5 ft. 6 in. in diameter; the large bevel-wheels are 7 feet in diameter, 3⅜ inches in the pitch, and 18 inches broad on the cog, their proportions being calculated to convey the united power of all the four water-wheels, should the original design ever be completed. The water for the supply of the wheels is conveyed from the river Ayr in a canal and tunnel, and from thence, along the side of a rising bank, to the wheel-house. From this point it is conveyed to the water-wheels by a large sheet-iron trough, supported on iron columns. When viewed from the entrance, the two wheels already erected have a very imposing effect, each of them being elevated upon stone piers; and as the whole of the cisterns, sluices, winding apparatus, galleries, &c., are considerably elevated, they are conveniently approached in every part. Under the wheels is a capacious tunnel, terminating at a considerable distance down the river.

The shuttle, and the method of regulating the water to obtain uniform velocity, might also be noticed; but as these must vary with the locality in which the water-wheels are established, it is not necessary to enter minutely into a description of them.

Water-wheels on a principle introduced by M. Poncelet have attained some considerable reputation on the continent; and as the author has constructed one of them for Mr. De Bergue, it is necessary to allude briefly to the peculiarities it possesses. The buckets are of a curvilinear form, and are quite open at the back, without any sole-plate; so that they are perfectly ventilated. The water impinges upon them at nearly the lowest point of the wheel, the shuttle being arranged to draw upwards; and as the water enters, it follows the inside cavity of the bucket, rises and falls over into the next in succession, and so on. By this system the force of the water is expended on the wheel itself, instead of losing much of its power in rushing along through the wheel-race, as generally occurs in even well-made undershot wheels.

M. Poncelet has treated this subject at such length in his able work on water-wheels, that it is not necessary here to enter into further details; but it may be observed, that a practical improvement might be effected by terminating the lower stone platform of the race somewhat short of the vertical line of the centre of the wheel, as the escape of the water would be facilitated, and the ascending buckets would be more easily relieved of their contents: this is a point of such importance for all wheels, that it must equally apply to this form.

In this Paper, the turbine, with the improvements recently introduced in it by Fourneyron, Zuppinger, Whitelaw, and others, has been entirely omitted. There are many published statements relative to these improvements; but its limited employment in this country, up to the present time, scarcely renders it necessary to refer to it. It is, however, asserted that as much as ninety to ninety-two per cent. had been obtained from M. Fourneyron's turbine; but that gentleman, in a recent visit to this country, kindly furnished the author with data taken from several of his machines, which reduce the duty to a mean of seventy-two per cent. M. Zuppinger and Mr. Whitelaw do not claim a higher duty in their machines, the average being from seventy to seventy-four per cent. upon the theoretical value of the fall.

Remarks made at the Meeting after the reading of the foregoing Paper.

Sir J. **Rennie** said, Mr. Fairbairn's experience in the construction of water-wheels was so great, and the general remarks of the Paper were so accurate, that little could be added, and he was grieved to disagree with any point in it; but he could not accord with the statement of few improvements having been introduced since the time of Smeaton. Sir J. Rennie must claim some merit for his late father, who had both studied the theory and practice of water-wheels; and he would not permit Mr. Fairbairn to detract from his own merit, as he was universally acknowledged to be at least one of the most successful constructors of these machines. The late Mr. Rennie introduced the system of laying the water on to the wheel in a thin stream, not exceeding 10 inches in depth. In addition to this, and for the purpose of taking the utmost advantage of the fall, he used the curved moveable shuttle, and at the same time tried various curves for the buckets. It appeared that Mr. Fairbairn had directed his attention to nearly the same points, as there was great similarity in the machines, he having apparently taken the subject up where Mr. Rennie had left it, and the excellent result appeared in the statements contained in the Paper. Poncelet's experiments on this subject showed, that in some wheels constructed with curved buckets, but without sole-plates, and receiving the water almost like undershot wheels, an advantage of ten per cent. over the ordinary forms could be attained. The experiments of the Franklin Institute, made upon large wheels, were perhaps the most valuable. The greatest result obtained was, he believed, about sixty per cent. with a velocity of about 8 feet per second. As the opinion of Professor Robison had been quoted, it might not be uninteresting to state, that on one occasion he was consulted by his former pupil, the late Mr. Rennie, as to the best form and dimensions of a water-wheel, and that the result was a complete failure; proving that his practice was not as good as his theory. Some time since, it was expected that the turbine would, in a great measure, supersede water-wheels; but, however well they might be adapted for peculiar situations, they had not been generally introduced. Fourneyron brought the idea from Germany, and materially improved upon the construction, until, as he stated, about seventy-five per cent. of power was obtained from them; but he had never yet seen any turbine perform that amount of duty. Whitelaw's wheel followed, and was stated to have attained about the same power. These machines, however, were both difficult of construction, and did not appear to make progress among engineers.

Mr. **Fairbairn** regretted that he had not read an account of the improvements of the late Mr. Rennie, both before he had constructed the wheels, and when he wrote the Paper, as he could not have failed to benefit by following in the steps of so worthy a predecessor. The turbine had been noticed very cursorily in the Paper, because the subject had been nearly exhausted in the excellent Paper by Mr. Lewis Gordon,[a] and because that machine had really been but little employed in this country, although somewhat extensively on the continent. He had constructed one for M. Fourneyron, which had been sent to Italy, and was stated to have done good work. He had also erected one for Mr. Whitelaw in Yorkshire, for a fall of 120 feet. It was at first 2 feet in diameter, and made about 400 revolutions per minute, at which speed about thirty per cent. of power was obtained: it was then altered to 2 ft. 6 in. diameter, when about fifty per cent. was arrived at; and he believed that other alterations had still further improved its action. Some practical difficulties always occurred, such, among others, as the means of lubricating the main vertical spindle under water, which, for ordinary cases, tended to induce a preference for good water-wheels. Mr. Whitelaw had asserted, that with a good fall, as much as seventy or seventy-five per cent. of power could be obtained but M. Fourneyron did not anticipate more than seventy-two per cent. Mr. Fairbairn had seen abroad a kind of turbine working horizontally, which received the water, through pipes, from a very high fall, into curved buckets, upon the two opposite extremities of its diameter: the velocity was very considerable, and the power gained was stated to be great.

Mr. **Croker** said, one of the most successful of M. Fourneyron's turbines was erected at St. Blasieu, in the Black Forest, upon a fall of 350 feet. The diameter was 12¼ inches; and when the sluice was open about one-third of an inch, the machine made 2,250 revolutions per minute, with an expenditure of water not exceeding 60 cubic feet. The supply of water was derived from streams amongst the surrounding hills, and being collected into a reservoir, distant about three-quarters of a league from the turbine, was thence conveyed to it in cast-iron pipes, 18 inches in diameter. The turbine was used for driving a spinning factory, containing 8,000 water spindles, with the roving-frames, carding-engines, and all other necessary machinery. The duty of the machine was calculated, from experiment, to be equal to seventy per cent. of the water expended.

Mr. **Glynn** said, his custom in the construction of water-wheels had been to obtain free egress for the air by simple openings through the sole-plate into the interior of the wheel. The contrivance for conveying the air upwards, adopted in the wheels which had been described, was a decided improvement, and would tend materially to that regular filling and emptying of the buckets, without which uniformity of motion could not be insured; and for many of the fabrics manufactured by water-power that regularity was essential. The ordinary velocity of the wheel was about 6 feet per second; and with respect to the per centage of power obtained, when the water fell upon the wheel without impulse, and left it without velocity, he conceived

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[a] See 'Journal,' Vol. V. 1842, page 265.

that nearly all the power was used. He admired the details of construction of Mr. Fairbairn's wheels, particularly the arrangement for taking the lift on the loaded side of the wheel, and thus making the axle only the means of retaining the wheel in its place.

Mr. Fairbairn stated, in answer to Captain Moorsom, that he considered the form of the bucket did contribute materially to the regularity of motion. It was important to carry the water down as near to the vertical centre as possible, so as to get the best effect from it, and yet to begin to part with it as soon as that line was passed. That form was also found to fill better, and waste less water in times of drought, whilst it worked very easily, and without injury from back-water in times of flood. The ventilating wheels were not so essential for very high falls; they would be more expensive, and the measure of all benefit being the cost, he could not consider them of much advantage for high falls.

Mr. Beardmore thought that there was scarcely a situation in Cornwall to which this kind of wheel was applicable, as all the falls were very high. The wheels in that district were chiefly employed for working stampers, or for pumping. In neither case was regularity of action at all necessary: for pumping, an exertion of force was essential to raise the heavy plunger-rods, and then the wheel might run at any velocity during the other portion of its revolution; and before the next stroke was made, power was accumulated, by the extra filling of these particular buckets, the others possibly not having been more than half-filled: the millwright therefore gave plenty of bucket room, and ventilation was afforded at the extremities.

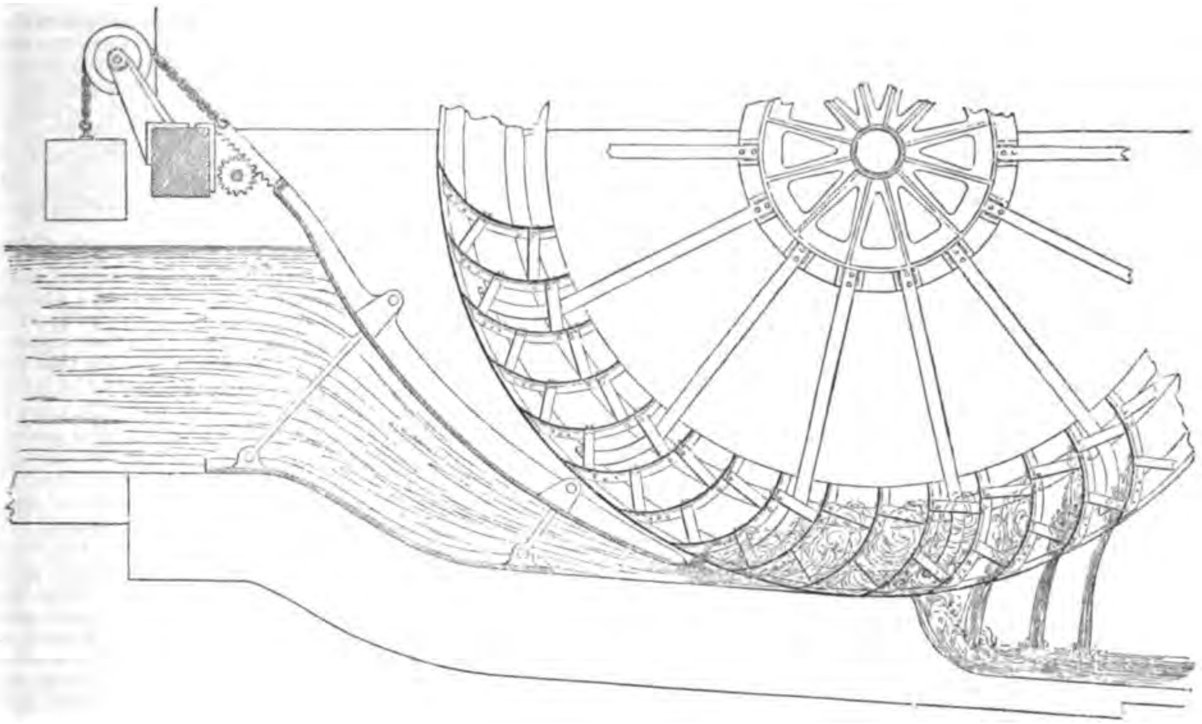

Fig. 6.—Water-wheel on Poncelet's system.

Mr. Wicksteed considered the wheels in Cornwall and those in Lancashire were so differently employed, that no useful comparison could be drawn between them. He thought, however, that no doubt could exist as to the advantages of Mr. Fairbairn's improvements, where steadiness of action, and the economical use of water, were required. He apprehended that some difficulty might occur in times of flood; but the form of the buckets was calculated to meet, to some extent, even that objection. Great attention appeared to be deservedly given to the angle formed by the bucket with the periphery, and he conceived that it was a question of importance, particularly in relation to the amount of strain upon the axis. Mr. Wicksteed had tried some experiments upon large-sized water-wheels, built both on Smeaton's and Rennie's systems, but had not obtained from them more than fifty-six per cent. of power: the velocity was generally about 6 feet per second.

Mr. Scott Russell had rarely seen better designed, or more ably executed machines, than these ventilated water-wheels, and he thought the profession was under obligation to Mr. Fairbairn for the improvement he had introduced. He might instance, especially, one point of importance; this was, the method of taking off the power, by inside gearing, from the loaded part of the periphery, thus avoiding all risk of straining the wrought-iron tension arms. Attempts had been made to improve upon the system, by taking off the power from the two sides of the wheel; but they had not been successful, as the gearing on both sides did not work well together, and a tremulous motion was communicated, which was very objectionable for spinning-mills, where it was important to obtain the utmost regularity of movement. He had heard it remarked, that the yarn spun by water-power obtained a higher price in the market than that produced by steam-power. Mr. Russell had tried some experiments on water-wheels, and found the radial breast-wheels give very good results, with a fall of about 14 feet, and the sluice and water-course so arranged as to bring the water on with as little velocity as possible, filling the buckets properly—which, however, could only be accomplished up to a certain speed without a system of ventilation. In high falls, this became even more essential, and, in fact, indispensable.

Mr. Fairbairn explained, that he had tried both methods of taking off the power, and preferred taking it from one side only, as, in addition to the other objections, when the gearing was fixed on both sides, the elasticity of the wrought-iron tension arms tended to break the teeth of the pinions. It could therefore only be done when the wheel was perfectly rigid. Mr. Strutt, of Derby, and the late Mr. Hewes, of Manchester, had made many important improvements in water-wheels, particularly those on the suspension principle, which appeared now to be acknowledged as the most advantageous construction.

Mr. De Bergue said he had obtained nearly seventy-eight per cent. of power from a breast-wheel, with a good fall, when the periphery was travelling at a velocity of 6 feet per second. He had erected several of Poncelet's wheels, and thought well of them; indeed, for certain situations he thought they were preferable to any other form, although M. Poncelet had never yet been able to obtain very superior results from wheels erected under his own superintendence. Mr. De Bergue then exhibited a drawing (fig. 6), and explained the construction of a wheel, on this principle, to be erected at the Loubregat, near Montserrat, in Catalonia; one of the same kind having been already erected by him at Gerona, between Barcelona and Bellegarde. The diameter was 16 ft. 8 in., and the width was 30 feet, which, with a fall of 6 ft. 6 in., passed 120,000 cubic feet of water per minute, when the periphery travelled at a velocity of 11 to 12 feet per second. An ordinary breast-wheel would require to be 90 feet wide, to use advantageously that quantity of water. It was found that the velocity of the periphery should be about fifty-five per cent. of that of the water flowing through the sluice; and upon these data the power of the wheel would be about 180-horse power. The buckets were of a curved form, and made of wrought-iron $\frac{1}{4}$ of an inch thick; and it would be observed that there was a larger number of buckets than usual, and that the water came upon them at a tangent, through an orifice of such a form and dimensions as to allow the buckets to fill easily, at the rapid speed at which the periphery passed before the sluice. This great primary velocity was very important, as it caused a considerable saving in the gearing of the mill. The main shaft was formed by a hollow cylinder of cast-iron, 4 ft. 6 in. diameter, in short lengths, bolted together; and the arms were of wrought-iron, made very light, and of the same form as those of a paddle-wheel of a steamer, and placed very close together. The strain was brought entirely upon the main shaft, and the weight of the wheel was thus reduced to about 30 tons, which was very little for so powerful a machine. The sluice was formed of cast-iron plates, with planed joints, bolted through the flanches, to form one large shuttle, of the entire breadth of the wheel, and its motion was regulated by radial tie-rods, between the stone apron and the back of the sluice, which could thus be raised with great facility by racks and pinions, and be regulated by the ordinary governor, the weight of the sluice being in a great degree supported by the water flowing beneath it, on to the wheel. It moved very accurately between the side walls of the pen-trough, and cup-leathers at each side prevented any waste of water. This kind of wheel was less affected by back-water than any other form, and the water acted upon it with its full power of velocity, without any impediment from the air in entering, as there was no sole-plate; the buckets were, therefore, filled and emptied with great facility. Mr. De Bergue was satisfied that this was the best kind of wheel for all falls under 8 feet in height; and though the principle differed essentially from that generally taken as the basis of construction of water-wheels, he was inclined to prefer it to any other system.

BUILDING MATERIALS IN PARIS.

On the Building Materials Employed in Paris and in the Valley of the Lower Seine. By George Burnell, Esq.—(Paper read at the Royal Institute of British Architects.)

At the present day, when the attention of the profession has been so powerfully directed to what may be called the physiology of the materials employed in the execution of the works committed to their charge, it may be interesting to examine the practice of the architects in the neighbouring capital. Such an examination, moreover, becomes more interesting from the comparatively superior attention paid by the French architects and engineers to the study of the philosophy of the mechanical parts of their pursuits. With the glorious exceptions of Rennie, Tredgold, Barlow, and Hodgkinson, nearly all that we know of the chemical and mechanical nature of the materials we have to employ, is derived from the works of the French authors. The practical lessons they have drawn from their researches become, therefore, of much more immediate importance; and, although the geological nature of the country in which they are applied differs so entirely from that of our own, yet the mode of analysis adopted, and the conclusions arrived at, are as applicable here as elsewhere.

Building materials may be separated, for the purposes of classification, into the following groups:—1st, stone; 2nd, bricks; 3rd, limes; 4th, woods; 5th, metals. Under the head of bricks are included tiles, pottery, and artificial stones; under that of limes are included plaster, cement, sand, stuccos, &c. These materials are to be examined—firstly, as to the nature and qualities of their constituent parts; secondly, as to the manner of their use.

I. Stones.—The stones employed in building are grouped thus —1st, the argillaceous; 2nd, the calcareous; 3rd, the gypseous; 4th, the silicious; 5th, the volcanic and divers natures.

1st. *The Argillaceous Stones.*—These are comprised of a base of alumina, generally combined with silicates and the oxides and sulphurets of iron. They do not effervesce with the acids, and are composed of successive layers, easily separated. The schists and slates are of this class.

The slates used in Paris are extracted at Angers, in the department of the Maine and Loire. The quarries are opened in a bed of silurian argillaceous schist of an enormous thickness, which outcrops for a length of 10 miles, between Avrillé and Treluzé, passing under the town of Angers, where the Mayenne cuts the direction of the formation at right angles. There are eight quarries opened in a direction from east to west. Immediately under the vegetable soil is found a bed of incoherent schist, named in the country "cosse." This is followed by a bed difficult to cleave, and, therefore, used locally as a rubble building stone; and lastly occurs, about 14 or 15 feet from the surface, the useful slate. It is worked in patches about 400 feet wide, leaving underneath an unknown thickness, though the depth quarried in many cases extends to 300 feet.

The quarries of Angers furnish a slate of a very fine grain, remarkably thin and light; although the specific gravity of the slate itself is very great. It is 3·000, water being 1·000, or 188 lb. per foot cube. Four sizes are worked for the Paris market—viz.: the "grande carré forte," 11⅝ long by 8¼ wide, and ⅛ thick ($0^{m}.298 \times 0^{m}.217 \times 0^{m}.003$); 2nd, the "grande carré fine," of the same dimensions as to length and breadth, but of about half the thickness; 3rd, the "cartelettes," 8¼ long by 6⅜ wide by ⅛ thick ($0^{m}.217 \times 0^{m}.162 \times 0^{m}.003$; and 4th, the "cartelette fine," of about half the thickness. According to the statistical returns of the Ingénieurs des Mines, the value of the slates extracted at Angers in the year 1845, was at the pit's mouth 1,420,056f. (56,400*l.*); and there were employed in the quarries 2,366 workmen.

The quarries of Charleville, in the department of the Ardennes, are worked upon a larger scale for the supply of slates for the east of France, Holland, and the Low Countries; but the expensive land carriage prevents them being employed in the capital. The value of their produce is about 1,793,945f. (72,000*l.*); they employ 2,843 men. The slates are somewhat softer than those of Angers, consequently they decayed rapidly in the damp countries where they were usually employed. M. Vialet, Ingénieur des Ponts et Chaussées, overcame this objection by roasting the slates until they assumed a red tinge; their durability was doubled by this process. In the neighbourhood of St. Lô, in the department of Calvados, are some slate quarries in the Cambrian strata, which are used to a considerable extent in the neighbourhood, and which, if the land carriage were not so ruinous, would doubtlessly be formidable rivals to those of Angers. The cathedral of Bayeux is covered with the former; but even there, the price of the Angers slate is so much inferior to that of St. Lô, as to ensure the preference for general use, in spite of the superiority of the latter. The value of the slates extracted in the department of the Calvados in 1845 was 10,360f. (414*l.*)

The usual practice in Paris and in the departments of the Lower Seine, is to nail the slates with two nails upon battens half an inch thick, and from 4¼ inches to 7 inches wide, that is to say, either of deals cut in two, or of battens. Sometimes these "voliges," as they are called, are of poplar or sycamore, but they decay very rapidly. The slates lap over one another two-thirds of their length, leaving a "pureau" of one-third, when the inclination of the roof is not above 33°: at 45° the pureau is one-half of the slate; at 60° two-thirds. The battens are rarely laid close, for the slates are found to decay more rapidly if there be no circulation of air. The usual space between the battens is about 1¼ inch. Hips, ridges, valleys, and gutters are executed as in England, with the trifling exception, that step-metal flashings are unknown; the slates are made good to the Pignon walls by merely covering the meeting angle with plaster.

2nd. *The Calcareous Stones.*—The formations which furnish the building stones of this class occur in the neighbourhood of Paris, and of the basin of the Lower Seine, in vast deposits. The ease with which they are extracted, and the proximity of the quarries to the places in which the stone is to be used, render their employ almost imperative; and it is to the use of these materials that the monumental character of Paris is in a great measure to be attributed.

The nature of this class of stone is too generally known to render it worth while to dwell upon it at present. Our geological observations will therefore be merely confined to an enumeration of the great sources of supply. These are, for Paris itself, the vast tertiary formation, which nearly covers the whole of the departments of the Seine, Seine and Oise, Seine and Marne, l'Oise, and extends into those immediately around. Rouen, and some of the small towns above and below it, use large quantities of an indurated chalk met with on the banks of the Seine, whilst Havre and the intermediate towns derive their building stones principally from the oolitic formations of the department of Calvados.

Nearly the whole of the department of the Seine in which Paris is situated, may be considered as capable of furnishing calcareous stones for building purposes. The excavations which have been, and still continue to be made, in and around Paris, are immense. About one-sixth of the town is built over the abandoned quarries, which are known under the name of the catacombs. The quarters St. Marcel, St. Jacques, St. Germain, and Chaillot, are in this condition; and it is calculated that the mass of materials extracted thencefrom is not less than 385 million cubic feet. At present the bulk of the superior stones furnished by the department, comes from the quarries of Arceuil, Bagneux, Montrouge, and St. Cloud, which lie to the south-west of Paris.

The department of the Seine and Oise, is rich in quarries. Amongst them may be cited those of Saillancourt and Conflans, near Pontois, of Poissy, St. Nom, St. Maure, l'Ile Adam, and Chèrence near Mantes, and upon the borders of the Chalk. The department of the Oise furnishes the lias of Senlis, and the Vergelée of St. Leu. The Seine and Marne furnish the very beautiful stone called the Chateau Laudon.

This stone of the Chateau Laudon is the hardest, densest, and, consequently, heaviest, employed in Paris. It is nearly a pure carbonate of lime, containing in 1,000 parts 18 only of magnesia, and 18 of silicate of alumina. Its colour is a grey, slightly tinged with yellow; it is subcrystalline, resists the action of the atmosphere, and bears a kind of polish. The quarries from which it is extracted are about 63 miles from Paris; yet the great superiority of the stone causes it to be preferred wherever great solidity is desired. It was first employed in the erection of the bridge of

Nemours; subsequently Rondelet used it for the paving of the Pantheon. The Barrière de l'Etoile is faced with it; the pedestals of the Pont d'Jéna, the large basins of the Chateau d'Eau, and of the foundation of the Innocents, and the parapets of the terre-plein of the Pont Neuf are executed of this stone, as are also the steps, parapet walls, and balustrades of the church of St. Vincent de Paul.

The specific gravity is 2·605; its weight about 163 lb. Eng. to a foot cube; and it is able to resist a crushing weight of 332 kilo. per centimètre square.

The lias, which was formerly extracted to the south of Paris, was an excessively hard stone, but the quarries are nearly exhausted. The name is still retained amongst the quarrymen, and is by them applied indiscriminately to the hardest beds of *calcaire grossière*, which rarely occur in any great depth. At Arceuil, Bagneux, Montrouge, &c., the lias is fine-grained and compact, but is rarely raised in blocks of more than a foot thick. At Montereau it is occasionally 2 feet thick. At St. Cloud, it is soft; at Maisons, in the south-west of Paris, it takes a rose tint, and occurs in beds of from 9 to 10 inches thick. The specific gravity of the lias is, on the average, 2·439; the foot cube weighs 152 lb.; the crushing weight per centimètre square is even greater than that of the Chateau Laudon; it is 445 kilog. It was doubtless for this reason that it was chosen for the execution of the columns of the exterior of the Madeleine and of the Bourse. The crown moulding of the large pediment of the Louvre is executed in lias, extracted at Mendon; it is of two pieces each 16 m. 24 c. long, by 2 m. 60 c. wide, by 46 c. high (53 ft. 3 in. × 8 ft. 6 in. × 1 ft. 5 in.)

The "cliquart" extracted at Vangirard and Mendon is a species of lias of a rather looser texture.

The stones called the "roches" are hard, of a coarse grain, very shelly. They occur in beds varying in thickness from 1 ft. 4 in. to 2 ft. 2 in.; their specific gravity is between 2·415 and 2·305, the heaviest being, as usual, the best. The foot cube weighs between 151 lb. and 141 lb.; the crushing weight 302 kilogs. and 283 k. p. c. square. The roche of St. Cloud is red and shelly, but of a very superior quality; it occurs in beds from 18 inches to 2 feet thick, and has the peculiar quality of being able to be employed on the wrong way of the bed. The isolated columns of the court of the Louvre and of the garden front of the Tuileries are of this stone, and have stood well for upwards of 200 years. We shall have occasion to revert to this apparent anomaly on some future occasion. The basements of the Madeleine, St. Vincent de Paul, Notre Dame de Lorette, of the Palais du Quai d'Orçay, and of the Bourse, are executed in the "roche de Bagneux."

The bridges of Neuilly, the Pont d'Jéna, of Louis XVI., and numerous similar constructions, are built of the "roche" of Saillancourt. At Rouen large quantities of the roche of Chèrence are employed in works which require solidity: for instance, the stone bridge and the basement of the Custom House. The rubble filling of the bridge is, however, of the Vetheuil stone, one of the lowest members of the tertiary formations. At Havre, the plinth of the Museum is executed in the Chèrence stone. The practice of the French architects is never to employ the softer materials, such as the Caen oolite, near the ground.

The "pierre franche" is a fine, close-grained stone, less dense and hard than the "roche," but preferable for the decorative purposes of architecture, on account of the superior homogenity of its grain. Its specific gravity is about 2·130; the foot cube weighs 133 lb. nearly; the crushing weight is about 126 kilogs. per centimètre. The lower parts of the Pantheon are of this stone, extracted at Arceuil. The angle stones of the façade of the same building are executed in blocks from the banc royal of Conflans, of the same nature; they were 10 feet square by about 6 ft. 6 in. high, and weighed about 24 tons. The arches of the portico and of the interior of the church and the dome, the entablature, and the capitals of the exterior order, are of the same stone. The Vergelée and the St. Leu are of the same category, as is also the stone of l'Ile Adam; they are extensively used in Rouen and the neighbouring cities, on the banks of the Seine and the Oise, in those of the canal, and on the Northern Railway. The exterior dome of the Pantheon is in Vergelée stone.

The lambourde is a soft stone of an even, coarse grain; it decomposes when exposed to moisture, and is therefore only used in positions in which the action of the atmosphere is the slightest. The best stone of this description is extracted at St. Maur, where it reaches 1 ft. 8 in. in thickness. Some beautiful stones for internal works are obtained in this series of Conflans and at St. Leu, which attain 2 ft. 2 in. thickness. The specific gravity varies between 1·897 and 1·709; the weight per foot cube is between 113 lb. and 107 lb.; the crushing weight is about 59 kilogs per cent. square.

The chemical type of the building stones of Paris may be regarded to be that of the stones found near Marly; they are thus composed—

Carbonate of lime	89
Magnesia	1
Silicate of ammonia	10
	100

Sometimes the magnesia disappears, and the quantity of clay and flint diminishes considerably: thus it is—

Carbonate of lime	0·985
Silex and clay	0·015
	1·000

At Vernon, in the department de l'Eure, a species of indurated chalk is largely quarried for local uses. The church of Vernon, and that of Louviers, are executed in this kind of stone, as are also those of Pont de l'Arche, and of les Andelys, When fresh from the quarry these stones are soft, but they harden by exposure to the atmosphere; so much so as to resist atmospheric action in a very extraordinary manner. In the instances of the three first-named churches, all the external ornamentation is of the most elaborate character of the "flamboyante" architecture; and in all cases where the water does not lodge, the details of the foliage, and the arises of the mouldings are preserved in a very remarkable manner. The blocks are sometimes 3 ft. 4 in. high, their specific gravity is 2·155; the foot cube weighs 135 lb. nearly, the crushing weight is about 220 kilogs. per centimètre square.

The most correct chemical analysis of the chalk in the department of the Lower Seine was made upon some extracted at St· Catherine. It is more fissured than at Vernon, St. Etienne, or Caumont, but may be regarded as of the same mineralogical type. It contains—

Carbonate of lime	68
Silicate of ammonia	12
Sand	6
Oxide of iron	2
Water	12
	100

A similar description of indurated chalk is extracted at Caumont, in the Seine Inférieure, to the north-west of Rouen. This, or a like stone from St. Etienne, nearer still to the town, was much employed in the middle ages in the buildings of Rouen. The cathedral, St. Ouen, St. Maclou, the Archbishop's palace, may be cited as instances.

The lateral elevations of the Madeleine are of the Pierre Franche of l'Ile Adam, the upper parts of St. Vincent de Paul, of N.D. de Lorette, of Vergelée de St. Leu; those of the Palais du Quai d'Orçay, are a mixture of the pierres franches of Carrières St. Denis, Montesson, and Carrières sous Bois, near St. Germain. The façades of the Bourse are in stone of l'Ile Adam and of Conflans. The restoration of the Palais de Justice, the completion of St. Ouen, the upper parts of the Douane and of Entrepôt des Sels, at Rouen, are in Vergelée de St. Leu.

At Havre, and generally in the embouchure of the Seine, the calcareous stone of the Calvados are used. An examination of them would lead us into too many details at present; but they have become so interesting to us, from the extensive use made of them in England, that it is much to be desired that a more elaborate examination be made than we have at present. The notices contained in *The Builder*, notwithstanding their undoubted merit, present questionable points. The chemical analysis, firstly, I am convinced, is not correct; inasmuch as the Caen stone is stated only to contain *a trace* of magnesia, whilst it is notorious that the lime it yields is thin, without being hydraulic, which would not occur unless there were present a very considerable quantity of magnesia. The use of the franc banc is justly objected to, but the use of the stone from the quarries of la Maladrèrie is much more dangerous, and this, I observe, is sent over to London in very large quantities. It is, if not asserted, at least given to be understood, that no inconvenience would arise from the use of Caen stone placed the wrong way of the bed; whereas all the most accurate and scientific observers who have made any researches into the subject—namely, Rondelet, Soufflot, Peyronnet, Ganthey, Sganzin, Reibel, and Vicat,—all agree in asserting that the resistance of stones is much greater when they are employed upon their natural bed. As to the action of the sea water upon the Caen stone, it is universally received amongst the French practical masons that the sea water destroys it very rapidly; and chemistry teaches us that the muriates and sulphates of magnesia, present in the sea water, enter into energetic combination with the salts contained in the limestones, and produce rapid disintegration.

The calcareous stones when first extracted are certainly in a very different state to that in which they appear after losing the quarry damp, to use the expression of the quarrymen. I suspect that they exist in the quarry only as a sub-carbonate of lime; at any rate, it is certain that they are hydro-carbonates. In either case the lime is, comparatively speaking, free to enter into new combinations. If sea water be introduced, the magnesia enters into combination with the lime, the more readily if carbonic acid be present, giving rise to the formation of a magnesian carbonate of lime. The sulphuric acid gas also enters into combination with the lime, giving rise to the formation of sulphate of lime. These combinations take place with the commencement of a confused crystallization, the mass is disintegrated, and falls to powder.

Practically, at Paris, where from the nature of the subsoil it is expensive to form cellars, and where the bulk of the houses are built upon the ground, without deep foundations, where the land is all freehold, building leases are unknown, and consequently where the interest of the proprietors is evidently to obtain the greatest number of dwellings upon the least possible surface, and the houses, therefore, are generally from six to seven stories high, the lower parts of the houses are built of the roche stone, towards the street and up to the first floor; from thence two stories are carried up in la pierre franche; and the remainder is executed in lambourde. The party walls are mostly executed of moellon, or small coursed stones, of similar natures to the corresponding parts of the façade. The back walls and partitions are of wood, filled in with light rubble, and plastered. Such construction is about as bad as can be: the front wall, built of carefully-squared ashlar, sinks very little. The party walls, of rubble and plaster, not only sink more than the front, but, from the fact that the plaster in setting expands, it becomes necessary to build these walls totally independent of one another. The back walls, of wood framework, shrink still more. It is therefore almost impossible, in the new quarters of Paris, where this style prevails, to find a house which is not disfigured in all directions with cracks and settlements of every kind and size imaginable.

The mode of using the stone is, however, logical, and merits imitation. The harder and less hygrometric stones are placed at the bottom, as being the most fit to resist the crushing weight and the capillary action of the stone upon the humidity of the soil. The finer grained stones are employed at the heights destined usually to be ornamented; the lighter and more perishable stones are used above, where they load the foundations less than the others would do, and where they meet with the atmospheric conditions the most adapted to their own preservation.

In Rouen, the Chèrence stone, or that of Vernon, are used in the situations where the roche is used at Paris; the upper parts are of the softer stones. At Havre the same rule is observed: the Chèrence, Caumont, Ranville, or granite, are used in all cases where there is danger to be feared from humidity; the Caen stone is only used in the upper works. Wherever I have seen the Aubigny stone used, it has decayed rapidly. Indeed, the French architects do not much advocate its use externally.

The value of the building materials extracted in 1845 was, for the departments before cited, as follows:—

	Building Stones.	Plaster.
Seine and Marne	F. 647,000	F. 750,000
Seine	2.413.212	1,295,067
Seine and Oise	1.375.576	504.509
Seine Inférieure	109,593	
Eure	222 958	182,784
Calvados	837.551	
Oise	300,400	148,350

besides the value of the slates, quoted previously.

3rd. *The Gypseous Stones.*—These stones, from their soft and friable nature, and the facility with which they decompose in the atmosphere, are not allowed to be used as building materials in Paris. Sometimes enclosure walls are built of them, employed as moellon. The principal use is in the fabrication of plaster.

The chemical nature of these stones as found at Montmartre, Belleville, Charonne, Menilmontant, le Calvaire, Triel, and Meulan, is, according to Fourcroy, 32 parts of oxide of calcium, 46 parts of sulphuric acid, and 22 parts of water. They differ from the gypsums of other countries, in the large quantities of lime they contain, which gives them greater powers of resistance to the action of the moisture of the atmosphere. The operation of burning consists simply in driving off the water of crystallization. In this state the plaster has a remarkable avidity for water, and immediately that any is presented it absorbs it, and crystallises around the bodies in its immediate vicinity. I noticed previously the singular fact of the swelling of the plaster during this process; it is one that requires great attention in the employ of the material. Another fact worthy of notice is cited by Rondelet—namely, that two bricks set together with plaster adhere with one-third more energy than bricks set with lime during the first month; but that afterwards their adhesion diminishes, whereas that of the bricks and mortar increases almost indefinitely.

4th and 5th. *The Siliceous Stones, &c.*—They comprehend the grès, flint nodules, the meulères, the granites, porphyries, and the basalts.

The grès is a species of imperfect sandstone formation, at least as it occurs near Paris, and in the department of the Lower Seine. It is composed of a fine sand of a whitish tinge, cemented together by a silicious cement. Generally speaking it occurs in detached nodules, named "rognons;" sometimes it occurs in layers of different thicknesses. The quarrymen observe that the lower they descend the softer the grès becomes, and that the harder nature of stone is the most easy to quarry in regular forms. It has no definite planes of stratification or crystallization, and is therefore easily worked into any shape required. The streets of nearly all the towns between Paris and the sea-board are paved with these tertiary grès, which occur in isolated patches along the whole course of the river. At Havre, of late, the red sandstone of May, near Caen, a member of the Cambrian system, has been employed instead thereof, with remarkable success. The usual size of the paving stones is 9 inches square; but some of the last works of this kind have been executed with narrower stones, about 4 inches wide.

The flint nodules are sometimes used for rough rubble masonry. They occur in chalk and in the gravels overlying the tertiary formations.

The meulière is a species of quartzose concretion, with numerous small holes. It is met with in two forms; one which occurs in masses sufficiently large to form millstones of one piece; the other in detached nodules scattered over the country. The principal quarries of the first, for the supply of the Paris market, are at Montmirail (Marne) and la Ferté sous Jouarre (Seine et Marne.) The second sort are found nearer Paris, and in the department de l'Eure.

As the meulière is excessively hard, and resists all external action in the highest degree, it is much used by engineers and architects in situations where those qualities are required. The fortifications of Paris and of the detached forts are faced with it. Many of the works of the Canaux St. Martin, St. Denis, and de l'Ourc, the sewers of Paris, and the abattoirs also, are faced with the meulière; for all these works it is admirably adapted. One species is, however, to be avoided,—"la caillasse;" its surfaces are so perfectly even that they offer no key to the mortar.

The granites, a description of which would here be unnecessary, are only used in Paris, and the other towns in the interior, as borders for the footpaths, and occasionally as flagging. That used in Paris is mostly extracted at the island of Chaussey, and is of a nature closely resembling the best Devonshire granites. The plinths of the columns of the Law Institution in Chancery-lane* are of this granite, and may give a correct idea of its nature. The enormous cost of the granite, owing to the land carriage, must at all times limit its use in the interior. At Havre, however, and at Honfleur, it is much used in the different docks, and the fortifications towards the river are entirely faced with it.

The porphyries are very little used, nor do they occur abundantly in any position suitable to their being worked for the Paris market. The basalts also are rare, at least for practical building use. They are, however, occasionally used for flagging, as in the Rues de la Paix, de Richelieu, &c.

II. Bricks and Tiles.—In Paris, the use of bricks is entirely confined to carrying up the flues, and turning the trimmers to the hearths. The best that are employed are the bricks made in the department of l'Yonne, known under the name of the "Brique de Bougogne;" it is 1 foot long, 4 inches wide, by rather more than 2 inches thick. It is burnt to a very high degree. The colour is a pale rose, leaning towards the violet. The thousand weigh about 2¼ tons. Rondelet found that the force necessary to crush them varied between 73 lb. and 80 lb. per centimètre square.

The bricks made at Montereau are very nearly as good as the briques de Bourgogne; they are of the same size and colour; resist nearly as well. The thousand only weighs 2 tons ½ cwt.

The composition of the Montereau clay is as follows:—

Silex, per cent	0·644	
Alumina	0·246	
Magnesia	——	
Oxide of iron	trace	
Water	0·100	
	——	0·990

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* That is to say, of the columns of the portico.

The bricks of Sarcelles are those most used, but they are extremely brittle: they are about 8 inches long by 4 inches by 2 inches; the thousand weigh nearly 1 ton 14 cwt.

Some bricks are made of the clays which occur in the gypseous formations immediately round Paris. They resemble those of Montereau in quality, but differ a little in colour, being of a deeper red, and they are rather thinner and narrower. The thousand weighs 1 ton 18 cwt.

The composition of the St. Ouen and Pantin clays is as follows:—

	St. Ouen.	Pantin.
Silex, per cent.	0·510	0·506
Alumina	0·140	0·105
Magnesia	0·134	0·072
Oxide of iron	0·030	0·057
Water	0·182	0·260

In the neighbourhood of Bonnieres, in the valley of the Seine, a mass of clay occurred, from which the white bricks used on the Paris and Rouen Railway were made. Generally, the bricks used between Paris and Harfleur are, however, of a red colour, and made of a ferruginous clay. At Harfleur and Havre they are white, the clay being calcareous and impregnated with the marine salts. The mode of burning usually employed is in kilns; but of late, near Rouen, many brickmakers have begun to burn in clamps. Their success hitherto has been very equivocal.

Of late years wooden floors have become general in Paris, but the houses of the poor, and all the offices, passages, and kitchens of the best lodgings, are still paved with tiles; and it may, perhaps, be owing to this custom that Paris is so comparatively free from fires. The tiles are of four sorts for flooring purposes—viz., the large hexagon, of 6$\frac{1}{4}$ inches over the angles; the bastard hexagon, of 5$\frac{1}{8}$ inches over the angles; and the square tiles, 6$\frac{1}{4}$ inches, and 8$\frac{4}{16}$ths of a side: the thickness varies from $\frac{11}{16}$ths to $\frac{15}{16}$ths. The square tiles are used for the hearths, the hexagonal tiles for flooring. The best are made at Montereau, but their price is so high that the preference is generally given to the tiles made at Massy, near Palaiseau. Almost all the brickmakers of the neighbourhood of Paris, however, make tiles at the present day, both for flooring and roofing purposes.

Many of the houses of Paris and the neighbourhood are covered with tiles, though the use of this material is rapidly going out of fashion. The best are made at Montereau, as is the case with flooring tiles. They are of two sizes; for it is to be observed that there is only one shape in general use—the pantile. *Le grand moule* is about 1 foot long by 9 inches wide and $\frac{5}{8}$ inches thick; the part left uncovered is about 4$\frac{1}{8}$ inches. *Le petit moule* is about from 5$\frac{1}{4}$ to 7$\frac{1}{4}$ wide, by from 10 inches to 11 inches long. The ridge tiles are 1 ft. 3 in. long by 1 ft. 1 in. development.

A very great number of glazed tiles and common pottery chimneys and stoves are used throughout France. The dearness of combustibles renders the use of open fire-places too expensive for the lower classes. Iron also is too dear to be employed for grates, stoves, ranges, cheeks, and the thousand uses we make of it in England.

The clay of Forges of la Seine Inférieure is composed of—

	Forges.	Vanvres.
Silex, per cent.	0·650	0·540
Alumina	0·240	0·250
Oxide of iron	trace	0·060
Water	0 110	0·100
Magnesia	—	trace
	1·000	0·990

The clay of Forges is used for pots for glass-making, and similar purposes; that of Vanvres for kitchen-tiles.

The firebricks used in Paris are either made at Stourbridge, or at Hayange, on the Belgian frontier; some few are made in Burgundy, but they do not resist well.

One of the most ingenious uses made of pottery was in the construction of the floors of some houses in a street recently erected in the centre of the grounds of the ancient hotel Rougemont. At the time of the erection of these houses, there was a strike amongst the carpenters. The contractor adopted this manner of executing the floors simultaneously with the walls,—that being the invariable mode of proceeding adopted in Paris. These floors, however, cost more than those executed in the usual manner, and, consequently, have not been imitated. They were executed about 1845.

III. Limes and Cements.—All calcareous stones, when exposed to a sufficient heat, part with the carbonic acid gas which enters into their combination; but the limes resulting from the calcination assume different appearances, according to the chemical composition of the stones. These appearances are four in number,—at least of those sufficiently frequent in their recurrence to form the basis of a commercial classification. They are:—Firstly, as regards the manner of taking up water, divided into fat or thin limes. The fat limes are those which, in slacking, augment at least one-fourth in volume; the thin limes are those that remain constant in their bulk. Secondly, as regards their setting properties, limes are divided into the hydraulics and non-hydraulics. The hydraulic limes are invariably thin,—but all thin limes are not hydraulic.

An examination of the elaborate discoveries and researches of the French chemists and engineers into this still very little cultivated branch of the chemistry of building, would lead us into far too long a discussion at present. Suffice it to say, that the practice of the best architects, and of all the engineers in France, is to use hydraulic lime to the exclusion of others, unless almost insuperable difficulties, owing to their price, occur. In so damp a climate as our own, we should do well to imitate their example; the more especially as we have at hand the means of procuring both natural and artificial hydraulic limes in unlimited quantities.

The fat limes used in Paris are made at Senlis, Melun, Essone, Champigny, Marly, Sevres, &c. The natural hydraulics are made at Senonches, and of late years at Meudon; the artificial hydraulics are made wherever chalk is found in the proximity of clay, as at Marly, Mantes, and in the neighbourhood of Rouen.

The Lower Seine, from the neighbourhood of Mantes at least, runs through the chalk formation; the country, right and left, is of the same geological character for a great distance. Natural hydraulic limes do not occur until we reach Havre, and all the local consumption is therefore supplied by the factories of artificial hydraulic limes. The most important of these are at Rouen, where they assume very great importance, from the chemical and mechanical skill employed. The materials used are the chalk from the Mount St. Catherine, and the argillaceous deposits of the neighbourhood; the proportions of the different ingredients, and the degree of burning, depending upon the rate of setting required.

At Havre, upon the outcrop of the chalk, or rather at the junction of the chalk and the Wealden formations, a bed of argillaceous limestone is met with, which yields a very superior hydraulic lime. In the valley of Harfleur a large establishment has lately been formed for the making of artificial hydraulics; and all the immense dock or fortification works executed at Havre have been constructed with either one or the other. Cement is only used for pointing, or, on extraordinary occasions, for rendering works exposed to the action of the sea immediately after being finished.

The cements used in Paris are principally made in Burgundy, at Pouilly. They participate of the nature of our Roman cements; but do not acquire so great a degree of hardness. The same objection is to be made to the Vassy cements; and to the artificial cements made at Rouen with chalk and pounded bricks. The French architects and engineers do not advocate the use of cement to the same extent we do in England. Personally, I think they are nearer the truth than we are. Materials which set so rapidly may decay in the same manner. The processes of nature are slow, at least where great duration is its object; and we are most likely to succeed by following the same course. The competition, moreover, in the supply of cement is so great, that the article, as usually sold, is little better than sand. Even the extreme rapidity of the setting of cement is an objection to its use in many ordinary cases, for it requires so much care in its manipulation as to render it liable to be slighted where the interest, or even the carelessness of the workman, may oppose its receiving proper attention.

Occasionally, in the neighbourhood of the large towns, the houses are entirely built with rubble-stone, or of bricks, and covered with a coat of plaster. Cement is never used for this purpose, nor does there appear to be any necessity for its introduction; the climate of France is sufficiently dry, and the plaster, as usually employed, is sufficiently capable of resisting the atmospheric changes, to render the use of the more expensive material unnecessary. Precautions require, however, to be taken in the application of plaster. The tops of cornices, and all weatherings, require to be covered with zinc; the parts of the houses near the ground must be rendered with a less hygrometric material; but for all other positions plaster succeeds remarkably well. Internally, it is the only material used in any part of France within reasonable distance of water-carriage from the gypsum quarries. Stuccos and imitations of marbles are sometimes employed in public buildings, but very rarely in private houses.

IV. Woods.—The practice of the French architects in the use of wood differs little from our own. On the sea-board, and in the large commercial towns, Swedish and Baltic fir is principally employed; in the interior oak is cheap enough to insure the preference. The oak used in Paris comes principally from Champagne and Burgundy; lately, however, the Prussian oak has been imported in considerable quantities. For large roofs, Dantzic and other Prussian fir is used; but the architects pay such very low prices that the best woods invariably are sent to England. Indeed, there are few architects who seem to be able to distinguish the Swedish from the Prussian timber, for in all cases I have noticed that for roofing purposes the former is employed where the latter is demanded by the specifications. Indeed, so small is the supply of Baltic timber in France, that in 1848, after the bridges over the Seine had been burnt down by the mobs, it was impossible to find 50,000 cubic feet in all the markets of Dieppe, Fecamp, Havre, Rouen, and Paris.

Norway timber is used largely for purlins, and for partition stuff. The deals and battens imported are of the second and third quality; but as all the better class of joiner's work is executed in wainscot, this becomes of less moment. Some of the French oak is very beautiful, and admirably adapted for joiner's work; but its gradually increasing price, owing to the clearance of the forests, renders necessary the importation of the German, or, as we commonly call it, the Dutch wainscot. Mahogany is only imported for cabinet-making: its use for joinery, or for ship-building, is almost unknown. Rosewood and ebony are also imported for cabinet-makers. American timber, *e.g.*, pine, spruce, &c., rarely enters France, except for the purpose of making masts and spars of ships; teak is totally unknown, as are the whole tribe of African or Australian woods.

France furnishes very beautiful poplar, ash, and beech timber, which are much used in building. Almost all the slate battening for provincial use is made of poplar; the ash serves for cart-building and carriage-works; the beech is principally employed for piles and gratings, &c., under water. The department of Calvados furnishes some of the finest beech-trees I have ever seen.

In practice the French architects are much behind our own as far as carpentry is concerned. There are, certainly, exceptions. Some of the roofs in Paris are light, elegant, and strong, the thrusts well balanced, the resistances most skilfully calculated; but, as a rule, the scantlings are far too heavy, the framing clumsy, the affectation of mathematical construction too glaring. Little or no precautions are taken to prevent the decay of the timber from the moisture of the walls; the wood itself is often used full of sap, and thoroughly wet—an objection, by the way, which may be made to carpentry in London, for we often see the wood taken from the river, cut up, and placed in buildings long before it can have dried. It is, however, to be observed with reference to the heavy scantlings used by the French architects, that the price of woodwork is about 25 per cent. higher with them than with us. Motives of economy serve as vast incentives to scientific investigations in all countries.

V. Metals.—The metals used in building are iron (cast and wrought), lead, copper, zinc, and some of their compounds.

1 (*a*). The greater part of the cast-iron used in the valley of the Seine is derived either from the mines upon the Belgian frontier, from the province of Berri, or from England; the importation from our own country being principally for the supply of the markets of Rouen, Havre, and the north-west of France. The wrought-iron comes from Berri and Flanders, and there are some scrap-iron factories at Paris and Havre.

The great distance the iron has to be transported, and the dearness of fuel, render its use in the prodigal manner we are accustomed to, quite out of the question. At Paris cast-iron costs about 50 per cent. more than in London; at Havre it costs about 33 per cent. more. Its use is therefore avoided as much as possible, the more especially as wood and stone-work are so much cheaper than with us. The French founders are, however, very skilful, and some very remarkable works are to be met with in Paris, executed in cast-iron. The northern gate of the Madeleine, the fountains and lamp-posts of the Place de la Concorde, may be cited as illustrations.

1 (*b*). The best commercial wrought-iron is that from the province of Berri; but it is very unequal in quality, sometimes as tough as our best Welch iron, at others as short as the very commonest Staffordshire, owing to the had manipulation in the factories. The very high price of iron, also, prevents so much attention being paid to the details of its production as is the case where its economy renders its use a matter of every-day necessity. Indeed, the state of the ironworks in France is a singular illustration of the evils of the protective system. The manufacturers have a monopoly; they fear no competition, and make a bad iron. The public pays dearly, and therefore uses as little iron as possible. Since railways have been in fashion, however, the use of iron for roofs has become more general, and there are in Paris certainly some of the finest roofs in Europe. Amongst them may be cited the roofs over the Entrepôt réel des Marais, of the Halle aux Blés (in cast-iron), of the St. Germains and Rouen Railway, executed by M. Eugène Flachat.

The plate-iron box-girders are at present unknown; corrugated iron is but of very recent introduction, nor do the French architects appear to approve much of it.

Owing to the very high price of wrought-iron, the use of iron wire for suspension bridges has been pushed to a very great extent throughout France. There are upon the Seine many very remarkable bridges executed with this material, such as the bridges at Triel, Gaillon, and Rouen. The iron wire is exposed to this inconvenience, that with all possible care in the fabrication of the chains, the separate threads cannot be drawn out to the full; the chains, therefore, always stretch, and the platform of the bridge necessarily sinks. Wire chains, however, bear a greater weight in proportion to their sectional area than square bars, and are more likely to be homogeneous in their strength. They avoid, moreover, the necessity for the coupling-links, which, on the last suspension bridges executed, augment the weight of the chain 31 per cent. beyond that absolutely necessary, supposing the chain to be of one piece. The surface of oxidation is greater for the wires than for the bar-iron chains, nearly in the proportion of 40 to 1, and this becomes one of the greatest practical objections, for not only does it necessitate frequent painting, but it diminishes, in time, the real strength of the wire cables. The practical strength of these is found in fact, to be as 0·70 to 1·00 of the theoretical strength; after a few years it falls to 0·66. The voids in the wire cables, according to theory, should be to the solids as 0·1025 to 1·0000; in practice they are found to be 0·25 to 1·00. On the suspension bridges, the government engineers enforce a proof of 17 kilogs. per millimètre square of the sectional area of the iron wire chains, to ensure a surplus of strength as a guarantee against deteriorntion; on the bar-iron chains the proof is only 12 kilogs.

A very beautiful bridge was erected at Suresnes, by M. Flachat, of hoop-iron bands to form the main chains, which answered remarkably well. This application attained a sort of medium result, both as to cost and strength, between the systems hitherto employed.

There is a very beautiful adaptation of the use of the suspension principle to roofing purposes in the Panorama in the Champs Elysées, at Paris. The chains are of wrought-iron wire.

2. *Lead.*—For building purposes, the bulk of the lead used is imported from England, Spain, and America. It is dearer than with us, consequently its use is not so general, zinc being generally substituted for it. The use and modes of fabrication, wherever it is employed, are precisely the same as in England.

3. *Copper.*—France also draws the bulk of its copper from foreign countries, at very considerable expense; its use is therefore very much restrained in building. The only instance I know of its application on a large scale is at the Halle aux Blés, which was covered with copper in the year 1712, and I think at the Bourse.

4. *Zinc.*—The high price of the two last-noticed metals has given rise to the use of zinc upon a very large scale throughout France. It is imported from Belgium and Germany in very large quantities, to the extent of 13,000 tons, worth 280,000*l*. Except upon the borders of the sea, it stands well in France; for the atmosphere does not contain (as in England, where so much coal is consumed) the carbonic acid gases which destroy zinc. On the contrary, in the interior, an oxidation of the external face of the zinc takes place, which prevents its decay. The roof of the palace on the Quai d'Orçay, the Northern, and some parts of the Rouen Railway Station, the Orleans Station, and a crowd of other buildings, are covered with zinc, to the perfect satisfaction of the architects.

The sizes of the metals usually employed for roofing are as follow:—Lead in sheets, 12 ft. 3 in. long, by 6 ft. 1$\frac{1}{4}$ in. wide; the thicknesses are either a full eighth, or a short 3-16th of an inch: the first weighs 89$\frac{71}{100}$ lb. per yard square; the second weighs 118$\frac{88}{100}$ lb. per yard square. The lap is generally made from 3 inches to 6 inches longitudinally.

The sheets of copper are made 3 ft. 6$\frac{1}{2}$ in. long by 3 ft. 3 in.; the thicknesses are 0·0021236 and 0·0024526 of a foot, the respective weights 13$\frac{71}{100}$ lb. and 17·15 lb. troy per yard superficial.

The sheets of zinc are made 6 ft. 4 in. long by 3 ft. 2$\frac{5}{8}$ in., the thickness varying from a short $\frac{1}{24}$ to a very full $\frac{1}{14}$; the weights are respectively 17·15 lb.; 19·06 lb.; 20·80 lb. troy per yard superficial. The sheets of less thickness than these are rarely used in good buildings. Of late years, in the neighbourhood of Paris, zinc tiles have been much used; they are made from 14 inches to

16 inches long, by 12 inches to 14 inches wide; nailed at top, and fastened by hooks to the slates, which lie immediately beneath them.

The compound metals used are brass, bronze, and the galvanised iron. No difference exists in the mode of preparing these compounds from that observed in England. The bronze is, however, much more often employed than with us. For instance, the columns of the Place Vendome, and of the Bastille; the gates of the Madelaine and St. Vincent de Paul; the fountains of La Place Louvoise and the numerous statues which adorn all the quarters of Paris are in this metal.

Painting and Glazing.—The modes of house-painting employed in Paris are similar to those we employ, except that the oils are better, but the colours and white-lead immeasurably worse. Indeed, there is not the same necessity for excellence in the painter's art, so far at least as mere flat tints and common graining are concerned, in a country where oak is so universally employed for joinery. For all objects of luxury, however, we are frightfully behind our neighbours. The decorations of Notre Dame de Lorette, the Madelaine, the former Chamber of Peers, the Louvre, and the Sainte Chapelle, cease to be mere decorations, to pass into the higher walks of art. St. Vincent de Paul, St. Germain l'Auxerois, offer illustrations of polychromic decoration, which contrast painfully with the attempts we see in London.

These two last-mentioned churches may also be cited as specimens of the excellence our neighbours have attained in the art of painting on glass. For drawing and colouring, the windows of St. Vincent de Paul are superior to anything, either ancient or modern, it has ever been my fortune to examine.

The decorations, painting, and glazing of the cafés and shops might afford useful lessons to the architectural student. Great attention is shown to the distribution of the light, and the general tone of the colouring, so as to suit the goods exposed. Glass is cheaper than in England, and in consequence is more prodigally used. The window glass is, however, bad, both in colour and in its powers of resistance; it is thin, green, and wavy.

Although the above notice of the building materials employed in Paris, &c., has grown to a very great length, I have been forced to pass over some of the most important and interesting subjects the review suggests. The chemical process, called by the workmen saltpetring, and its action upon stones when laid bedwise, or against the bed; the manner in which stones are affected when exposed to the various strains; the composition of mortars and cements, and all the phenomena which attend their use in the air, or under water—salt or fresh; the qualities of woods and metals—have all glided before us; but from the limited time we can here devote to them, these subjects have not met with the attention they merit. Indeed, this remark holds good not only here but elsewhere. Very little is known, comparatively speaking, of the chemistry of our profession; what little we do know may principally be sought for amongst the French authors. Perhaps I may not have occupied your attention in vain, if my remarks should call attention to subjects so full of interest to us, but at present so involved in obscurity.

DISCHARGE OF WATER FROM RESERVOIRS.

The Theory of the Contraction of the Movement of Water flowing from Apertures in thin plates, in a Reservoir in which the Surface of the Water is maintained at a constant altitude. By J. BAYER, Lieutenant. (Translated from Crelle's '*Journal für die Baukunst.*' Baud 25.)

1.

When an aperture is made in a reservoir of water, the perpendicular distance of the upper surface of the fluid from the orifice is in general termed the altitude of pressure. Horizontal apertures are distinguished from those which are vertical. The former are made in the horizontal bottom of the reservoir, and at every point have the same altitude of pressure. The vertical orifice is made in the vertical side of the reservoir, and at every point in its vertical section has a different altitude of pressure. This altitude is distinguished according as it is taken at the upper edge, the centre, or the lower edge of the reservoir. The velocity V of water flowing under the altitude H, is the same as that which a falling body acquires in descending the same distance, and therefore $V^2 = 4gH$, where g is the distance fallen through in one second of time. This equation, called the Torricellian law, was first confirmed by the experiments of Michelotti, and neglects the resistance of air.

The section of the issuing column of water is smaller after it has left the orifice, than at the orifice itself. This phenomenon is termed the *Contraction*. If, therefore, Q signify the quantity of water which issues in a second of time, and ω the section of the orifice, and C be put $= \frac{Q}{\omega}$, C is smaller than V. Let, therefore, $C = kV$; it follows that $Q = \omega kV = \omega k\sqrt{(4gH)}$. When Q, ω, and H are found by observation, the constant k, which is called the coefficient of contraction, may be determined from this equation. Such experimental inquiries respecting the value of k have been very numerous; but they all fail to give a sufficient explanation of the phenomena of contraction; and it is this which will be attempted in the following pages.

From the middle of the 17th century, when Torricelli (1614) first determined the above relation—namely, that the velocity of the issuing water is as the square of the altitude of pressure—the learned have been much occupied with this subject of Contraction. In the beginning of the last century, the experiments of Poleni directed attention to the discharge which takes place under similar circumstances, from cylindrical and conical discharge-pipes; and endeavours have likewise been made to estimate the diameter of the contracted column. Poleni himself gives it $= \frac{21}{26}$ of the diameter of the orifice. Newton, by actnal measurement, found it $= \frac{21}{25}$. Daniel Bernouilli made it by his experiments $= \frac{1}{\sqrt{2}}$; and Bordu estimates it by direct admeasurement to be $= 0{\cdot}802$. In later times, Bossut, Langsdorf, Vince, Michelotti, Dubuat, Eytelwein, Hachette, Bidone, Smeaton, Brindley, Christian, Poncelet, Lesbros, &c., have made experiments on the discharge of water.

Bidone, Rudberg, and Navier, have attempted, on different hypotheses, a theory of the contracted issue of the stream of water through circular orifices. Their hypotheses do not always hold good, and their results do not sufficiently agree with experiment.

2.

When water issues from an orifice in the vertical side of a reservoir, it is observed that the particles of water in every part of the reservoir—that is, to the right or left, above or below, the orifice—move to the orifice with increasing velocity. Upon this observation the following hypothesis is founded: *That the velocities of the particles of water in the reservoir are inversely proportional to the square of their distance from the centre of the orifice.*

If, by help of this hypothesis, all the results observed in the discharge of water be completely explained, so as to be capable of computation, the hypothesis itself must be deemed true.

From this hypothesis, if e and e' be the distances of two particles of water from the centre of the opening, and v, v' their velocities respectively, we have the proportion

$$\text{(A)} \qquad e^2 : e'^2 = v' : v.$$

For $e = e'$, v will equal v'; that is, at equal distances from the centre of the opening the particles of water have the same velocities.

Let there be described within the reservoir a hemisphere with radius e from the centre of the orifice: all the particles in the surface of this hemisphere will have equal velocities

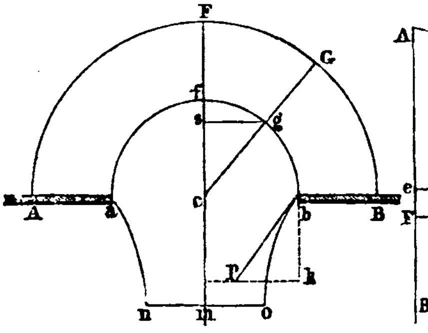


Fig. 1.

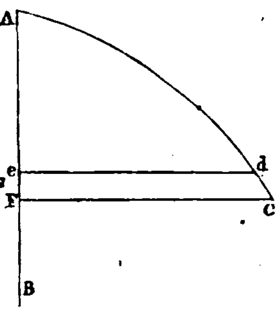


Fig. 2.

To render this observation clearer, it may be illustrated by a figure. Let AB, fig. 1, be the projection of the vertical side of a reservoir on the horizontal plane of the paper, which intersects the centre c of ab the aperture; ab the horizontal diameter, and Fm the horizontal axis, of the aperture. In order that nothing may impede the free motion, it will be assumed that the edge of the orifice is at such a distance from the side-plates and bottom, that little disturbing influence exists.

All the particles of water in the horizontal plane AFB sustain the same pressure, since this plane is parallel with the surface of the water in the reservoir. The direction of the motion of the issuing particles being towards the centre of the opening, it follows that the velocity of all points equally distant from the centre must be equal, because the pressure with which the motion proceeds is on all sides equal; or, in other words, all the particles in the circumference of the semicircle AFB must have the same velocity towards the centre of the orifice.

Let the semicircle AFB be turned about its axis F*m* until it be in the vertical plane: then the pressure above F*m* is smaller, and beneath greater, than in F*m* itself. Call H the altitude of pressure at the centre of the orifice, or in F*m*; $+a$ the distance from F*m* for a lower, and $-a$ the distance for a higher point: then $\frac{1}{2}(\mathrm{H}+a+\mathrm{H}-a)=\mathrm{H}$; and since F*m* bisects the semicircle, the mean altitude of pressure in all points of the semicircle turned through an angle of 90° or vertical, in like manner $=\mathrm{H}$. This remark holds good when the semicircle is turned through any other angle than 90°. Let, therefore, the semicircle make a complete revolution about its axis, so as to describe the surface of the hemisphere of which the centre is the centre of the aperture: the mean value of the pressure which the particles of water in this surface sustain, for the above reason, is the same which a point in the axis F*m* sustains—that is, $=\mathrm{H}$.

Now, since the mean pressure of all the particles in the surface of the hemisphere is equal to the pressure which at the centre of the opening takes place in the direction of *c*, the mean motion of all those particles will be equal to that which takes place in that direction (provided that the opening be not very large); whence it follows that all the particles in the surface of hemisphere AFB have the same velocity.

The surfaces of the hemispheres diminish towards the orifice in proportion to the square of their radii; the velocities must therefore be in the inverse proportion which the surfaces follow. Consequently, as was above stated, the velocities of the concentric shells of water are in the inverse proportion of the squares of their distances from the orifice; and if $e=\mathrm{F}c$, and $e'=fc$, we have, as above,

$$(\mathrm{F}c)^2 . v = (fc)^2 . v'.$$

The motion proceeds in this relation until the radius of the last shell of water is equal to the radius of the orifice: then occurs an alteration in the direction as well as the velocity. The particles which proceed from B to *b* towards the centre *c*, at the instant of reaching the orifice are acted on by pressure in the direction *bk*, parallel with *cf*. They possess also already a certain velocity towards the centre *c*, and move therefore in the direction *bp*. Another thread of water moving from G to *g*, is acted upon by pressure in the direction *gi*; and so on. In this manner, at the orifice, all the particles in the surface of the hemisphere are suddenly acted upon in a direction parallel to *cf*, and alter their velocity together; up to the particle of water in *f* which moves along the axis itself, and as neither its direction nor velocity is altered, moves with the *greatest* velocity, which according to Torricelli's theorem $=\sqrt{(4g\mathrm{H})}$. Let the velocity which the altitude of pressure H produces be designated by V; hence, $\mathrm{V}=\sqrt{(4g\mathrm{H})}$. V is the greatest velocity of discharge, and exceeds the velocity which takes place in the plane of the aperture by a certain factor which is called the coefficient of contraction. Let the mean velocity in the orifice be C, which is also the mean value of all the velocities with which all the particles of water pass the orifice. In order to find this value, we must ascertain, for the equal velocity of all the particles, their mean distance from the axis *ab* in all the sections passing through the axis. But the particles in the periphery of the circle *afv*, and in the surface of the generated hemisphere, have the same velocity: their distance in this periphery from the orifice will be therefore the perpendicular, as *gi*,—or what is the same thing, it will be the ordinate *y* in the equation to the circle $y^2=2rx-x^2$, in which *ab* is the axis of abscissæ. This is the case for every position of the semicircle turned about its axis.

The sum of all these ordinates is the area of the semicircle *afv*, or $=\int y\,dx$. Now, the mean value of *y*, which may be called y', may be put as a function of the same form and value, in which *y* is invariable, and consequently we have for it $y'\int dx$; and when the two expressions are equated, we have $y'\int dx = \int$ [illegible] and, consequently,

$$y' = \frac{\int y\,dx}{\int dx}.$$

This integral between the limits $x=0$, and $x=2r$, gives

$$y' = \tfrac{1}{4}r\pi;$$

and thence, according to the proportion (A),

$$\text{(B)}\quad c : \mathrm{V} = (\tfrac{1}{4}r\pi)^2 : r^2;$$

$$\text{or, (C)}\quad c = (\tfrac{1}{4}\pi)^2 = (\tfrac{1}{4}\pi)^2\sqrt{(4g\mathrm{H})} = 0{\cdot}617 \ldots\ldots \sqrt{(4g\mathrm{H})}.$$

The co-efficient *k* is therefore .... $(\frac{1}{4}\pi)^2 = 0{\cdot}617$
The experiments of Bossut give this co-efficient $= 0{\cdot}617$
Eytelwein makes it .... $= 0{\cdot}6176$
D'Aubuisson .... $= 0{\cdot}617$
Other experiments .... $= 0{\cdot}619$

The agreement of theory with experiment is therefore so complete as to leave nothing to be desired.

3.

For the velocity perpendicular to the axis *cf* (fig. 1), the distance *gs* above referred to is found; and if *s* designate the corresponding velocity, we have by the proportion (A)

$$s : c = (gs)^2 : (gi)^2 = 1-(\tfrac{1}{4}\pi)^2 : (\tfrac{1}{4}\pi)^2;$$

$$\text{or,}\quad s = c\left\{\left(\tfrac{4}{\pi}\right)^2 - 1\right\}.$$

And when these velocities are estimated by the Parallelogram of Forces, we find for their direction

$$\tan\gamma = \frac{s}{c} = \left(\frac{4}{\pi}\right)^2 - 1;$$

which gives $\gamma = 31^\circ\ 51'\ 6''$. Hence it follows that for the angle which the tangent of the issuing column makes with the radius of the orifice,

$$90^\circ - \gamma = 58^\circ\ 8'\ 54''.$$

Poncelet and Lesbros ('*Experiences hydraulique sur les lois de l'ecoulement de l'eau.*' Paris, 1832; Table 5) have, by their experiments at Metz, made, propably, a very accurate measurement of the column issuing from a square orifice, and, as far as the drawing indicates, find very nearly the same angle; which besides, as we shall see further on, by the co-efficient, is, for the square orifice, not quite equal to, but on the average must be found something smaller than, that for a circular orifice.

4.

We have seen that the mean velocity with which the particles pass the orifice is less than V. But as in the plane of the orifice itself, all sustain the same pressure, H, which produces the velocity V, they must be accelerated outside the orifice—and, indeed, up to a point where they obtain their velocity which belongs to the altitude of pressure H. Let this distance, therefore, be *x*: it follows, by the proportion (B),

$$\mathrm{C} : \mathrm{V} = (\tfrac{1}{4}r\pi)^2 : x^2;$$

and when for C its value in § 2 is put, we find $x = r$: that is, all the particles obtain outside the orifice the greatest velocity V, first at the distance *r* from the orifice; whence it follows, *that the point of greatest contraction of the column of water takes place at a distance from the opening equal to its semi-diameter.*

5.

In the proportion (B) § 2, $(\frac{1}{4}r\pi)^2 : r^2$ is also the proportion of the normal sections of the column of water; and thence it follows, that *when r is the radius of the orifice, $\frac{1}{4}r\pi = \rho$ is the radius of the column at the point of greatest contraction.*

For the quantity of water issuing through the different sections of the opening is always the same; and if the sections corresponding to the velocities *c* and V be designated ω and ω_1, we have

$$\mathrm{Q} = \omega c = \omega_1\mathrm{V};\quad \text{and, therefore,}\ \omega_1 = \frac{\omega . c}{\mathrm{V}}.$$

But $\omega = r^2\pi$; $c = (\frac{1}{4}\pi)^2\mathrm{V}$; consequently,

$$\omega_1 = r^2\pi(\tfrac{1}{4}\pi)^2 = (\tfrac{1}{4}r\pi)^2 . \pi = \rho^2\pi.$$

And, therefore, $\rho = \frac{1}{4}r\pi = r . 0{\cdot}7854$.

Poleni's experiments ('*Nuova raccolta d' autori che trattano del moto dell' acque'—delle pascaje* III.; Parma, 1766) give $\rho = r . 0{\cdot}7884$; and Borda ('*Mem. de Paris*,' 1766) found by direct measurement, $\rho = r . 0{\cdot}802$.

6. *Comparison of the results in § 3 and § 4 with Experiments.*

Name of Experimenter	Altitude of Pressure.	Diameter of Orifice.	Distance of the greatest contraction from orifice		Diameter of the contracted column.	
			Observed	Computed	Observed.	Computed
	Paris feet.	Paris Lines	Paris Lines	Paris Lines	Paris Lines	Paris Lines
Bossut	11·736	12	$6\frac{1}{2}$	6	$9\frac{4}{5}$	9·43
„	11·736	24	$12\frac{1}{2}$	12	$19\frac{5}{8}$	18·85
„	11·736	36	18	18	$29\frac{1}{4}$	28·27
„	9·000	6	$4\frac{1}{2}$	3	$4\frac{5}{6}$	4·71
„	9·000	12	$6\frac{1}{2}$	6	$9\frac{4}{5}$	9·43
Venturi	2·708	18	11	9	14·3	14·14
	Rhenish ft.	Rhen. Lin.	Rhen. Lin.	Rhen. Lin.	Rhen. Lin.	Rhen. Lin.
Eytelwein	3·000	15	8	7·5	12·0	11·78

The experiments of Michelotti give for the diameter of the contracted column nearly the same results. The distance of the greatest contraction from the orifice is estimated by him smaller, so that it more nearly agrees with the radius of greatest contraction, than with the radius of the orifice. But it appears that the exact measurement of these distances is subject to various difficulties, and that the difference lies at least not wholly beyond the limits of the uncertainty of measurement.

7. *Remarks and Inferences.*

1. The contraction, according to the above investigation, arises from the sudden change of direction and velocity to which the particles of water immediately in the plane of the orifice are subjected. It depends (so far as the above experiments leave to be safely inferred) only on the radius of the orifice; whence it follows, that the force of contraction is proportional to the radius of the orifice.

2. For circular orifices, all the diametrical contractions will be equal and opposite; whence it follows, that *the sections of the contracted stream will be similar.*

3. When, on the other hand, the different diameters of the orifice are unequal, the sections of the stream vary in form, while the distance of the greatest contraction from the orifice will (1) be proportional to the several diameters or secant lines, and therefore will not be equally distant from the orifice, nor be in one plane; which must be considered as the condition of the *similar* form of section of the stream.

4. The above theory of contraction assumes that the reservoir is large, the movement of the water free, and the orifice completely isolated from the bottom and sides; also that the altitude of pressure is so large, that the depression of the surface which takes place above the orifice is inconsiderable. Without these conditions, the regular effect of the contraction would be intermitted; and in such cases, since the law of the irregularities is not yet known, we must for the present be content with an approximate computation.

5. The greatest mean velocity V determines the distance of projection of the stream, and takes place in the point of greatest contraction: we have, therefore,

$$(\mathrm{D})\quad \mathrm{V} = \frac{\mathrm{Q}}{(\frac{1}{4}\pi)^2 . \omega} = \frac{\mathrm{C}}{(\frac{1}{4}\pi)^2};$$

since $\mathrm{Q} = \mathrm{C} . \omega$ (§ 5).

6. The accurate determination of the quantity of discharge from the orifice, depends on the correct determination of the velocity V. Usually this is obtained by means of the altitude of pressure above the centre of the orifice, by the formula $\mathrm{V} = \sqrt{(4g\mathrm{H})}$, which neglects the influence of the height and figure of the orifice. This influence is considerable, but is smaller as the altitude of pressure increases, and for great altitudes may therefore be safely neglected. For a general investigation of the question, a more accurate and general computation of the velocity is however necessary.

7. The friction of the sides of the orifice, the difference between the pressure of the air at the surface of the water in the reservoir and the orifice, the resistance of the air against the issuing stream, and the influence of temperature on the quantity of discharge, must for the present remain unconsidered, as the foregoing experiments are insufficient to determine these small various effects.

8.

The mean velocity of water discharged through orifices in thin plates.

In the theorem of Torricelli, the altitudes of pressure are the abscissæ, and the velocities generated by them the ordinates of a parabola of which the parameter $= 4g$. If, therefore, in the parabola (fig. 2), AB be the axis of abscissæ, $z^2 = px$.

In the theorem of Torricelli, $\mathrm{V}^2 = 4g\mathrm{H}$; and, therefore,

$$z = \mathrm{V};\quad p = 4g;\quad \text{and } x = \mathrm{H}.$$

If the orifice be made in the bottom of a reservoir, and its surface be horizontal, the depth of water above it, or its altitude of pressure, is equal for every point in the orifice. Let, therefore, H designate the altitude of pressure; the velocity of issue for a horizontal orifice is found directly from the above equation—that is, $\mathrm{V} = \sqrt{(4g\mathrm{H})}$.

If, on the other hand, the orifice be vertical, as in one of the sides of the vessel, every horizontal section of the orifice has a different depth below the surface of the water; and then the mean velocity of issue for all the different velocities in the vertical extension of the orifice has to be calculated.

If ACF (fig. 2) be the vertical plane through the centre of the orifice, $e\mathrm{F} = v$ the diameter of height, $\mathrm{A}e = \mathrm{H}$ the altitude of pressure at the upper edge, the velocity for the altitude $\mathrm{A}e$ is equal to ed, and the velocity for the altitude AF (at the lower edge of the orifice) $= \mathrm{F}c$. The mean velocity between e and F, in the vertical section of the orifice, is therefore the mean value of the ordinates of the parabola between the limits ed and Fc, which may be easily found, as y' in §2,—namely,

$$z' = \frac{\int z\,dx}{\int dx} = \frac{\sqrt{(4g)}\int x^{\frac{1}{2}}\,dx}{\int dx};$$

since $z^2 = 4gx$.

Taking this integral between the limits $x = \mathrm{H}$, and $x = \mathrm{H} + v$, we find

$$(\mathrm{E})\quad z' = \mathrm{V} = \tfrac{2}{3}\sqrt{(4g)}\left\{\frac{(\mathrm{H}+v)^{\frac{3}{2}} - \mathrm{H}^{\frac{3}{2}}}{v}\right\}.$$

This expression gives the mean velocity in the vertical plane of the orifice eF, under the altitude of pressure H.

9.

A column of water may be considered as made up of an indefinite number of slices parallel to the vertical section; and every slice again may be represented as a very large number of threads of water. Give, now, to each thread a length equal to its velocity: and so a prismatic body is obtained of which the mean length or height gives the required velocity.

To estimate this length more closely, let the origin of co-ordinates be transferred to e (fig. 2): for the length of every thread of water, or what is the same thing, for its velocity, we have the equation $z^2 = 4g\,(\mathrm{H} + x)$.

Let y designate the indeterminate ordinate of the orifice, of which the area is therefore $= \int y\,dx$, and the content of the prismatic body $z\int y\,dx$, or rather $= \int zy\,dx$, since z is variable and a function of x. To find the mean length or height of this prism, we must divide its content by the sum of the threads of water, or by the area of the orifice—that is, by $\int y\,dx$. In this manner we obtain generally—

$$(\mathrm{F})\quad z' = \mathrm{V} = \frac{\int zy\,dx}{\int y\,dx};$$

Substitute for z the above value, and we have—

$$(\mathrm{G})\quad \mathrm{V} = \frac{\sqrt{(4g)}\int y\,dx\,\sqrt{(\mathrm{H}+x)}}{\int y\,dx}.$$

And this is the expression for the mean velocity with which the water at any vertical orifice whatever in a thin plate is discharged.

The velocity being known, the quantity of discharges at the orifice is easily determined. Let the quantity of discharge $= \mathrm{Q}$, and k the co-efficient of contraction: we obtain—

$$Q = kV\int y dx.$$

And when for V its value found above is substituted, it follows, that

$$(H) \quad Q = k\sqrt{(4g)}\int y dx \sqrt{(H + x)}.$$

If the orifice be situated in the bottom of the reservoir, and be horizontal, $V = \sqrt{(4gH)}$, we obtain

$$(I) \quad Q = k\sqrt{(4gH)}\int y dx.$$

(To be continued.)

THE PUBLIC WORKS OF ENGLAND.

No. II.—Caledonian Canal.

The whole progress of the Caledonian Canal is so entirely illustrative of the conduct of public works in this country, that a detailed account of it would not be undesirable.

The act for the purpose, which passed on the 27th December, 1803, granted to the government the sum of 20,000*l.* for the undertaking. The engineering and conduct of the canal was entrusted to Telford, but the commissioners appointed another eminent engineer—Mr. Jessop—to survey the line and calculate the cost. The estimate of these gentlemen for the whole work was 474,000*l.*, exclusive of the price of land, which expense, they supposed, would not be considerable—many proprietors having offered their land gratuitously, and the general value of land in the country through which the canal passed not being great. The expense for the first year was calculated at 75,000*l.* Before the close of the year docks on both seas were in a considerable state of forwardness; they were set out at 400 yards in length and 70 in breadth; 400 bolls of oatmeal (56,000 lb.) were lodged in storehouses, and delivered to the workmen at prime cost; 150 persons were set to work, besides persons making and repairing utensils—a number in those days thought very great, though a railway engineer would smile at it. The average wages to the workmen was 18*d.* a-day. Fir was cut down on the spot or in the neighbourhood, costing from 10*d.* to 14*d.* the cubic foot—imported timber would have been twice as dear, and answered no better. Thus the preparatory arrangements were begun with much forethought and economy.

The salary of the engineer, Mr. Telford, was at the rate of three guineas per diem, including travelling expenses, with some allowances for the expenses of one or two lengthened journeys. This sum would make Mr. Brunel stare. The salaries of the superintendents were fixed at from 50 to 150 guineas per annum. The valuation of the land was about 15,000*l.*

Great apprehensions were entertained that the nature of the soil would interpose insuperable difficulties. Mr. Jessop's report, in the actual state of geological knowledge, is curious. "It seems (he states) probable that in some early age of the world the immense chasm, almost two-thirds of which is still occupied by water, has been nearly (why did I not say quite) open from sea to sea, and that the land which now separates the locks has been formed from the decay of the adjoining mountains. This decay is very apparent in Ben Nevis, which is evidently a part only of a much greater mountain which seems to have included the present one and two adjoining mountains of lesser height. Impressed with this idea, I was very apprehensive, after the first trials of the ground at Inverness, that many other parts would be found similar to it. That greatest part of the land there being composed of gravel and sand, is so open that the water in the pits sunk and rose with the tide. Fortunately, a place has been discovered where a foundation on clay may be got at by surrounding the pit with a cofferdam." It was found generally that the gravel and sand had a sufficient admixture of earth to exclude water.

The width of the locks was calculated at 38 feet, length in the chamber 152 feet: 23 locks were provided for, at an estimate of 171,327*l.*, and as many bridges, at an approximate estimate of 34,000*l.* The common cutting of the canal was estimated at 142,000*l.*, the depth being 20 feet, with a bottom of 50 feet—a slope of 18 inches to a foot, and 90 feet width at the surface. The remainder of the estimate was for deepening rivers, cofferdams, aqueducts, culverts, with a sum of 12,000*l.* for steam-engines.

By the time a single year had passed, the usual fate attended these estimates. It was found that the locks would be too small, as frigates of 44 guns might be required to pass—the length was extended to 185 feet and the breadth to 43, with an addition to the estimate of 122,624*l.* Then side locks were required for small vessels, to save the wear and tear of the large locks; these were further estimated at 75,200*l.* Iron railways were constructed for the purpose of conveying stone from the quarries opened in the vicinity of the canal—one of them 11,000 yards, a great length in those days for such a purpose. The number of labourers was increased from 150 to 900. The greatest difficulty was encountered in the erection of the sea locks, in the construction of which a good deal of ingenuity was exhibited.

In addition to the increase of other estimates, the salaries, as usual, were increased. Two resident inspectors were appointed, and several other officers, at allowances of upwards of 200*l.* yearly each. Far more trouble and expense than was anticipated occurred in the valuation of land, which the proprietors did not seem disposed to part with gratuitously, nor at other than a high value.

A great improvement on the usual practice of canals was introduced at the very commencement of the undertaking in the construction of the bridges. On the Forth and Clyde Canal wooden drawbridges had been used at first, raised by chains and timber framings; as these wore out, cast-iron bridges were substituted, raised by a wheel and pinion; but the Caledonian bridges were of iron, on the swivel principle, which had been already used in the London Docks. One of the most important works in the early stage of the canal was the altering the course of the rivers Ness and Oich. The beds of both of these rivers were required for the canal. The embanking necessary was very extensive.

In 1820 the first steamboat was constructed for the canal by Mr. Henry Bell, the introducer of steam navigation into England, and the person who established the well-known steamboats on the Forth and Clyde.

On the 23rd of October, 1822, the canal was opened from sea to sea with very great ceremony. The principal landlords along the land fired salutes and gave entertainments on the occasion, and the papers of the day describe the affair as one of great magnificence. The passage back, from west to east, was made in 13 hours. The depth of water was then only 12 feet, but dredging-machines were in active operation for the purpose of deepening the canal to 20 feet.

The entire term, from the commencement to the opening of the canal, was 19 years. It was begun in October, 1803, and opened, as we said, in October, 1822. The expenses to this time were 921,373*l.*—of this no less than 47,886*l.* was paid for land which was to have been granted gratuitously; 612,770*l.* was paid for labour and did vast good to the country. The steam machinery, estimated at 10,000*l.*, only cost 5,598*l.*, but the whole machinery cost upwards of 121,408*l.* The cost of management for the whole time averaged under 1,500*l.* per annum. On the whole, and by comparison with modern undertakings, this great enterprise was conducted with extreme economy and great ability. At times the persons employed on the canal at one time amounted to above 9,000.

In the first year of the opening 307 vessels entered the canal, of which 37 passed from sea to sea. This was then considered a favourable account. The tolls fixed were a farthing a ton per mile, with an increase upon very short voyages.

From May 1822, to May 1824, 278 vessels passed through the canal, but the expenses of maintaining the canal were considerable. Nearly 200 workmen were employed on the works, and the tonnage duty was consequently doubled. The canal dues, previous to the increase, from the year quoted above, amounted to 1,555*l.* Notwithstanding the increase the profits of the canal were small—more workmen were obliged to be employed. The increased tonnage drove the shipmasters to the circuitous passage of the Pentland Frith, though even now the duty on the whole passage was but 2*s.* 7*d.* per ton. One of the reasons for increasing the duty was the complaint of the proprietors of the Forth and Clyde Canal, who complained that the Caledonian, constructed at the public expense, entered into an unfair competition with them by low terms.

Since that time no efforts have been able to make it a profitable one, though the Caledonian Canal, taking the circumstances of the time in which it was constructed into consideration, is a work of which the nation may be justly proud.

The mounds, which guard the entrance of the canal at the Beauley Frith, were advanced from the high-water mark to 4 fathoms deep of water; at the end is the sea lock. These immense works are 400 yards long, and took four years to construct.

The settling of the vast bottom of mud and earth took two years; and the cradle of masonry which surrounds it, capable of receiving the largest merchant ships, is 170 feet long, 40 feet wide, and 30 feet deep. The other works throughout the canal are on a similar scale. At the entrance of the lakes, owing to the sponginess of the ground, great difficulties were surmounted by the perseverance of the engineer. The dredging necessary for excavation of such an extent was constructed with immense ingenuity. Neptune's Staircase, which we have already mentioned as connecting eight locks in succession, contains 400 yards of solid masonry. A construction of the kind had never been attempted before.

On the whole, few works show more vividly the untiring ingenuity and perseverance of the country than the Caledonian Canal.

No. III.—LIGHTHOUSES.

Before the invention of the mariner's compass, beacons and coast signals were indispensable for the safety of the mariner. The vessels whose safe voyaging depended upon their never losing sight of land, trusted to the natural and artificial signs which enabled the pilot to determine his position; and this object was accomplished in many instances by beacon lights, which served for guides during the darkness of night. Around the shores of the Mediterranean we have reason to believe that these lights were thickly studded—the Colossus of Rhodes and the Pharos of Alexandria being the most celebrated. Both of these beacons are supposed to have been erected about 300 years before the Christian era, and to have endured until long after its commencement. Next to these in point of time was a light-tower near Corunna, on the Spanish coast, built, it is said, to aid the Irish navigators in their voyages to Spain—this, at least, is the supposition of Mr. Moore, in his 'History of Ireland'—and which Humboldt states to be evidently an erection of the Roman period. The light in all these beacons was derived solely from the flame of wood or pitch burnt in open braziers, and visible comparatively for small distances.

Turning to the lighthouses of modern days, we find that the light-tower of Corduan, in the Bay of Biscay, is alike the first in point of time, the chief in height and range, and the example for all the improvements that have been successively made in the production and transmission of the warning rays of light to perplexed mariners. This tower was begun by Louis de Foix, in the reign of Henry II. of France, A.D. 1584, and finished in 1610, under Henry IV. It is situated at the mouth of the Garonne, about two leagues from Bordeaux, and serves as a direction to all the coast navigation of the Bay of Biscay, as well as to the large influx of shipping attracted towards the *embouchure* of the celebrated Languedoc Canal, which leads into the Mediterranean. The Tour de Corduan is 157 feet in height, and its light may be seen in a direct line for 25 miles in clear weather. Even on the Isle of Bone, 38 miles distant, a spectator, looking from some elevated point, may detect the blaze in the horizon; but the curvature of the ocean hides the light from the seaman on deck. Its light is intermitting, changing, at half-minute intervals, from white to red. Even the red rays, whose penetrating powers are far inferior to the white, are visible as far as 12 or 14 miles, except in hazy weather. From its erection down to 1780 the light of this tower was derived from the flame of wood. In that year M. Senoir substituted oil-lamps, with metal reflectors; and in 1822 M. Fresnel extended the range of illumination to the extraordinary distances we have mentioned above, by the addition of dioptric lenses, acting upon lamps of an improved and more powerful construction. The use of this and similar beacons upon that coast has been enormous. In the era of its first erection one of the Breton counts, who, as lord of the soil, possessed rights of trover and wreckage along the coast, is said to have boasted to a jeweller that a single black rock which stood in the tideway was more valuable to him than the best diamond in his caskets.

In England, the earliest lights and beacons along the coast were erected by individuals, to whom royal patents were granted, authorising them to collect certain tolls from the passing vessels to defray the cost of building and maintenance. The right of constructing those sea signals, however, rested solely with the crown; and, in fact, the far larger number were used only in times of warlike expedition, and for certain special purposes. The earliest lighthouse which still remains in existence was that of Lowestoft, built in 1609. Another at Hurstbarton Point, on the east coast, was erected in 1665; and the light on the Scilly Isles dates its establishment from 1680. Besides these there were two light-towers erected during this period at Dungeness and Orfordness, under patents granted by James I. to Sir R. Howard and Sir W. Erskine. These establishments remained private property, paying only a small quit-rent to the crown, until very recently, when the Trinity Board, under the act of 1836, purchased them both at a high price from their owners, Mr. Coke and Lord Braybrooke.

The earliest of the above dates (1609) saw the final establishment of that board under whose control all the English lighthouses, and almost all the authority over English commerce and navigation, was ultimately to pass—namely, the Brotherhood of the Trinity-house. This institution first commenced in the time of Henry VII., as a private confraternity of seamen and shippers. In the sixth year of his successor, Henry VIII., the brotherhood received their first charter as a recognised "Guild," under the title of the "Brotherhood of the Trinity-house of Deptford le Strand and St. Clement." The charter commences with the curious declaration, that "On account of the sincere and entire love, and likewise devotion, which we bear and have towards the most glorious and undividable Trinity, and also St. Clement the Confessor," his Majesty gives and grants licence for the establishment of a guild, or perpetual fraternity, to certain individuals and their associates, "as well men as women." Early in Elizabeth's reign this charter was confirmed, and again in the 36th year of that sovereign, when, for the first time, those powers were granted which have subsequently led to the authority of the Trinity Board over all lighthouses. In that year the Lord High Admiral of England, Charles Howard of Effingham, formally relinquished all claims on his part and on the part of the crown in the rights, privileges, and emoluments for "buoyage, ballastage, and beaconage," which were thenceforth assigned to the Trinity Brotherhood. James II., in confirming this charter extended the powers of the fraternity, and organised the board pretty much as it still exists. His first patent appoints "Our trusty and well-beloved Samuel Pepys, Esq., secretary of our Admiralty of England, to be the first and present Master of the said Guild, Fraternity, or Brotherhood." The charter was again enrolled and confirmed by George II., and in the 6th and 7th session of William IV., the Trinity-house received enlarged powers, under which the whole number of lighthouses on the English coasts, many of which had up to that time remained private property, under grants or leases, were re-purchased, and amalgamated under a uniform administration. The only exemptions to the rule of the Trinity Board are in the instances of certain harbour lights, which still continue in the control of local trustees.

The dates of the several patents granted to the Trinity-house begin with 1680, when Charles II. authorised the erection of the Scilly Light. Two other patents were issued by that monarch, for the light beacons of Spurm and Tynemouth Castle. Anne granted one patent to the Trinity-house for Milford Haven; George I. granted four; George II., seven; George III., fifteen; George IV., seven; and William IV., five.

The year 1656 saw the foundation first laid for that celebrated structure the Eddystone Lighthouse. Mr. Winstanley was the architect, and the tower stood 60 feet high in a sea whose waves, during heavy storms, dash to an altitude of nearly 100 feet above the lantern. The light was first exhibited in 1698, and burnt steadily for five years, when the whole edifice was swept away by a furious gale in November, 1703, while Mr. Winstanley was himself within it. This lighthouse was formed of courses of stone, bound together with timber, and its destruction is attributed to the comparative lightness of its materials and the slight foundation prepared for it on the rock.

A tradesman on Ludgate-hill. Mr. Rudyerd, then undertook the construction of a tower, wholly of wood. The form was that of a conical cask, 70 feet high, with its lower ranges stiffened and strengthened with courses of masonry. But the chief improvement in this tower was in the contrivance of its foundations. The irregular and shelving surface of the rock was levelled into a range of broad steps. Into these steps a number of holes were drilled, in sets of three each, diverging slightly from above downwards; when the three being broken into one, left a cavity of a conical form, widest at its lower end. A compound wedge of iron being driven tight into this cavity, clamped together, and the interstices filled with melted lead, formed an immovable basis whereto the lower piles of timber or blocks of stone might be secured. This contrivance, introduced by Mr. Rudyerd in the Eddystone, has since been extensively employed in lighthouse and submarine works. The wooden tower bore the brunt of the weather from 1708 until 1755, when it unfortunately caught fire, and, after burning for several days, was totally consumed. Two years later Mr. Smeaton was engaged in founding the present edifice. On the 16th October, 1759, the lights were first shown, and have never since ceased to shine from sunset to sunrise. At first the only source of illumination was derived from tallow candles, which were continued long after the far better method of lighting by means of Argand burners had been extensively used. In 1807, at the expiration of a long lease, the Trinity Board came into possession of the Eddystone lighthouse, in which they at once substituted the oil lamps as they at present exist. The light is revolving, in a period of one minute, and is visible, in clear weather, for 13 miles.

The successive improvements in the mechanical operation of lighting introduced during this period may be thus recapitulated. Up to 1784, open fires of coal, wood, or pitch, were generally used; in some few instances a system of tallow candles, protected by glass frames, being substituted. In that year M. Argand invented the oil-lamp known by his name. M. Borda, very shortly afterwards, contrived to adapt the invention to lighthouses. The Trinity Board were not insensible to the value of this discovery. A deputation, consisting of the deputy-master and several of the brethren, visited France to inspect the results, and reported so favourably, that it was speedily adopted in this country, and extended to Scotland and Ireland. In 1789, the suggestion of Buffon and Condorcet, for the manufacture of glass lenses of large diameters, was adopted for a lighthouse in the Isle of Portland; but, owing principally to the imperfect state of the glass manufacture, was found impracticable. In 1811, Brewster invented the method of building large lenses in segments or zones of separate pieces, and recommended the adoption of these infracting or "dioptric" glasses in lighthouses. Nothing was done, however, until Fresnel set the example eleven years afterwards in France, where the majority of lights are now constructed upon that system. Only a few, comparatively, of the British lighthouses have to the present day abandoned the use of the reflectors, or "catoptric" lights. Yet the relative power of the dioptric lamps is two to one, and its economy nearly three to one over the reflecting burners, and they transmit no less than 360 times the light of an unassisted flame. On the other hand, there is some additional cost in the first erection of the lenses. Some attempts have been made to employ the still higher illuminating powers of coal gas; but hitherto the difficulties have not been surmounted. The chief obstacle is in the danger of fire and the liability of disorder in the apparatus, which has to be reduced to a small compass within the narrow limits of the light-towers, and entrusted too often to the custody of men who are incompetent to conduct the operation. Nevertheless, gas was used in a lighthouse at San Salvore, on the coast of Istria, as early as 1818, and found to give a better light than oil, with a saving of 900 florins a-year. It was also employed in the Dantzic tower, which had formerly been lighted by an open fire of coal, consuming three times as much as the gas apparatus. Wax candles were afterwards employed in the same lighthouse, and 1080 lb. weight burnt in a year. Oil flames urged with oxygen gas, and the brilliant "Drummond" or lime light, were subsequently subjected to experiments, with a view to their introduction as sea lights. But the same mechanical difficulties and dangers stood in the way of their adoption, and it was further discovered that a light from a small luminous point, however brilliant, was not so appropriate as that from the extensive surface of the Argand burners, of which no less than 24 were sometimes used in a single lantern. Sir David Brewster also proves that the ordinary quantum of light from the oil lamp is quite sufficient for all maritime purposes in clear weather. Yet the lime light, which casts a distinct shadow at 18 miles distance, might be advantageously introduced as an assistant in hazy weather. At present the obscurity of fogs is compensated as far as possible by gongs, bells, and guns, which are rung and fired at intervals from the beacon towers.

As the lighthouse stations multiplied, it became necessary to contrive some distinguishing mark by which the pilot might determine the one he sought. Various forms and changes of the light were, therefore, introduced, accomplishing nine varieties—viz., the fixed white, revolving white, revolving red and white, revolving red and two whites, revolving white and two reds, flashing, intermittent, double fixed white, double revolving white. As the red rays penetrate little more than half as far as the white, no light must consist of red alone, especially as even white will look red through a dry haze. The other colours are less penetrating still, and therefore wholly unfit. According to the rule laid down by Mr. Stevenson, no two lighthouses within 100 miles of one another should have the same characteristics. The catastrophe of the *Great Britain* steamer is a sufficient evidence of the necessity of observing this rule, as it arose solely from a misapprehension of the light on the Calf of Man. Now that lighthouses are becoming so thickly multiplied, even the nine variations we have mentioned become insufficient; and efforts are making to invent means for making numeral figures visible at great distances when traced in light. Already it is stated that the numbers can be distinguished at a distance of 12 miles.

A parliamentary committee was appointed in 1844, chiefly by the perseverance of Mr. Hume, to investigate the condition and administration of the British lighthouses, and published a voluminous report as the result of their labours. As usual, great mismanagement was proved to exist, combined with an uncertainty and inconsistency in the charges and tolls levied upon shipping, which must have occasioned considerable injury to our commerce. The worst results, however, were found to arise from the system of private management which still existed, either under old grants from the Crown, or in virtue of some very inconsiderate leases by the Trinity Board. The private owners in all cases thought only of making a large revenue from their monopoly, and in many instances had omitted to adopt the improvements in lighting universally employed elsewhere, and had occasioned some severe losses of shipping by their criminal negligence. There was one light-tower in the Isle of Man, on the Scotch coast, which belonged to the Duke of Portland, and so late as the year 1810 was lighted by the primitive contrivance of an open coal fire. In that year, two frigates of the royal navy, the *Pallas* and the *Juno*, mistook for this light the flame from a lime kiln on the shore of East Lothian, and were lost in consequence. Several lives were sacrificed, besides the two ships, which were worth 200,000*l.* The lighthouse has since passed into the keeping of the commissioners of northern lights, and is provided with the proper Argand and reflecting apparatus. The purchase money paid to the duke, together with the outlay requisite for the introduction of an improved system of illumination, amounted to 70,452*l.* Proofs of inattention, less in degree but equally unjustifiable, were discovered in other lighthouses under private management. It was proved also that while the costs of maintenance were far less than in the navy lights erected by the Trinity Board, the revenues collected were per light somewhat superior, and the net income to the proprietors and lessees 60,392*l.* per annum, drawn from the commerce of the country.

Some curious anomalies were also exposed in the levying of tolls on vessels, for the supposed advantage of the lights. Thus, throughout England a duty of ½*d.* to 1½*d.* per ton was levied on every vessel passing a lighthouse, the rate varying with every light, which had its distinct rules and system of collection. In Scotland, on the other hand, a ship that passed one light paid a certain rate per ton for the whole number, and no more, if it went the entire circuit of the coast. In the voyage from Leith to London, therefore, a vessel of 142 tons would pay 1*l.* 9*s.* 7½*d.* for the Scottish lights, though it passed only one of them; and would have 4*l.* 17*s.* 3*d.* charged for the 19 English lighthouses passed between Berwick and London. A Yarmouth vessel also, bound for the Thames, but driven by stress of weather to the Frith of Forth, would pay for the whole series of Scotch lights, though it had used none, having only been driven into their waters. In Ireland, the charge was made at certain rates on the tonnage of every ship entering an Irish port, whether it had passed a lighthouse or not.

In consequence of the report of the committee in 1834, the act 6 and 7 William IV. was passed. Under this statute all the private rights in lighthouses were extinguished, and bought up by the Trinity-house at a cost of no less than 1,182,546*l.*, such was the presumed value of these indispensable monopolies. Of this sum Mr. Coke had 20,900*l.* for Dungeness lighthouse, and Lord Braybrooke 37,896*l.* for the one on Orford Point. The Small's light cost more than four times as much—170,468*l.* But the worst instance was that of the Skerries lighthouse in the Irish Channel. Queen Anne had granted a patent, in 1715, to Sutton French, Esq., to erect a light-tower off the coast of Anglesea, for the benefit of the Irish shipping, and levy a toll of 1*d.* per ton on all passing vessels, in recompense of the same. The immense increase in Irish commerce had rendered this light incredibly profitable, as it was kept up at a cost, probably, of under 500*l.* per annum, and the returns were over 20,000*l.* For a long time Mr. Morgan Jones, the representative of the first possessor, resisted all the efforts of the Trinity-house to make him surrender his claim, or even furnish any account of his receipts, alleging that his patent was granted in perpetuity, and without rent or fee to the Crown or other authority. The stringency of the late act, however, compelled a production of the accounts, and after much litigation a jury assessed the compensation to Mr. Jones at 444,980*l.*, being 22 years' purchase of 20,042*l.* annum revenue. This transaction closed in 1842, and since then all the English coast lights are under the management of the Trinity-house, and quite free from private claims. Some steps have also been taken towards reducing the tolls which are a heavy burden on commerce, and being levied per voyage, fall with unjust severity on the coasting and packet trade. When the debt for purchase has been extinguished, further remissions are promised.

In Scotland, the earliest lighthouse was that of Cambrae, on Little Cambrae Island, built in 1756, and rebuilt in 1793. The Leith light was established in 1780, and that on Cape Wrath, completed in 1796, is visible for 26 miles, being the widest range of any British light. The Bell Rock, finished in 1811, at a cost of 61,331*l.* and the Skerryvore Lighthouse in Argyleshire, completed as lately as 1844, for which the estimated cost was 31,500*l.*, are the works of most interest in an engineering point of view. Enormous difficulties were overcome in the construction of these edifices, and both remain triumphs of British skill and science. Their details are, however, too well known by the memoirs of their respective engineers, Alan and Robert Stevenson, to justify a repetition. The height of the Bell Rock tower is 100 feet, that of the Skerryvore 138 ft. 5 in. In the lantern of the former there were 24 parabolic reflectors, each 18 inches across the tips, and containing 21*l.* worth of silver on its polished surface. Ireland first possessed a lighthouse in 1768 at Poalbeg, at the entrance of the Dublin river. The Balbriggen light was erected in the following year; that on Clare Island in 1807, and is visible for 15 miles. Cape Clear and Arran lights were built in 1817. The Scellig Rock Lighthouse was the most expensive of the Irish beacons, costing 41,651*l.*

The Isle of Man has seven lights, that of the Calf being the chief. Two beacons, one in Denby Haven, built in 1659, and another in Castletown Harbour, built in 1765, are intended to aid the herring fishery, and are lighted only during that season.

At present the British system of lighthouses remains under the control of three boards—1. The Trinity-house Brotherhood, consisting of 31 members, 11 of whom are honorary, and the rest more or less connected with commerce or shipping. Established about 1553.—2. The Commissioners of Northern Lights, holding jurisdiction over the Scotch and Isle of Man lighthouses, consisting of 25 members, being sheriffs and county magistrates. Established 1786.—3. The Dublin Harbour Corporation, otherwise called the Ballast Board, to whom was committed, in 1810, the custody of the Irish lights, consists of 20 members, chosen for life among the chief merchants and bankers, together with the mayor and the sheriffs of Dublin for the time being. One day in each week the board sits for lighthouse purposes.—A number of small lights remain under the control of local authorities and harbour trustees, &c.

The system of lights administered by the three boards abovementioned, comprised in the year 1844—Trinity-house, 65 fixed and 23 floating lights; Northern Commissioners, 32 fixed, 2 floating; Dublin Board, 27 fixed, 4 floating; local and harbour lights made up a grand total of 312 British lighthouses. The cost of maintaining the public lights was, on the average, about 500*l.* per annum for the fixed, and 1,200*l.* for the floating lights. The gross sum collected by the three boards for 150 lights (local and harbour being exclusive) was 349,475*l.* Of this 131,036*l.* was expended on maintenance, and 15,814*l.* in charges of collection, leaving a surplus of 196,631*l.* on the year's receipts. The charge for collection amounts to 4*l.* 5*s.* per cent., an exorbitant sum, when the Customs duties are collected for 2*l.* 2*s.* 8*d.*, and the parish rates for Marylebone at 1*l.* 6*s.* 8*d.* per cent. The tolls are now paid by a rate per ton for every lighthouse passed in the ship's voyage. No symmetry is, however, preserved by the different boards in the rates levied. The Irish Corporation charges $\frac{1}{4}$*d.* per ton for every light without exception. The English lighthouses vary their tolls from $\frac{1}{8}$*d.* to $\frac{3}{4}$*d.*; and the Scotch from $\frac{1}{4}$*d.* to 1*d.* per ton per light. These are for English merchant vessels; foreigners pay double, and Royal Navy ships nothing. Many complaints are urged against the amount of these tolls, and of the injury they inflict on trade. England is the only country, indeed, where the lighthouses are not supported out of the general finances of the State, instead of being made a source of revenue wrung from the shipowner and trader.

Of the original cost of the early lighthouses no accurate account has been kept Of course the local difficulties occasioned an enormous difference in the necessary outlay on each. The most expensive seems to have been the Bell Rock, 61,331*l.* The Isle of Man Beacon, exhibiting three lights, cost 20,823*l.*; the Cape Wrath, 14,506*l.*; and the Barrhead 12,575*l.* The engineering improvements of modern days have much diminished the expense of their construction: 12 lighthouses erected by the Trinity Board between 1820 and 1834, cost 47,124*l.*, or, on the average, 3,918*l.* apiece. In the way of receipts, the Bideford Bar light stands lowest; its annual return having been 350*l.*, while the cost of maintenance was nearly 800*l.* It is the only losing concern in the whole lighthouse system. Eddystone has four keepers regularly employed; about 12 others, 2; and the rest 1. The consumption of oil varies from 1,200 gallons per annum at Beachy Head to 64 at Pakefield.

France, in 1845, possessed 153 lighthouses—77 in the Channel, 47 on the west coast, 24 in the Mediterranean, including Algiers, and 5 in Corsica. No less than 93 of these were on the lens or dioptric principle. By an *ordonnance* of the Emperor, in 1806, the lighthouses were placed under the control of the Minister of Travaux Publiques and defrayed out of the Exchequer. The cost was about 110*l.* annually per light.

America, at the same date, possessed 272 lights of various descriptions on her seaboard. For the cost of them 83,333*l.* was charged upon the public service of the year, amounting to a little over 300*l.* for each establishment.—*Daily News.*

REGISTER OF NEW PATENTS.

MACHINERY FOR ROLLING IRON.

William Clay, of Clifton Lodge, Cumberland, engineer, for "*improvements in machinery for rolling iron or other metals, parts of which improvements are applicable to other machinery in which cylinders or rollers are used.*"—Granted December 16, 1848; Enrolled June 16, 1849. [Reported in the *Patent Journal.*]

The improvements relate to rolling certain forms of iron and other metals which are wholly or partially taper, or conical. In the ordinary methods of manufacturing such taper bars, the centres of the compressing rollers are maintained at the same distance apart during the whole of the process of rolling; the requisite taper being given to the bar rolled by eccentricity of the grooves or their depth below the surface of the rollers; thus, if the depth of the grooves upon the rollers progress the same depth throughout, the result will be parallel bars; but if the depth gradually varies, then the result is a gradual taper bar.

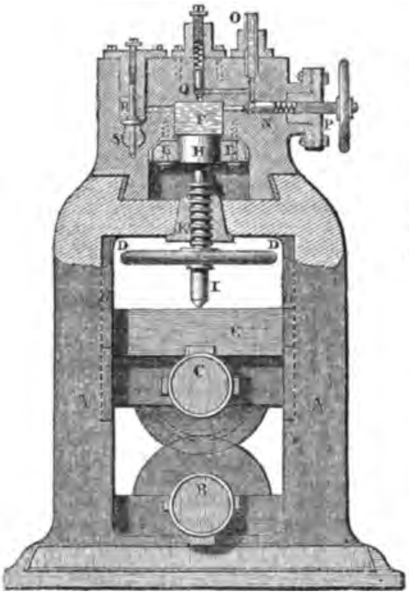


Fig. 1.

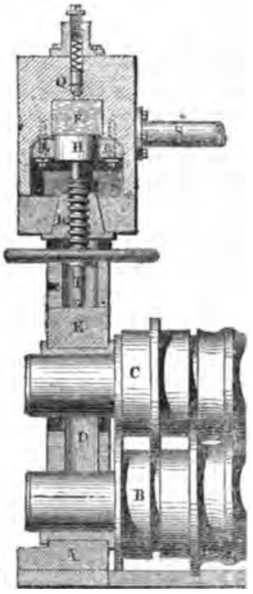


Fig.

The improvements are for producing taper bars from rollers, although the grooves in them may be the same depth throughout. This is to be effected by the gradual separation of the centres of the two rollers; and, as the bottoms of the grooves are concentric to the centres, it follows that their surfaces are also increasing their distance apart, and thus allow the bar of metal which passes between them during the time of this separation, to assume a taper form; the amount of taper given corresponding to the proportionate rate at which the rollers are separated from each other.

The patentee describes two modes of effecting the object in question; the first by means of hydraulic apparatus; and the second by means of an eccentric or heart-shaped cam.

The first method is shown in the annexed engravings, fig 1 being an end elevation of the rollers, the upper part representing the hydraulic apparatus, being in section; and fig. 2, a vertical section of the hydraulic apparatus and the framing, taken through the centre line of the rollers. A, the framing, constructed in the manner usually adopted in ordinary rolling-mills; B, the bearings of the lower roller, stationary upon the framing, as usual; but those E, of the upper roller C, are moveable, by sliding vertically in the grooves D; and for the purpose of placing the bearings E, within their respective grooves, portions of the frame A, in front of the grooves, are made moveable, as shown at *a*; and when the bearings E, are placed within the grooves, these pieces *a*, are secured in their places. Upon the upper part of the framing A, is placed the head containing the hydraulic apparatus; and this consists of the cylindrical chamber F, to contain the water or other fluid employed. Into this chamber passes the solid ram or piston H; the rod I, of which passes downward loosely through the screw K, to the bearing E, of the upper roller, against the upper side of which the end of it bears. The ram H, passes into the chamber E, in a fluid-tight manner, by means of the packing and the packing-ring or plate L, which is secured by screw-bolts N. The regulating valve, when opened, allows a stream of the fluid to pass from the chamber E, to the discharge-pipe O, by which it is carried off. The quantity of the fluid discharged by this valve will depend upon the extent to which it may be opened; and this can be regulated to the greatest nicety by means of the screw and wheel-handle P. The purpose of the valve is to regulate the flow of fluid from the chamber E; and thereby, by allowing the upper roller to recede from the lower one, to shape the bar passing between the rollers of the taper form required. As the smaller in quantity the stream of fluid which flows from the chamber E, the less will be the taper of the bar rolled; the taper being greater when the flow is larger in quantity. As the fluid employed in the chamber is water, or some other of practical incompressibility, the rise of the piston H, into the chamber E, will depend upon the quantity of fluid discharged, and consequently, the receding of the upper roller from the lower. Q, is another valve, the exit from which flows into the discharge-pipe O. This valve is retained in its seat by means of a powerful spring, and is only intended to act under great pressure, to prevent injury to the apparatus;—it is, in fact, a safety-valve.

After a taper bar has been rolled, the upper roller again approaches the lower one, resuming its former situation; and to allow the piston to descend with it, it is requisite a quantity of water should be passed into the chamber, equal to the quantity expelled through the valve N; and this is accomplished through the valve R, from the feed-pipe S. At the back of the valve N, is a slight helical spring, for the purpose of closing the valve against its seat—immediately upon the flow of fluid through it ceasing. This takes place upon the rolled bar leaving the rollers; the valve not being attached to the screw, allowing it. The use of the screw will be explained hereafter.

In rolling taper bars by this apparatus, the workman regulates the flow of fluid from the chamber F, by means of the valve and screw, and which by a little experience, he is enabled to do with facility and with great accuracy; the bars in passing between the rollers assume the taper form, by reason of the upper roller receding from the lower one, the passing of the piston H, into the chamber F, admitting of this elevation, and the extent of that elevation being regulated by the discharge of fluid from it past the valve N; the bar being rolled, it passes from between the rollers, the upper roller again approaching the lower one to its original situation. The flow of fluid from the chamber F, is suspended, the valve N, closes by means of the spring, and a supply of fluid is admitted to the chamber, by the valve R, preparatory to another bar being passed between the rollers. The rollers B, and C, are of the ordinary construction. The patentee describes a modification of the above-described mode of effecting the same object: in place of employing the hydraulic apparatus described, he employs an eccentric, or heart-shaped cam, fixed upon a revolving horizontal shaft; to effect the rise of the upper roller, a rod somewhat similar to the rod I, already described, bears against the upper side of the bearing of the upper roller, and the other end against the periphery of the cam—the movement of the cam allowing the upper roller to rise. When it is required to roll a bar which shall be taper for only a portion of its length, the remaining portion being parallel, the screw K, is brought into operation, which is to be screwed up or down, as required, until it assumes such a situation that, by the time a length of the bar, equal to the taper part required, shall have passed between the rollers, the upper side of the bearing of the upper roller comes against the under side of the screw; thus preventing all further separation of the rollers. The remainder of the bar will consequently be parallel.

The patentee claims: First—The application to rolling machinery generally, of apparatus which will allow the bearings of one of the compressing rollers to rise gradually in the framing during the operation of rolling, and by this means admitting of taper forms of bars being produced with facility equal to parallel bars.

Secondly—The arrangement, construction, and adaptation of the hydraulic apparatus described to machinery, for rolling iron, or other metals, by which the compressing rollers are caused to separate gradually, for the purpose of rolling, and forming bars of taper form, &c.

Thirdly—The modification of the apparatus consisting of an eccentric, or heart-shaped cam, which, revolving, is employed to regulate the gradual separation of the rollers described.

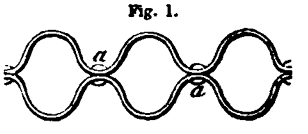
Fourthly—The adjusting screws in connection with the other apparatus, for the purpose of rolling and forcing the bars of metal taper for a portion of their length, and parallel for the remaining portion.

CORRUGATED IRON BEAMS

John Henderson Porter, of 2, Adelaide-place, London-bridge, in the city of London, engineer, for "*an improved mode of applying corrugated iron in the formation of fire-proof floors, roofs, and other like structures.*"—Granted December 2, 1848; Enrolled June 2, 1849.

This invention relates to the construction of fire-proof floors, roofs, and similar structures, with two or more plates of corrugated iron, placed one over the other,—the corrugations of one plate being so situated with reference to the corrugations of the other, that, when the plates are riveted or bolted together, they will form a series of united tubular ribs; which ribs are to be used either in a horizontal, arched, or inclined position, as joists, beams, ribs, rafters, or other like supports.

Fig. 1.



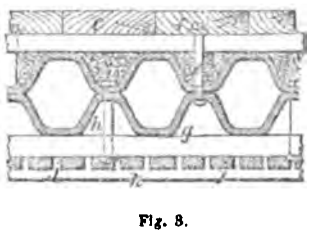


Fig. 3.

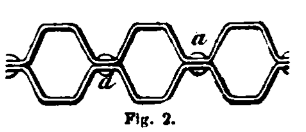


Fig. 2.

Figs. 1, and 2, represent end views of two different forms of corrugated plates, which may be used for the purposes above-mentioned,—the plates being united by rivets at *a*, *a*. The form of corrugation may be varied; but that preferred by the patentee is shown at fig. 3.

Fig. 3 represents a section of corrugated plates forming a united series of tubular horizontal beams or joists, and applied to the formation of a level boarded and ceiled floor. For this purpose, the corrugations or grooves in the upper side of the top plate may be filled with concrete *b*; the flooring boards *c*, are nailed to fillets of wood *d*, which are laid across the upper parts or ridges of the corrugated plate, and secured at intervals by bolts *e*, and nuts *f*; and, in order to form the ceiling, fillets of wood *g*, are secured by bolts *h*, and nuts *i*, to the under side of the lower plate, at suitable intervals; and to these are nailed the laths *j*, which receive the plaster *k*, in the ordinary way. Instead of bolts the plates may be united by rivets.

BRIDGE GIRDERS

John Gardner, of Wokingham, Berkshire, engineer, for "*improvements in girders for bridges and other structures.*"—Granted December 9, 1848; Enrolled June 9, 1849.

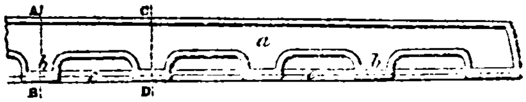
The improvement relates to girders, beams, bars, or bearings, employed in engineering, building, and architectural structures, for bridges, viaducts, aqueducts, railways, archways, dock-gates, roofings, and floorings; and consists in making the same of cast-iron, with a strengthening bar or bars of wrought-iron embodied or dovetailed into the same.

Fig. 1 is a side view of part of a girder; fig. 2 shows the under side of the same; fig. 3 is a section on the line A, B, of fig. 1; and fig. 4 a section on the line c, D. *a*, is the cast-iron girder; *b, b*, the bottom flanges; *c, c*, two wrought-iron bars inserted into the bottom of the girder, at a small distance apart, and, at the centre of each flange, they are slightly bevelled outwards on each side, so as to be dovetailed, as it were, into the girder at those parts. The wrought-iron bars are introduced in the process of casting the girder;—such bars having been previously rolled into the required sectional form, and well cleansed from oxide by heating them in a furnace or otherwise. Fig. 5 is a cast-iron girder *d*, strengthened by a bar of wrought-iron *e*, which forms the bottom of the girder, and connected to the upper part by a central ridge, of a dovetail form in its cross section, and of an undulating form in the longitudinal direction. Other modifications in the form of the wrought-iron bars may be adopted. Figs. 6, and 7, show how this compound mode of construction may be adapted to railway-bars and bearings where these are (as is now ordinarily the case) of great weight:—c, c, are the cast-iron parts; and w, w, are the wrought-iron parts.

Fig. 4.

Fig. 3.

Fig. 1.



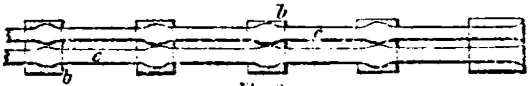


Fig 2.

Fig. 5.

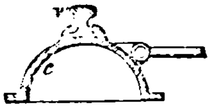


Fig. 6.

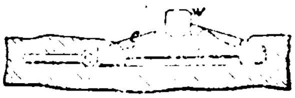


Fig. 7.

SILVERING OF GLASS.

Thomas Drayton, of Regent-street, practical chemist, for "*improvements in the silvering of glass and other surfaces.*"—Granted December 4, 1848; Enrolled June 4, 1849.

The improvements relate to silvering glass, by precipitating silver on the surface of glass, and causing it to adhere thereto, without previously coating the surface with any kind of material, in the following manner:—Take one ounce of hartshorn, or ammonia, and add thereto, two ounces of nitrate of silver, three ounces of water, and three ounces of spirit, preferring spirit of wine for the purpose; mix the same together, and allow the mixture to stand for three or four hours, and then filter for use. When the mixture is used, to one ounce of it add ¼-ounce of saccharine matter, previously dissolved in equal quantities of water, and spirit of wine, say half a pint of each, preferring grape sugar for the purpose, when it can be allowed two or three hours to dissolve. This mixture is to be laid over the entire surface of the glass, which is to be kept at a temperature of 160°. When the silver has become thoroughly dry, it is to be coated with mastic varnish, which serves as a protection from friction. The fluid is also well adapted for silvering the surface of metals.

TUBULAR BRIDGES.

An account of the Construction of the Britannia and Conway Tubular Bridges, with a complete history of their progress. By William Fairbairn, C.E. London: Weale; Longman. 1849. 8vo. pp. 291; 20 plates.

Disputes respecting priority of scientific discovery are seldom terminated satisfactorily or conclusively. Of all the more important instruments and methods which have given man new powers in the domains of art and science, there is scarcely one for the invention of which there are not many claims to this day unsettled. The tempting nature of the prize offered, and the congruity of the thoughts of men of learning at particular epochs, render the suits which arise in the Chancery of science numerous and complicated; while from the difficulty of discerning the hidden processes of the mind, and the subtlety of the distinctions between absolute originality of thought and its numerous counterfeits, the cases are always difficult to adjudicate. We know that large books have been written expressly to discuss the question of the invention of the telescope. The antagonistic claims of Newton and Leibnitz to the honour of devising the methods of fluxions, gave rise to a paper war which is not yet terminated. To come down to a period within our immediate recollection—the prediction of the place and motion of a new planet has raised to the highest scientific rank two rival and independent discoverers.

The controversy to which the experimental and theoretical inquiries respecting Tubular Bridges have given rise, is on many accounts to be regretted. The subject was eminently one which required concurrence and unity of purpose among the investigators. They themselves are men who have one and all done good service for science,—men who have been honourably associated for years in the mutual pursuit of science,—men whose attainments have won for them public respect and confidence. We have not yet the whole evidence of the case before us, and feel it premature to decide upon an *ex-parte* statement. We, moreover, are anxious to avoid participating in a contest in which too much of the gall and bitterness of jealousy has been exhibited. But we have enough evidence at least to be quite certain that the discussion has throughout been too strongly marked by the absence of mutual concessions, and has been caused solely and entirely by feelings of distrust, and a jealous concealment or reserve, which seem absolutely incompatible with a pure love of science.

They love science best, and are its most successful disciples, who follow it for its own sake—not for the aggrandisement of personal renown. We like not to see men too avaricious and greedy over their scientific wealth,—hiding and hoarding every morsel of truth which they can snatch unobserved. It is only the miser who acts so. They who are really rich in intellectual treasure, who possess the mines of exhaustless minds, are liberal withal. The craven, who tremble for the little by which they are richer than their neighbours, have but a pitiful store. *There is that scattereth and yet increaseth; and there is that witholdeth more than is meet, but it tendeth to poverty.*

The present work does not very distinctly set before us the exact nature of the claims which Mr. Fairbairn prefers; but we believe the following may be fairly stated to be the principal results which he asserts to have been the fruits of his inquiries—1st, the preference of a rectangular to a circular tube; 2nd, the abandonment of the suspension chains originally contemplated; 3rd, the cellular structure of the top of the tube; 4th, the hydraulic lifting apparatus.

On the first question it seems unnecessary to enlarge, as it was disposed of at a very early stage of the inquiry. It requires such a very mild knowledge of mechanics to perceive, that of two uniform tubes of equal height and length, the rectangular must be stronger than the circular for a given quantity of metal, that, instead of assigning any merit for the settlement of the point, we are rather disposed to wonder how it could have been ever doubted.

On the other questions raised by Mr. Fairbairn, we shall for the present content ourselves almost entirely with a mere condensed narrative, in which it is to be understood that in general the authority for disputed facts is the work before us. It is probable that counter-statements will hereafter appear; but, until then, sufficient data will not have been furnished for a decisive opinion on the general merits of the case.

The tubular bridges for the Conway and the Menai Straits appear to have been first proposed by Mr. Stephenson, about April 1845; and it is, happily, a point uncontroverted that the original idea of substituting a rigid tube for bridges of the ordinary forms, belongs exclusively to him. We are informed in the work before us, that, at the time mentioned, a "consultation" with Mr. Fairbairn took place, at which Mr. Stephenson appeared to think that "the tube should be either of a circular or egg-shaped sectional form. He was strongly impressed with the primary importance of the use of chains, placing his reliance in them as the principal support of the bridge; and he never for a moment entertained the idea of making the tube self-supporting.........In fact, for several months afterwards, and even up to the time of the experiments on the model tube, in December 1846, he insisted, as will be seen from the annexed correspondence, on the application of such chains."

Of course, we are quite unable to contradict any statement made by Mr. Fairbairn, of what took place at the consultation in question. But we are prepared to contradict the assertion, that for several months afterwards Mr. Stephenson insisted on the application of chains. On the contrary, we have incontrovertible proof that in the *month following* this consultation, he distinctly and strongly urged the practicability of dispensing with the chains altogether.

From an authentic copy of the minutes of evidence of Mr. Stephenson, on the 5th and 6th of May 1845, before the Committee of the House of Commons on the Chester and Holyhead Railway (No. 1), we give verbatim the following extracts, which will probably be deemed conclusive :—

> "Perhaps I may at once explain to the Committee the idea I have adopted. I conceive a tube—supposing a wrought-iron tube—to extend across the straits; that that tube to have, we will say to have 25 feet diameter, to hold a line of railway, and the line of railway would run inside of it. In addition to that, we should have to erect a chain platform for the purpose of the building. *Then the question would arise, whether the chains would be allowed to remain, or whether they would be taken down. My own opinion is, that a tube of wrought-iron would possess sufficient strength to support a railway.* I am instituting a series of experiments with Mr. Fairbairn, of Manchester. In fact, he is already in possession of experiments with respect to iron ships which place the thing beyond a doubt. He has ascertained that a vessel of 250 feet in length, supported at the ends, will not yield with all the machinery in the middle."

Here it appears that Mr. Stephenson not only thought, in May 1845, that the tube might be made sufficiently strong of itself, but that the experiments of Mr. Fairbairn removed all doubts on the subject. Further on, the Minutes of Evidence are as follows :—

> "It occurred to me that a rigid platform might be obtained by substituting a tube in addition to the chains. Then, on going into the calculation of the strength of the tube, I found that I did not require the chains themselves."

In another place, the following questions and answers occur :—

> "*Q.* You have not made up your mind as to the safety of dispensing with the chains?
>
> *A.* No, I have not.
>
> *Q.* It would be impossible to do so until it is constructed, would it not?
>
> *A.* I would rather leave that, because I would make the design so that the chains might either be taken away or left; and during the construction we should have ample opportunity of ascertaining whether we could safely take away the chains or not.
>
> *Q.* There would be no great advantage from taking away the chains?
>
> *A.* No; only it would make it more costly if they remained: they would be applicable to other purposes, and they would cost from thirty to forty thousand pounds."

The opinion of Mr. Stephenson as to the expediency of removing the chains, is not expressed here quite so strongly as before,—but distinctly enough to show that Mr. Fairbairn is mistaken in supposing that Mr. Stephenson *insisted*, for several months after March 1845, on the application of chains. We readily believe that Mr. Fairbairn has correctly stated the impression on his own mind; and the apparent contradiction may be easily reconciled by supposing that the subsequent experiments, and perhaps the opinions expressed by Mr. Hodgkinson and others, shook that faith in the strength of the tube alone which Mr. Stephenson had when before the Committee on the Chester and Holyhead Railway.

In the Report presented by him to the directors of that railway, twelvemonths afterwards—(February 9, 1846)—he treats the question of the adoption of chains as still undecided:—

> "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 hereafter found 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 oscillation."

Throughout this paragraph Mr. Stephenson expresses a doubt as to the expediency of using chains. It seems, therefore, a necessary inference that his final determination to abandon those adjuncts must have been produced by subsequent information: and we cannot see how Mr. Fairbairn could prove that the information was derived from *his* experiments exclusively, and not from a general review of *all* the experiments undertaken. We find, indeed, the following statement by him in a foot-note (p. 22) :—

> "The drawings and designs for the Britannia and Conway Bridges were made out, and the parts proportioned, without the aid of Mr. Hodgkinson's formulæ; and the above, as well as other hollow girder bridges, have since been constructed independently of that gentleman's assistance."

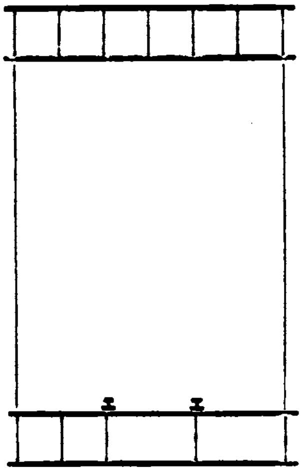
But surely so general a statement must be extremely injudicious, unless supported by very distinct and specific proofs. As far, however, as we can perceive, there is not even an attempt to give evidence of the alleged construction of the Britannia and other hollow girder bridges independently of Mr. Hodgkinson's assistance. On the contrary, a few pages further on, we find Mr. Fairbairn stating in his report to the directors of the Chester and Holyhead Railway—

> "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."

—How does Mr. Fairbairn reconcile this last statement with the previous assertion?

With respect to the cellular structure of the top and bottom of the tube, Mr. Fairbairn certainly appears to have established his claim more fully. This point is a very important one. It is undeniable that the peculiar, and altogether novel, form adopted for these parts of the bridge, constitutes one of its most essential features. The first notice or suggestion of this cellular structure appears in a "private"* letter from Mr. Fairbairn to Mr. Stephenson, dated Millwall, Sept. 20, 1845. After noticing some experiments on elliptical and other tubes, the letter proceeds :—

> "The defective powers of resistance of all the tubes of this shape, have suggested a new arrangement and distribution of the metals; it being evident from the experiments that the tube will resolve itself into a huge hollow beam or girder, leaving the two resisting forces of compression and extension as wide apart as possible. It is further conclusive, that the sides must be made comparatively light, and considerable additional material introduced into the top and bottom of the tube. This will give greatly-increased strength; and a few more experiments will determine which of the two shall have the preponderance. It is more than probable that the bridge, in its full size, may take something of the following sectional shape."



Mr. Fairbairn calls the attention of his readers to the close resemblance of the sectional form indicated in the sketch to that of the bridges actually constructed for the Conway and Menai Straits; and certainly he is fully justified in insisting on the very close similarity. The only ambiguity of the above quotation is the phrase "The defective powers, &c., have suggested a new arrangement." To *whom* did that suggestion occur?—Is the writer to be understood as expressing his own ideas only, or the collective deliberations of the several persons present at the experiments described?

The remaining question as to the invention of the methods of raising the tube and some other points, we must leave for a subsequent paper. We cannot, however, conclude, without repeating the expression of great regret at the circumstance, that the two principal experimenters, Mr. Hodgkinson and Mr. Fairbairn, performed their experiments independently of each other, and maintained strict reserve as to the results. How far better might it have been for science, could they have worked together as heretofore! May we not hope that the day may come in which we may again receive instruction from the associated labours of men who have already worked together so well for the public benefit? Our respect for Mr. Fairbairn must not induce us to conceal the opinion that he has taken a very ill-advised step in attempting to exalt himself at the expense of his colleagues. Had he contented himself with a simple statement of his share of the transaction—what experiments he made—what suggestions he offered—what labours of every kind, theoretical or practical, he undertook in aid of the great result,—no blame could have attached to him. We willingly allow that his labours were great and deserve great praise—nay, we will confess that the perusal of the present work has increased our admiration of his efforts considered by themselves. But surely others worked well and ably too. He himself gives reiterated proof of the anxiety and toil which this undertaking cost Mr. Stephenson. And we know that the investigations of Mr. Hodgkinson were most laborious, and confidently believe, that when published, they will be esteemed among his most successful researches.

We cannot tell with whom the system of distrust and jealousy began; but to these feelings are to be attributed all the unfortunate results that followed. Let us hope that these feelings will be soon consigned to oblivion by a generous acknowledgement of mutual mistakes, and be replaced by a worthy emulation of "in honour preferring one another."

A short time will probably suffice to put the public in possession of further and independent information respecting the history of

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* Mr. Fairbairn does not appear to state anywhere that the publication of private letters addressed to him was authorised by the writer.

the Tubular Bridges. But enough is before us to warrant us in affirming that Mr. Fairbairn deals unfairly both with his own fame and with that of his colleagues, in assuming a controversial tone—unfairly towards them, by endeavouring to depreciate their merits, —unfairly towards himself, because the attempt will re-act against himself, in the minds of those who will estimate his labours by personal, and not by purely scientific considerations.

BELL ROCK LIGHTHOUSE.

Sir—I have read in the June number of your excellent *Journal*, Sir John Rennie's letter of the 17th May. As it contains nothing new, I would simply, in addition to the facts contained in my former letters, refer to the Minutes of the Lighthouse Board of 6th June 1827, wherein there is a Report of a Committee appointed to examine accounts connected with the publication of Mr. Stevenson's work on the Bell Rock Lighthouse. That Committee recommended the Board to express to Mr. Stevenson "their sense of his merits as the engineer of the Bell Rock Lighthouse, and the author of the history of its erection;" and accordingly, Mr. Duff, in name of the Commissioners, begged to return him "their thanks for the ability, assiduity, and enterprise displayed by him in the completion of that great useful public work, and of the clear and instructive narrative which he has given of its erection in this publication."

I also embrace this opportunity of laying before your readers the accompanying letter which I have lately received from Mr. Cuningham, the retired Secretary of the Northern Lights Board,—the gentleman whose name Sir John Rennie has mentioned with deserved but (in the eyes of all who know him) supererogatory commendation, and who drew the very Minute on which Sir John has attempted to raise his claim.—Again, with thanks,

I remain, &c.,

Edinburgh, 8th July, 1849. Alan Stevenson.

Copy of Letter from Charles Cuningham, Esq., to Mr. Alan Stevenson, above referred to.

"My Dear Sir—I have your note of the 26th, and I presume that I am indebted to you for a private copy from the *Civil Engineer and Architect's Journal* of this month, of the correspondence between Sir John Rennie and you relative to the Bell Rock Lighthouse, which I have perused with much interest. A copy of your letter of the 26th December last to Sir John, which was sent to me by my son, was the first intimation I ever had, and I received it not without surprise at Sir John Rennie having claimed for his father the merit of having *designed* and *built* this Lighthouse.

"It so happened that among the first professional duties with which I was intrusted was to act as clerk to the joint committees of Edinburgh and Leith, who had the charge of the construction of the Leith Wet Docks. This must have been in 1799 or 1800; and very shortly afterwards I was conjoined with the late Mr. Gray, as Secretary to the Commissioners of Northern Lighthouses; and in both capacities I had frequent opportunities of being with Mr. Rennie during his periodical visits to Scotland. The Wet Docks he planned and executed under the superintendence of a resident engineer appointed by himself. The Bell Rock was planned by your father, and after having been sanctioned by Mr. Rennie, was executed entirely under your father's personal superintendence; and in all my communications with Mr. Rennie, which were not unfrequent, I never heard him lay claim to this work, nor am I aware of his having had anything to do with the execution of it—unless, perhaps, your father may have seen fit to consult him in his character of chief engineer.

"You ask me under what impression I framed the Minute of 3rd December 1806; but at this distance of time it is not to be expected that I can retain exact impressions. That Minute must have been framed under directions; but I have no hesitation in saying generally, that I conceive the Commissioners having obtained Mr. Rennie's *fiat*, thereby gave their sanction to the building being of stone, as recommended by your father, the plan of which had long before been submitted to them. But surely the fact of the Commissioners having placed your father's bust in the library of the Lighthouse, conveys, in a manner not to be mistaken, *their impression* of the party entitled to the merit of the work.

"I am, &c.

(Signed) "Charles Cuningham.

'*Newholm, Dolphinton, Lanarkshire,*
"*29th May*, 1849."

Haytor Granite.—The size of some of the stones quarried at the Dartmoor Granite Works may be imagined from one which was blown out a few days ago by Messrs. Filmer and Hoar. The length of the block was 30 feet; breadth, 23 feet; height, 24 feet. cubical contents, 16,560 feet; and it weighed no less than 1,380 tons. Only 50 lb. of powder were used in blasting.

IMPORTANT RATING CASE.

Sir,—The rating of the property belonging to gas, water, and railway companies, to the relief of the poor, being now so much in dispute, every decision thereon is of importance.

On Friday, July 6th, an important decision was made, in the case of an appeal of the Phœnix Gas Company, against the assessment of their property to the poor-rate, in the parish of Greenwich, which assessment had been increased when the last rate was made, in April last, from the sum of 1680*l.* to 5671*l.* (both sums including the stations and mains), without any alterations having been made by the company, to increase the value of their property in that parish. The Phœnix Gas Company has very extensive buildings and plant, the mains extending into twenty-three parishes, with large manufacturing stations at Vauxhall, Bankside, and Greenwich; also store stations in Kennington-lane and Wellington-street. The parish officers, by the advice of their surveyor, Mr. Charles Penfold, of Cornhill, valued the property belonging to the company, in the parish of Greenwich, as separate and distinct from the rest of the company's works and mains (although the whole is most intimately connected, also managed by one board of directors, having one office and only one set of clerks and officers); by which scheme, the whole value of the station and mains in Greenwich was assessed to the poor-rate of that parish, as well as a portion of the value of the gas rental of the other parishes supplied with gas from the Greenwich station,—for the reason that the gas used in those parishes passed through the mains laid in Greenwich parish. They then proceeded to ascertain the net rateable value, by assuming that the rent which a tenant would give, "from year to year," for the whole property in Greenwich, with the right of supplying that and the other parishes now supplied from the Greenwich station; and this assumed rent was arrived at by finding the power of production (not the quantity produced) of gas at the station in Greenwich: the result was—

Net rateable value of the station	£2,000
Ditto of the mains in Greenwich supplying gas in Greenwich only ..	2,924
Ditto of the mains in Greenwich supplying Lewisham..	154
Ditto of the mains in Greenwich supplying other parts	593
Total net rateable valuable	£5,671

The surveyor of the company, Mr. Lee, of Golden-square, contended, that the whole of the property belonging to the company must be considered as one concern, and taken as a whole, and so assessed to the poor-rate. Or, that the rent which a tenant would give, "from year to year," for all the stations, stores, and mains in the twenty-three parishes, must first be assumed; that the basis of this assumed rent should be the gas actually produced at the three stations, and sold in the twenty-three parishes; and from the rent so ascertained must be obtained the net rateable value of the whole property.

Then, that the net rateable values of all the stations and stores must be assumed and deducted from the net rateable value of the whole property, the balance being the net rateable value of all the mains in the twenty-three parishes, and that this balance should be divided in proportion to the quantity of mains in each parish. Or, that the stations and stores should be rated in the parishes in which they may happen to be situate, in proportion to their present value; and the net rateable value of all deducted from the amount of the net rateable value of the whole property, including the stores and stations; and that the remainder should be divided amongst the twenty-three parishes, in proportion to the quantity of fixed apparatus situate in each parish instrumental in earning gas-rent: the result would be—

Net rateable value of all the stations	£5 438
Ditto ditto of all the mains	3,320
Total net rateable value of the whole property	£8,758
Net rateable value of the Greenwich station	£1,316
Ditto ditto of the street mains in Greenwich..	314
Net rateable value of all the property in Greenwich	£1,630
The total present value of all the stations being	£173,238
Ditto ditto of all the street mains	105,761
Total present value of all the property	£278,999
The present value of the stations at Greenwich being	£41,953
Ditto ditto of the street mains in Greenwich..	11 048
Total value of the property in Greenwich..	£53,001

The Court decided that the assessment must first be made on the whole of the property in the twenty-three parishes, as a whole, in accordance with "The Queen *v.* the Great Western Railway Company," and that it was to be then divided as contended for by the company's surveyor; that the net rateable value of the whole was to be 13,600*l.*, and in Greenwich parish 2,532*l.* —viz. station, 2,045*l.*; mains, 487*l.* The case was gone into at great length; it came on by special appointment, and occupied the Court from nine until half-past seven o'clock.

The company have appealed against the assessment of their property, in various parishes, several times, for the purpose of having a principle decided, but have not succeeded before this case.

I am, &c.

A Surveyor.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

June 18.—T. Bellamy, V.P., in the Chair.

Mr. Fergusson read a paper "*On the History of the Pointed Arch.*"

Dismissing the usual theories invented to account for the mode in which its form may have been suggested, and rejecting also the narrow limits into which the inquiry into its history had hitherto been confined, he commenced dividing the subject into four sections or series of pointed arches:—the two earliest belonging to the East, the two others to Northern Europe. The first series Mr. Fergusson defined as commencing with the earliest dawn of architectural history, and extending downwards to the period of Roman domination. He pointed to examples of the form as existing in the pyramids of Gizeh and of Meröe, and also as found in the Great Oasis at El Kargeh. This branch of the subject was further illustrated by examples taken from the sepulchres and city walls of ancient Etruria, from similar remains in ancient Greece—more especially at Mycenæ—and lastly from Assos, and other places in Asia Minor, showing how universal the form was at a very early period in all Pelasgic countries. He then pointed out how completely this form was lost under the all-pervading influence of the Romans, who introduced everywhere their own favourite round arch; but proceeded to show how immediately on the decline of their influence the pointed arch re-appeared in all the countries of the East: illustrating this by examples drawn from the Church of the Holy Sepulchre at Jerusalem—now known as the Mosque of Omar—but which, he asserted, was the identical edifice raised by Constantine the Great on that spot. His other examples were taken from the Mosque at Diarbekr, a building in the same style and of the same age as the Mosque at Jerusalem—the Palace of Khosröes at Ctesiphon—the Aqueducts of Constantinople, and other edifices of that period; in all which the pointed form of arch is still found. He then showed how the Arabs who, as a nomadic race, had no architecture of their own, adopted the pointed form of arch; using it as early as the twenty-first year of the Hejira, and continuing the use of it almost universally from that time to the present hour in all the countries of the East, and also in Sicily, as well as in their oldest edifices in Spain. In the latter country, however, it appeared that they most generally adopted the round or horse-shoe form of arch; thus confirming the idea that the Arabs had no architecture of their own, but adopted the forms of the country which they occupied.—The third series Mr. Fergusson called the Provençale, and defined it as a style existing to the south of the Loire, to the north of the Garonne, and as extending from the Gulf of Nice to the Bay of Biscay. The date he assigned to this style was from the age of Charlemagne to about the end of the eleventh century. He adduced instances of this early pointed arch style from the Churches of Notre Dame d'Avignon, Churches at Vaison, the Churches of Pernes and Carcassone, the Cathedral of Cahors, St. Front Perigeux, the Abbeys of Souillac and Moissæ, and more especially of Loches, &c. All of these he maintained to be earlier than the round-arch style in as far as their pointed peculiarities are concerned, and certainly as preceding in every respect the true Gothic style with which they had little or no affinity.—The fourth and last division of the subject was the true Gothic style; which arose in Northern Europe in the latter half of the twelfth century, was perfected in the first part of the thirteenth, and continued to be practised so generally till the Reformation.

With regard to the invention of the pointed arch, Mr. Fergusson showed that the second style certainly arose from the first; but mentioned that the Western nations had no right to claim as an invention what had so long been practised in the East, and which they certainly saw and knew long before they adopted it. But though this may have suggested the form, he maintained, with Dr. Whewell, that it was only its practical utility or necessity that could have rendered it so universally prevalent; and he pointed out the manner by which, not only in the Provençale, but also in the true Gothic styles, the greatest constructive difficulties were solved by its adoption. Mr. Fergusson concluded by distinguishing between the invention of the pointed arch and of the Gothic style. The former he conceived to be an idea borrowed from the East; the latter he maintained to be a thoroughly native and original creation, owing all its beauty and perfection to the talents and energy of the native architects of Europe,—who combined to elaborate it out of the chaos of classical fragments which they had inherited.

July 2.—S. Smirke, V.P., in the Chair.

Among the donations were some models representing the actual state of the Temples at Agrigentum, and executed in the native stone. They were presented by J. St. Barbe, Esq.

Communications were read from the Chevalier Bunsen and Herr Stülin, of Berlin, recommending specimens of zinc castings of columns, capitals, bases, and figures, executed by Herr Geiss,—who attended, and offered some further explanation of his mode of preparing and casting zinc.

A paper was read, written by Mr. Foster, British Consul to the Republic of Nicaragua, describing the Cathedral of St. Peter, Leon, Nicaragua, and the domestic architecture of that city.

A paper was read by C. R. Cockerell, Esq., Professor of Architecture in the Royal Academy, "*On Style in Architecture.*" After alluding to that latitude of style in architecture and the license in the choice of style which unhappily at the present epoch are not only permitted but professed, the author observed, that as intensity of character is commonly distinguished in society by a peculiar aspect, habit, or bearing, so should the great national works of a people be distinguished in the pages of time. The architect, therefore, who limits his ambition to the reproduction of an antique model, carries a lie in his right hand;—he shows himself to posterity as a renegade to his country and his age;—he is false to history, for his aim would seem to be to deceive posterity and to perpetuate anachronisms;—he confesses his incapacity to delineate his own times, and shrinks from the exhibition of them, as if knowing their unworthiness. As well might the popular writer insist on the use of the style of Bede or Spenser, and the obsolete language of Wickliffe and Wykeham, as that the architect should absolutely reproduce the form and character of taste in that period,—and if art means anything, and we assume to read its language, the one proposition is certainly not more ridiculous than the other. In speculating on the latent causes of the vicious system of copying without any attempt at modification, Professor Cockerell said, that although the mere *fashion* of public opinion always influences art, as it does everything else, yet he thought much of the evil may be attributed to the want of an enlightened, searching, and generous criticism, such as existed in the beginning and to the end of the last century, from Boileau and Pope to Payne, Knight, Alison, and others. He especially drew attention to the remarkable fact, that during the last thirty years of devotional building, in which upwards of 1,400 cheap churches of England have been erected by the zeal of churchmen, not one of that learned body (as in the middle ages) has produced a critical work on style, as adapted to our Ritual, to guide architects. They have changed their "building regulations" every five or six years, and have waived all consistency; and they seem to have been satisfied in raising "folds," in any way for the wandering flock. The decline of the drama—that mirror in which the state even of the Arts was wont to be reflected—has not been without its effect; and it is worthy of remark, said the Professor, that when the drama has flourished, so have the sister Fine Arts, especially architecture. One of the great faults committed by architects was their allowing all logical consistency of feeling, all regularity, harmony, and conformity, enjoined by the first principles of sound sense and artistic composition, to be sacrificed to a pedantic display of our universal knowledge of historical styles and dates, and the trivial conceit of a dramatic reproduction to the very life (in the absence of the theatre itself) of the several periods they represent. Again, we find them preferring the ornaments, the rhetoric, so to speak, to the logic which is its only just foundation. This is mere pedantry and affectation. Such a spirit will not do in the war of the camp or of politics; at the bar, or in engineering. Why, then, should it be tolerated in the serious and responsible art of architecture? Nature is never illogical, —for her rhetoric is the mere appendage and the natural consequence of her use and purpose. How often do we find the young architect, fired with the beauty of the classic column and entablature, of the portico and the pediment, introducing them where their unfitness actually destroys the very beauty he is so anxious to display! It is from this false principle that we have churches on a Roman Catholic plan adapted to a Protestant Ritual,—buttressed walls with tie-beam roofs, belfry towers without bells, and all the quackery of sedilia, piscina, &c., where they are without use or purpose. The rigid adherence to Palladian or Italian example and dimensions in designing masonic architecture, without the slightest allowance for the growth of modern scantling—the glazing of windows in Elizabethan, or "early domestic" buildings with *quarré* glass, in bits of four inches square, in preference to the splendid and cheap plates of the present day, each of which would fill a window—all this results from that mania for imitation which, far from showing progress in Art, is disgraceful retrogression. It is in earnestness of purpose that we must look for what is called genius for fitness, novelty, and beauty. Genius, so called, is but the more strenuous attention to the means presented to our faculties by a closer criticism—by greater diligence in the artist—by concurrent efforts, liberality, and patronage—and, above all, by a field to work in offered by the public. Until these conditions are presented, we shall of course have imitation; that ready evasion of the most difficult and painful of all labour—the labour of thought. If the prize and occasion be mean, the enterprising and the powerful mind will take another career, leaving those pursuits to second and third-rate minds. The wise architect, while he admits the whole power of association in the effects and influence of his art—while he sanctifies his work with archaisms, and bends in some degree to fashions—still seeks to embody the spirit of the actual times as well as that of antiquity, engrafting the useful powers of growing science and the recent graces of convenience with a certain reserve; and thus he fulfils the great purpose of his office, captivates all observers by the production of things new and old,—remembering always the immortal words of Schiller—

> The artist is the child of his time;
> Happy for him if he is not its pupil,
> Happier still if not its favourite.

After some suggestions on the style to be employed in the several departments of architecture, devotional, monumental, or domestic—urging the necessity of conformity to the Ritual as regards the plans of our churches in whatever style, and showing that the mediæval architecture was not applicable to our domestic buildings of the present day—Prof. Cockerell said, in conclusion:—"Let us only be true to ourselves. Remember that we are *masters* as well as *servants* to the public. Without dogma or pedantry, let us investigate and disseminate good principles and exercise a wholesome discretion. Let us for a moment consider the mighty influence for good on all the technic and æsthetic Arts—those Arts that either occupy or captivate half mankind—which our *Ars regina*, guided by this Institute, exercises over not only her graphic sisters of Painting and Sculpture, but those of Manufacture also, throughout this mighty empire and her colonies, and indeed over every civilised country in the world."

July 16.—Earl De Grey, President, in the Chair.

Closing General Meeting of the Session.—Among the donations were portraits of the Earl of Burlington and Sir Christopher Wren, by Sir Godfrey Kneller,—of Palladio, by Fradelle, after Biglioschi,—and of Bramante, by the same, after Aless. d'Este. These were contributed by Mr. J. W. Papworth.

The President distributed the medals and premiums awarded during the session. In handing to Mr. Donaldson the royal gold medal to be forwarded to the Chevalier Canina, his lordship mentioned that when the award of the Council had been submitted for the approbation of Her Majesty, Prince Albert had expressed his satisfaction at this evident mark of the impartiality of the Institute, awarding to a foreigner so high a mark of distinction as that of the royal gold medal. By encouraging merit abroad as well as at home they showed their anxiety to do all in their power to advance their art wherever it was practised. Mr. W. Papworth received the silver medal of the Institute, for his Essay on 'The Peculiar Characteristics of the Palladian School of Architecture,'—and Mr. T. Hill, student, the annual premium in books for the best series of Monthly Sketches.

The Hon. Secretary read a communication from Sir. G. Wilkinson, "*On the History and Origin of the Pointed Arch.*" After reccurring to his discovery at Thebes of round arches built of crude bricks and lined with stucco, proving their use as far back as the thirteenth century before our era, Sir G. Wilkinson showed that in all probability the pointed arch was also familiar to the ancient Egyptian. There is, however, no positive evidence of this being the case. The pointed arch was commonly used by the Saracens at a very early period. In the Mosque of Ahm ebn e'Toolóon, built A.D. 879, all the arches are of that form. Other early examples also exist. The author of the paper considers, however, that the Saracens did not invent this form, but copied it from the Christians; and in support of his theory he mentions many instances of the pointed arch being used by the Christians before the Arab Conquest. They were, however, of small span; showing a mistrust in the strength of that form, which was doubtless more fully developed in countries where the architecture is less interfered with by the Arab conquests. The transition from the semicircular to the oval and finally pointed form of arch in those early ages was shown by numerous sketches of arches still existing—in some of which the round arch has been changed into one of oval form by means of bricks and stucco. It is not impossible that the Christians of the Thebäid, in their attempts to form a pointed arch, may have imitated those of the same form which they saw in the ancient monuments; for although those were not constructed on the real principle of the arch, but cut into horizontal courses of stones, still, from their size being about the same as that of the arches at Thebes, there is reason to believe that in them originated the idea of the pointed form as found in the houses of the early Christians,—where it certainly first became generally adopted, subsequently giving rise to a particular style of architecture in the hands of the Saracens, and passing at the period of the Crusades into the churches of Western Europe.

Earl De Grey read some account of the excavations now proceeding under his direction at Fountains Abbey. The remains lately discovered are situated towards the east front of the monastery, which until now has generally been considered the principal one. The building now brought to light was doubtless the abbot's house, situated at the rear of the monastery, and communicating with it by a passage or vestibule 15 feet in width, richly decorated on the north wall in the same style as the sides of the choir and the Lady Chapel in the abbey itself. The whole of the house is built on arches over the river, its level being about 6 feet above that of the cloister garden. The passage leading from the monastery to the house had probably apartments over it, for a fragment of the original wall still standing to a height of 16 feet above the turf contains at the height of 11 feet a portion of a fire-place. The foundations of the great hall are clearly to be made out, extending through the whole building from north to south; and its size may serve to show what importance must have been attached to the rank of abbot. Its total length was 167 feet, and width 69 feet,—being divided into three aisles by rows of columns. The private oratory,—the refectory placed obliquely with regard to the grand hall,—the abbot's kitchen, &c., are all to be easily traced among these remains. Among the most curious portions of the ruins is a large stone grating, if so it may be called, which appears in the top of one of the arches supporting the kitchen;—the size of the aperture (6 ft. 6 in. by 8 ft. 5 in.) precludes the supposition of its having been used for any purpose of drainage.—A plan of the buildings, showing all the recent discoveries, was exhibited in illustration, as well as plans of some of the principal monastic ruins; and attention was drawn to the similarity which existed between most of them in the arrangement of the several parts, more especially as regards those at Fountains and Durham.

NOTES OF THE MONTH.

A Large Tubular Iron Girder-Bridge has been constructed to cross the Trent at Gainsborough on the line of the Manchester, Sheffield, and Lincolnshire Railway. It consists of two principal hollow girders which form the parapets of the bridge, and the roadway is supported by transverse wrought-iron hollow beams, or tubes, rectangular in section, suspended to the side tubes. This bridge was designed by Mr. Fowler, and the tubes have been constructed by Mr. Fairbairn, of Manchester. The stone-work consists of a centre pier, and two elliptical arches of 50 feet span each, terminated by the usual land abutments. The iron-work consists of two spans, together 308 feet, which gives a total length to the bridge of 460 feet. The principal girders are each 336 feet long, 12 feet high, and 3 ft. 1 in. wide, having their tops formed of cells 18 inches wide, and 12 inches deep, to resist compression, and the bottom of double riveted plates, to withstand tension. They are fixed securely on the middle pier, thus covering both spans; and their ends are supported on the land abutments upon rollers, resting on cast-iron plates embedded in the masonry, thus admitting of expansion and contraction. On the outside of the girders two curved lines of angle-iron are riveted, which gives it the form of two arches, and adds much to the symmetry of the structure. The two principal girders weigh 300 tons; transverse beams, 4 feet asunder, 82 tons; cast iron 10 tons—making a total of 392 tons. The girders were constructed on one of the embankments, and hauled across into their positions on rollers—a feat of some difficulty, as one end of the girder would have no support for nearly half its length before it reaches the assistant resting-place of the centre pier.

On the Zincing of Iron.—There are, it is well known, two different methods of coating metals with zinc;—one by immersing in the molten zinc the articles required to be coated, and another by precipitating the zinc from a solution by means of galvanism. The solution most commonly used for this latter process is, a weak solution of oxide of zinc in potash ley. Numerous experiments have been recently made by M. Riepe, at the laboratory of the Society of Encouragement, at Berlin, on the solution best adapted for this purpose. The following is a summary of the results obtained;—The compounds of zinc employed by M. Riepe were—a solution of sulphate of zinc; a solution of cyanide of zinc in cyanide of potassium; a solution of the double salt of chloride of zinc and sal ammonia (salt for welding); and a solution of hyposulphate of oxide of zinc. The operation appeared to be most successful with the solution of sulphate of zinc, and with the double salt, above-mentioned; but, to ensure success, the solution must be weak, and a weak galvanic current must be employed, otherwise the zinc precipitated will again separate from the iron in the form of thin scales; if proper precautions be taken, the operation will succeed perfectly well, and the zinc may, by that means, be laid on as thick as a sheet of paper. It is scarcely necessary to remark, that the article to be coated must be well cleansed previous to performing the operation. With regard to the preparation of the salts, the following remarks will be found requisite:—The sulphate of oxide of zinc is prepared by dissolving in water saturated with sulphurous gas, as much hydrate of carbonate of zinc, recently precipitated, as will completely saturate the water. With respect to the ammoniacal chloride of oxide of zinc, proceed as follows;—Dissolve one part of zinc in hydrochloric acid, and, to this solution, add one part of sal ammoniac; evaporate the liquor and crystallise. The crystals are colourless six-sided prisms, translucid, easily soluble in water, and very easily deliquescent.—*M. le Docteur Elsner.*

Reduction of Chloride of Silver.—M. Level gives the following simple method of reducing chloride of silver. It is placed in a solution of caustic potash, in which some sugar is dissolved, and the whole boiled. The silver is quickly reduced by the sugar, carbonic acid gas being evolved. It is easily washed, and obtained pure, and in the state of powder.

Restoration of Illegible Manuscript.—Mr. Murray gives the following process for restoring illegible manuscript, which he tried with success on some illegible fragments on vellum from the Record Office. He succeeded in restoring the manuscript by first steeping the vellum in a solution of chlorate of potassa, and, when subsequently dried, immersing the fragments in tincture of galls, or hydrocyatrate of potassa. The restored characters were black in the former, and blue in the latter case.

Gutta Percha Tubing for Water Services.—A series of interesting experiments has just been concluded at the Birmingham Waterworks, relative to the strength of gutta percha tubing, with a view to its applicability for the conveyance of water. The experiments were made, under the direction of Mr. H. Rofe, engineer, upon tubes of ¾-inch diameter, and ⅛-inch thick of gutta percha. These were attached to the iron main, and subjected for two months to a pressure of 200 feet head of water, without being in the slightest degree deteriorated. In order to ascertain, if possible, the maximum strength of the tubes, they were connected with the water company's hydraulic proofing pump, the regular load of which is 250 lb. on the square inch. At this point they were unaffected, and the pump was worked up to 337 lb. but, to the astonishment of every one, the tubes still remained perfect. It was then proposed to work the pump up to 500; but it was found that the lever of the valve would bear no more weight. The utmost power of the hydraulic pump could not burst the tubes. The gutta percha being slightly elastic, allowed the tubes to become a little expanded by the extraordinary pressure which was applied, but on its withdrawal they assumed their former size.

Beacon on the Goodwin Sands.—During the last few days several men, under the direction of the Trinity Board, have been employed on the Goodwin, about mid-sand. It appears the object is to force, by means of atmospheric pressure, several lengths of cylindrical iron tubes into the sand, until some solid material is arrived at; each length of tube is about 10 feet long and 2½ in diameter, but, although six lengths, securely fastened, have been made to penetrate a depth of about 60 feet beneath the surface, no foundation has yet been reached. It is in contemplation, as soon as a substratum sufficiently firm is found, to place several tubes of similar dimensions at approximate distances, and to erect a beacon thereupon. Should the attempt succeed, and sanguine expectations are entertained that it will, there exists little doubt of the important effect of a structure of this kind, in diminishing the amount of danger to shipping, on a spot proverbial for its disasters, and fatal consequences to life and property.

Poisoned Water.—It is not generally known to the public that the carbonic acid, or fixed air in water, decomposes lead pipes, and thereby imparts poisonous properties to the water. Within the past few months Sir Raymond Jarvis, of Ventnor, had occasion to repair the pumps which supplied his mansion, when, to his amazement, it was found that the large leaden feeding pipe was almost entirely eaten away by the water, and the interior covered with a white and poisonous crust. Sir Raymond has had the whole replaced with gutta percha tubing, which, from its extraordinary alkali and acid-proof qualities, will preserve the water perfectly pure. It seems remarkable that, at the moment when our sanitary movements have commenced with so much vigour, gutta percha should have come to our aid, not only as a means of preserving the feet from damp and wet, but also as a medium for supplying us with the best of liquids—water, untainted by the deleterious properties which we have endured by the use of leaden pipes.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM JUNE 7, TO JULY 24, 1849.

Six Months allowed for Enrolment, unless otherwise expressed.

James Steel, of Horton, York, and Benjamin Emmerson, of the same place, overlookers, for improvements in power looms.—June 7.

Gustave Francois Picault, of Rue Dauphin, Paris, cutler, for improvements in apparatus for opening oysters.—June 7.

Douglas Hebson, of Liverpool, engineer, for improvements in steam-engines.—June 7.

Henry Knight, of Birmingham, mechanical engineer, for certain improvements in apparatus for printing, embossing, pressing, and perforating.—June 7.

Stanhope Baynes Smith, of Birmingham, electro plater and gilder, for improvements in depositing metals and in obtaining motive power, parts of which improvements are applicable to certain other similar useful purposes.—June 7.

Joseph Samuda, of Parliament-street, Westminster, gentleman, for improvements in obtaining motive power, and the machinery or apparatus employed therein; which machinery or apparatus may be used for raising liquids. (A communication.)—June 9.

William Preddy, of Taunton, Somerset, watchmaker, for improvements in watch keys, and other instruments for winding up watches and other time keepers.—June 12.

Joseph Wade Denison, of New York, gentleman, for improvements in engines for raising or forcing liquids. (A communication.)—June 12.

Joseph Burch, of Craig Works, Macclesfield, engineer, for improvements in printing on cotton, woollen, silk, paper, and other fabrics and materials.—June 14.

Peter William Barlow, of Blackheath, civil engineer, for improvements in parts of the permanent ways of railways.—June 14.

Michael John Haines, of John-street, Commercial-road East, leather pipe maker, for improvements in the manufacture of packing for steam-engines, cylinders, and other purposes; parts of which improvements are applicable to the manufacture of waterproof fabrics and leather.—June 14.

Henry Mills Stowe, of Bermuda, master of the brig James, for improvements in blocks and sheaves.—June 20.

Alexander Francis Campbell, of Great Plumstead, Norfolk, for improvements in wheels ploughs, and harrows, steam-boilers, and machinery for propelling vessels.—June 20.

William Combauld Jacob, of Bread-street, city of London, warehouseman, for improvements in the manufacture of parasols and umbrellas.—June 20; two months.

Richard Archibald Brooman, of the firm of Messrs. J. C. Robertson and Co., of Fleet-street, city of London, for improvements in apparatus for transferring liquids from one vessel to another, and for filling bottles and other vessels with liquids. (A communication.)—June 20.

Charles James Coverley Griffin, of Southwark, hatter, for certain improvements in military accoutrements.—June 20.

Edward Lyon, Berthon, clerk, bachelor of arts, of Fareham, Southampton, for an instrument to show the velocity of a ship or other vessel propelled through the water, by wind, steam, or other moving power.—June 20.

Samuel Colt, of Trafalgar-square, Middlesex, gentleman, for improvements in fire-arms.—June 20.

Henry Bessemer, of Baxter-house, St. Pancras, Middlesex, engineer, for improvements in the methods, means, and machinery or apparatus employed for raising and forcing water and other fluids.—June 23.

Thomas Merchant, of Derby, civil engineer, and Robert Harland, of Derby, carriage builder, for certain improvements in the construction of railway carriages.—June 25.

George Benjamin Thorneycroft, of Wolverhampton, iron-master, for improvements in manufacturing railway tyres, axles, and other iron where great strength and durability are required.—June 26.

Thomas Wood Gray, of Limehouse, brass-founder, for improvements in waterclosets, pumps, cocks, lubricators, and deck-lights.—June 26.

James Nasmyth, of Patricroft, near Manchester, engineer, for certain improvements in the method of, and apparatus for, communicating and regulating the power for driving or working machines employed in manufacturing, dyeing, printing, and finishing textile fabrics.—June 26.

James Leadbetter, of Kirkby Lonsdale, Westmorsland, brazier, for certain improvements in the method of raising water and other fluids; which improvements are also applicable to the propulsion of machinery, pumping of mines, and other similar purposes.—June 26.

Walter Neilson, of Hyde Park-street, Glasgow, engineer, for an improvement or improvements in the application of steam for raising, lowering, moving or transporting heavy bodies.—June 26.

Christopher Nickels, of York-road, Lambeth, gentleman, for improvements in the manufacture of woollen and other fabrics.—June 26.

William Wilson, jun., of Campbellfield, Glasgow, for improvements in cutting plastic tubes or tiles.—June 27.

John Thomas Forster, of Plymouth, a master in her Majesty's Navy, for improvements in the building of ships, boats, and other vessels; also in the manufacture of boxes, packing-cases, roofs, and other structures requiring to be waterproof.—June 27.

Edward Woods, of Liverpool, Lancashire, civil engineer, for certain improvements in turn-tables.—June 28.

Thomas Beale Brown, of Hampen, Gloucester, gentleman, for certain improvements in looms, and in the manufacture of woven and twisted fabrics.—June 29.

Bram Herts, of Great Marlborough-street, Middlesex, gentleman, for improvements in and an addition to fountain pens.—June 30.

Thomas Greenwood of Goodman's Fields, in the city of London, sugar refiner, and Frederick Parker, of New Gravel-lane, Shadwell, animal charcoal manufacturer, for improvements in filtering syrups, and other liquors.—July 4.

John Robinson, of Patterson-street, Stepney, Middlesex, engineer, for improvements in machinery for moving and raising weights.—July 4.

John Grantham, of Liverpool, engineer, for improvements in sheathing ships and vessels.—July 4.

Josiah Bowden, of Liskeard, linen draper, and William Longmaid, of Beaumont-square, Middlesex, gentleman, for improvements in the manufacture of soap.—July 4.

Sir Francis Charles Knowles, of Lovell, Berkshire, bart., for improvements in the manufacture of iron and steel.—July 4.

Richard Archibald Brooman, of London, Middlesex, for improvements in steam generators. (A communication.)—July 4.

James Mulbery, of Parkersburgh, in Chester, Pennsylvania, in the United States of America, machinist, for certain improvements in the slide-valves of steam-engines.—July 4.

William Henry Wilding, of the New-Road, Middlesex, gentleman, for certain improvements in engines, and in obtaining and applying motive power.—July 4.

Robert William Thomson, of Leicester-square, Middlesex, civil engineer, for certain improvements in writing and drawing instruments.—July 4.

William Bush of Great Tower-street, in the city of London, civil engineer, for improvements in lamps and in lighting. (A communication.)—July 4.

John Combe, of Leeds, Yorkshire, civil engineer, for improvements in machinery for heckling, carding, winding, dressing, and weaving, flax, cotton, silk, and other fibrous substances.—July 4.

William Henry Brown, of Ward's End Wheel, at Wadsley, of Ecclesfield, Yorkshire, steel roller, for improvements in rolls, for rolling flat and half round file and other iron and steel.—July 4.

Pierre Augustus Chauffourier, of Regent's Quadrant, Middlesex, merchant, for improvements in castors. (A communication.)—July 4.

John Browne, of Great Portland-street, Portland-place, Middlesex, esquire, for improvements in apparatus to assist combustion in stoves or grates.—July 4.

Henry Bailey, of Wolverhampton, Staffordshire, chemist, for certain improvements in the construction of articles of wearing apparel; which improvements are also applicable to fastenings for the same.—July 4.

Robert Weare, of Birkenhead, Cheshire, clock and watch maker, and William Peter Piggott, of Wardrobe-place, Docotr's Commons, Middlesex, mathematical instrument maker, for certain improvements in electric batteries; and in the production of light; also a mode of transmitting or communicating intelligence, for the better protection of life or property, parts of which improvements are applicable to like purposes.—July 4.

Richard Garrett, of Leiston Works, Suffolk, agricultural implement maker, for improvements in horse-shoes, pug-mills, drilling, and thrashing machinery; and in steam-engines, and boilers for agricultural purposes.—July 7.

Edward Ives Fuller, of Margaret-street, Cavendish-square, carriage builder, and George Tabernacle, of Mount-row, Westminster-road, Surrey, coach ironfounder, for certain improvements in metallic springs for carriages.—July 7.

Thomas Sedgwick Summers, of Cornwall-terrace, Lee, Kent, lighterman, for certain improvements in fastenings for the mouth of sacks and bags.—July 9.

William Laurie, of Carlton-place Glasgow, merchant, for improvements in means or apparatus to be employed for the preservation of life and property, such improvements or parts thereof, being applicable to various articles of furniture, dress, and travelling apparatus.—July 9.

John Goodier, of Mode Wheel Mills, near Manchester, miller, for certain improvements in mills for grinding wheat and other grains.—July 9.

George Augustus Robinson, of Long Milford, Suffolk, gentleman, and Richard Egan Lee, of Glasgow, gentleman, for certain improvements in the manufacture of bread, and in the machinery and apparatus to be used therein; and also improvements in the regulation of ovens and furnaces, part of which improvements are also applicable to other similar useful purposes.—July 10.

George Cottam and Edward Cottam, of Winsley-street, Oxford-street, engineers, for improvements in machinery for cutting straw, clover, and hay; for grinding, for sawing wood; and in apparatus for ascertaining the power employed in working machines.—July 12.

Evan Leigh, of Ashton-under-Lyne, cotton-spinner, for certain improvements in steam-engines; and also improvements in communicating steam or other power for driving machinery.—July 18.

Reuben Plant, of Holly Hall Colliery, Dudley, Worcester, coalmaster, for improvements in making bar or wrought iron.—July 18.

Thomas Walker, of Birmingham, stove-manufacturer, for improvements in boots and shoes, and in the manufacture of parts of boots, shoes, clogs, and goloshes.—July 18.

James Usher, of Edinburgh, gentleman, for improvements in machinery for tilling land.—July 18.

Andrew Peddie How, of the United States, now residing in Basinghall-street, engineer, for an instrument or instruments for ascertaining the saltness of water in boilers.—July 18.

John Holland, of Larkhall Rise, Clapham, gentleman, for a new mode of making steel. (A communication.)—July 18.

Samuel Cunliffe Lister, of Bradford, Yorkshire, esquire, and George Edmund Donisthorpe, of Leeds, manufacturer, for improvements in preparing, combing, and spinning wool. (A communication.)—July 18.

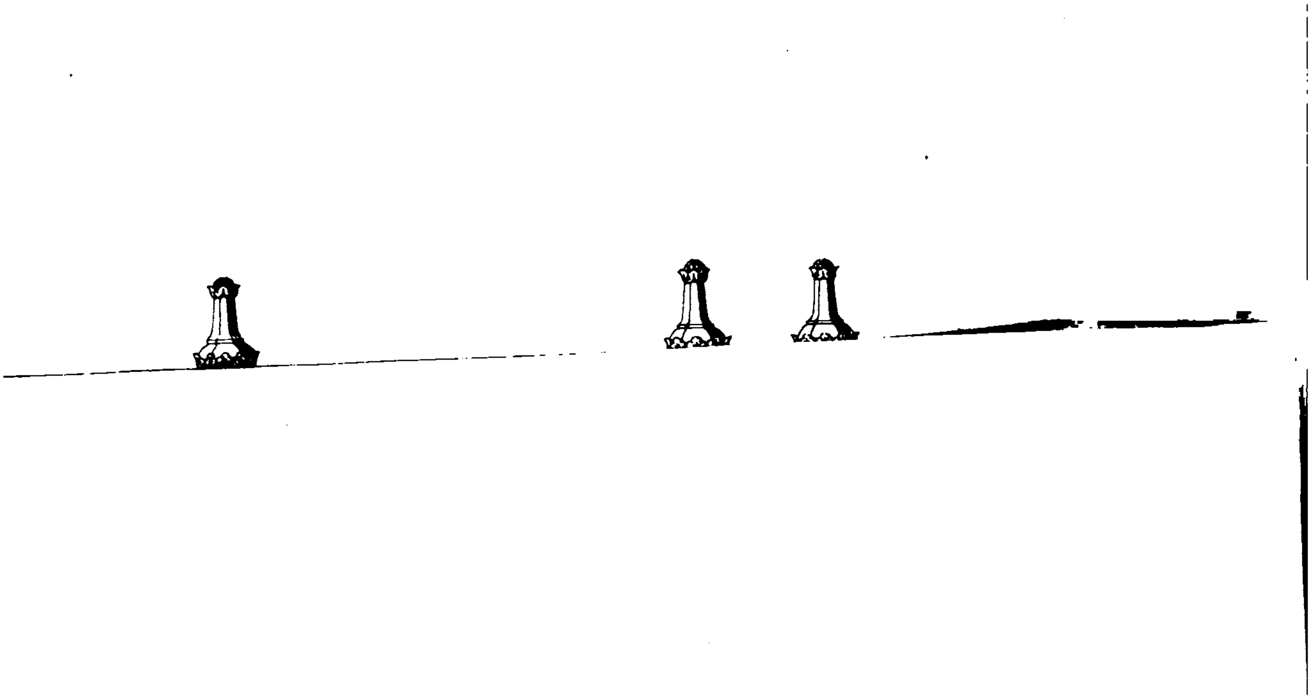
William Brown, of St. James', Clerkenwell, Henry Mapple, of Childe-hill, Hendon, electric engineer, and William Williams, the younger, of Birmingham, gentleman, for improvements in communicating intelligence by means of electricity; and improvements in electric clocks.—July 18.

Alexander Ferrier Rose, of Greenvale-place, Glasgow, gentleman, for a certain improvement or certain improvements in the process or operation of printing, and in the machinery or apparatus employed therein.—July 24.

John Holt, of Todmorden, Lancaster, manager, for improvements in machinery or apparatus for preparing cotton and other fibrous substances, parts of which improvements are applicable to machinery used in weighing.—July 24.

Joseph Woods, of Barge-yard Chambers, Bucklersbury, for improvements in bleaching certain organic substances, and in the manufacture of certain products therefrom. (A communication.)—July 24.

are [illegible] into compartments by arches and pilasters, to which [illegible]



g-cases, roofs, and other structures requiring to be waterproof.—June 27.

THE GLASGOW AND EDINBURGH NATIONAL BANK, GLASGOW.

John Gibson, Esq., Architect.

(*With an Engraving, Plate* XVII.)

A considerable change in architectural taste seems to have taken place within the last few years, in Scotland. The modern public buildings there have, till lately, been more remarkable for frigid plainness, than for either general design or any study of detail. That false sort of simplicity which consists in little more than the absence of all other ornament than that arising from columns and entablatures, has, for the greater part been their chief characteristic; owing to which want of artistic physiognomy, it is not much to be wondered at that they have never been represented architecturally by published elevations and sections of them. Among recent structures, on the contrary, both at Edinburgh and Glasgow, a much more *generous* as well as ornate style has been adopted, greater attention being now paid to the highly-important point of carrying out design consistently,—extending it to every visible side of a building, instead of confining it to a mere front, or single elevation. Of that regard to completeness which has hitherto been generally more or less, and in some instances so grossly neglected, the building of whose east or street front we this month give an elevation is a distinguished example; for besides being quite insulated, and finished-up on each side, it possesses the exceedingly rare advantage of being placed in a *locale* expressly arranged and designed for it by its architect, Mr. John Gibson, of London (the same who erected the Imperial Insurance Office, in Threadneedle-street, an elevation of which was given in the *Journal* for July 1848, p. 193), whose plans for the various buildings were selected from those sent in to the competition, which took place in 1844.

In order to convey some idea of the general disposition of the entire mass of buildings, we may state that they constitute three sides of a quadrangular area on the east of Queen-street, measuring 113 feet (towards the street) by 130 feet. The north and south sides of this area present two uniform handsome elevations, whose ground-floor is occupied by a series of shops, in which regard has been had to architectural appearance,—while the west side is occupied chiefly by the Stock Exchange, and a thoroughfare passage at each end of it, leading to other buildings at its rear. Within the area thus formed the Bank is placed, in such manner however as to be on a line with the street, its front ranging with the ends (30 feet wide) of the shop buildings—so as to leave a clear space of about 50 feet in width between the Bank and the Exchange, the former building being 80 feet in depth by 62 feet in width.

Having thus shaped out the general plan of the collective buildings, so that any one may sketch it for himself upon paper, we proceed to give a more particular notice of the Bank itself. As the exterior, at least the principal front, requires no description from us, it being so infinitely better described by our Engraving than it could be by words, we need only say that the whole of the edifice is faced with Baring stone of a light grey tint; that the two figures on the summit of the front, representing Commerce and Plenty, are six feet high, and were executed by Mr. Thomas, of London; and the entrance door is of a bronze-green colour, and ornamented with bronze pateræ and studs. The north and south elevations of the front portion of the building are similar to the street one, except that there are only three windows on a floor, and the pilasters between them are coupled; but the remainder of those sides, where there is a slight break in the plan, the ground-floor only, with its entablature, is continued,—that division forming the exterior of the Banking Office or Telling Room, above which there are no other apartments. The west or back front (59 feet), facing the Stock Exchange, is of course similar, although with a difference, there being a break in the centre (advancing forward about 8 feet), formed by the loggia on that side within, and ornamented by two pair of coupled engaged Ionic columns, between which is another entrance door leading immediately into the Banking Room. On each side of that projecting division of the elevation is a single window, of the same design as all the other ground-floor ones.

The public apartment of the Bank, or Telling Room, being in the rear of the building, while the front portion of it is appropriated to the committee-room, waiting-room, manager's-room, &c.,—is approached through a handsome corridor, leading in a direct line to it from the street entrance. Even this corridor announces the superior style of embellishment adopted for the interior: its walls are divided into compartments by arches and pilasters, to which well-contrasted colours give additional richness of effect; and its architectural character is considerably enhanced by the beauty of vaulting or ceiling, in which are three compartments,—one of them forming a skylight, filled in with ornamental stained glass. Yet this is only a note of worthy preparation to something worthier still; for however high expectation may have been raised by the approach to the Telling Room, it is more than fulfilled by the *coup d'œil* which there presents itself. Agreeable as it otherwise is, here our task becomes an exceedingly difficult one, it being anything but easy to give anything like a perfectly lucid and satisfactory description. To say that, on first entering, the eye is bewildered by the splendour and variety of colouring and enrichment, would be wrong, and depriving the general design of one especial claim to admiration; for although decoration has been studied for every part of this interior—for floor as well as ceiling; for walls as well as columns or entablatures; for impost and archivolt mouldings and spandrel panels, as well as plain surfaces; and not least of all, for the glazing of the windows—neither the diversity of ornament nor that of colours produces any confusion, but, on the contrary, an *ensemble* so harmoniously combined, that the eye comprehends almost at a glance what it afterwards pauses upon with increasing satisfaction and delight.

This beautiful, and in some respects unique, apartment is by no means remarkable for its size, it being not more than 55 feet in length (from north to south) by 31 feet in width; which last, however, is increased in the centre of the plan to 50 feet, by two *distyle-in-antis* recesses or loggias on its sides, within each of which is an entrance—that on the east side being the one from the corridor. The vertical dimensions or heights are: 20 feet to the top of the cornice of the order; about 24 feet to the plafond, or flat ceiling; and about 30 feet to the summit of the dome. All the walls are beautifully executed to resemble Sienna, with a border of black marble next the floor, corresponding with the plinths or subbases of the columns and pilasters. Of both which last, the bases and capitals are of white marble, and their shafts coloured to resemble porphyry. The entablature has more than its usual complement of enrichment, its frieze being ornamented with an arabesque pattern in colour (blue), composed of the rose, shamrock, and thistle. The cove and plafond are also tastefully decorated with panelling and devices picked out in colours. The order being continued in pilasters round the room, the rich porphyry colour of their shafts, and those of the columns, is carried out uniformly; and the walls are divided into compartments, each of which is filled in with an arcade,—and the imposts, archivolts, and key-stones of these arches contribute not a little to the general embellishment, being all highly wrought, and heightened by colours. There are, besides, spandrel panels over them, filled-in with ornament similar in colour to the frieze, whereby that colour becomes pleasingly distributed. Of these arcades there are ten in all—viz. three at each end of the room, and one on each side of the two loggias; all of which, excepting the two on the east side of the room, have arched windows set within them, upon a ground of dove-coloured marble. The windows themselves, again, contribute not a little to the *ensemble* of decoration, owing to the ornamental pattern of the glazing, which accords with that introduced in the dome,—of which last-mentioned feature we have now to speak more particularly. This dome, then, or skylight—and it shows what a truly tasteful architectural feature what is merely a skylight in its purpose may be made—is 23 feet in diameter at its opening in the ceiling, and of flattish or segmental curvature, its vertical depth being barely 6 feet. It is closed above or at its vertex, beneath which the light is admitted through what may be called a cove, divided into eight compartments by as many ornamental ribs. The glazing of those open compartments consists of octagons and small intersticial squares, the former of which are filled-in with figured glass, wherein pale red and pale blue occur alternately, and produce something of the appearance of transparent coffering. We have accordingly here an example which convinces us how admirably stained glass—which has hitherto been considered so exclusively a property of the Gothic style, as to be totally unfit for any other—may, by a different treatment of it, be made not only to accord with but to enhance quite different modes of design, and become an equally novel and tasteful resource in interior decoration. The floor beneath the dome, where it is confined to the space between the counters, extending across the room from one loggia to the other, is a worthy accompaniment to all the rest of the apartment, it being paved with variously-coloured marbles, beautifully disposed, and forming in the centre a large radiating star. It hardly requires to be observed that the ornamental pavement is continued within the loggias. All the fittings-up—the counters (of Spanish mahogany, enriched with carving), the clerks' desks behind them, the candelabra or stands for gas-burners—everything, in short, has been designed with a most praiseworthy regard to artistic propriety and keeping in every respect. There is nothing of that paltry meanness, or downright slovenliness, with respect to lesser details and minutiæ which so frequently is permitted, even where embellishment is aimed at upon the whole, to operate more or less as a decided drawback upon the satisfaction which, but for such gross negligences and blemishes, might be experienced. To say the truth, if we may judge by the Glasgow Bank, the Scotch seem to have got greatly ahead of us in tasteful as well as liberal decoration of places of public business; at all events, there is not yet one building of the class in all the metropolis which offers anything like the same degree and completeness of embellishment.

The Stock Exchange, at Glasgow, we have as yet merely mentioned, but must reserve a description of it for some other opportunity,—when, perhaps, we shall be able to give an engraving of that building also.

CANDIDUS'S NOTE-BOOK,

FASCICULUS XCVII.

> "I must have liberty
> Withal, as large a charter as the winds,
> To blow on whom I please."

I. I ought, perhaps, now to desist from saying anything further concerning Mr. Ruskin and his "remarkable book"—as it has not untruly been called,—but the latter is so suggestive of remarks in opposition to his own opinions that I cannot refrain from making a few more observations. Those who have cried up the 'Seven Lamps' as a literary phœnix and matchless production of its class, will hardly be surprised at its obtaining a more than ordinary share of notice; or if they do, they will not own it, although they may feel sore at finding that their unqualified and hysterical admiration have provoked remarks of a very different tenour. Criticism is now beginning to open a debtor side of its account with Mr. Ruskin, so that when the balance comes to be struck, it may prove to be very much against him; more especially as the laudations have proceeded chiefly from those who are evidently not much *au fait* with the subject, and who, for fear of uttering anything to the prejudice of the book, have not ventured even to protest against the abominable hideousness of the Illustrations,—which are calculated to give one a fit of the nightmare. Those who have lauded Mr. Ruskin to the skies, appear to have done so chiefly on account of his language, or, as they call it, his eloquence; yet in some quarters his eloquence is now looked upon as little better than verbiage and cant. "He would be thought," says the *Mechanics' Magazine*, "a man of fine feelings and lively emotions; but only plays the part of the Bombastes' of the stage, and the Mawworms of the conventicle. The pith of his discourse lies in exaggeration; in saying odd and absurd things in a fantastic way!" so that, perhaps, after all, he may get the unenviable title of either Bombastes Ruskin, or Mawworm Ruskin. The publication just quoted takes him to task for his unqualified reprobation of "cast or machine wrought ornaments, in which he evidently points to the large share which the admirable wood and stone carving machinery of Mr. Jordan has had in the embellishment of the New Palace of Westminster." If such really be the case, Mr. Ruskin should have distinctly instanced that edifice as strongly exemplifying the unsatisfactory result of machine-carving, and of what he calls "deadly cut" work. For my own part, I must confess I do not see that it makes any difference whether what is mere pattern-work in itself be produced by the hand of the workman, or by either machinery or casting. The former operation is more tedious and expensive, but just as mechanical as the latter, the workman having merely to follow an express pattern, without being allowed to deviate from it in the slightest degree. The carver himself is not required to have any intelligence of design as regards the work he executes, but merely such skill as will enable him "to turn it out," as it is called, in a workmanlike manner,—that is, executed throughout with such uniform precision, that it shall appear to have been produced by a *machine* rather than by *hand*. Were the designer and the carver of architectural ornament the same individual—as seems to have been not unfrequently the case in mediæval building—then, indeed, he might treat his work with freshness and spirit. At present, on the contrary, the operative is a mere plodder, not even so much as allowed to think for himself, or in any way exercise his own discretion; consequently, what he does is just as "lifeless" as if it were wrought by purely mechanical means; which being the case, if machinery can be made to perform the same work, the employment of manual labour becomes little better than wasteful extravagance. According to the present practice, detail and ornament require scarcely anything amounting to design even on the part of the architect himself: however good it may be, his detail is rarely ever the product of his own mind and invention, but merely second-hand and borrowed. We may see the same columns and entablatures *facsimilized* over and over again in different buildings, so that, except as they differ in dimensions, they might just as well have been all cast in the same mould; and so is it, too, with other members and features. Here, then, we have "*lifelessness*" with a vengeance,—utter inertness of design, where design might be made to exert itself most strikingly. And surely if we can tolerate mechanical routine where there ought to be some evidence of artistic mind and thinking, we have no right to scoff at machine-carving. Rather let us hope that we shall ere long get *machine-designing*, we being even now in a very fair way towards reaching such consummation.

II. On the subject of deception with regard to materials, Mr. Ruskin is absolutely furious, denouncing it in the most unqualified manner not only as unworthy artifice, but as downright immoral falsehood and wickedness. Dishonesty and positive fraud it certainly would be, were an architect to make use of factitious materials and then charge his employer at the rate of the genuine ones; whereas, the merely deceiving the eye is, if not a particularly laudable, surely a very harmless species of imposition, notwithstanding that in his overrighteousness Mr. Ruskin actually foams against it in the genuine Mawworm style—as some one has observed of him,—reprobating it as nothing less than iniquity. The worst that can be said of all such artifices is, that they are unsatisfactory, and show paltriness; yet if we are to believe our Mawworm—Mr Ruskin, I mean,—the more exact the imitation—the more difficult it is to detect any difference between the feigned and the real material, the more unpardonable becomes the deception; the more clever the imposition, the more inexcusable does it become, and all the greater is the sinfulness of it—which is, assuredly, very strange and unartistic doctrine. So determined is Mr. Ruskin to reprobate imitation as to material, that he does so for the most contradictory reasons: thus, immediately after condemning those parts in the staircase of the British Museum which are painted to resemble grandite, as being "the more blameable because tolerably successful," he just as strongly condemns columns and other architectural decorations "*daubed* with motley colours" to look like veined marble. In the latter case his censure is sufficiently just; yet, according to his own doctrine, the paltry and slovenly executed imitation to which he alludes carries with it its own excuse, since the intended cheat is performed so bunglingly as to impose upon no one; therefore, like "whitewash, is not to be blamed as a falsity."

III. Imitation as to materials is neither to be absolutely approved, nor absolutely rejected. It may be perfectly satisfactory, or quite the contrary, according to the judgment and taste exercised in applying it. That it is generally the contrary of satisfactory is not so much owing to its being imitation, as to its being coarse and paltry imitation, and being also made to show exceedingly paltry and vulgar taste. Because it is comparatively cheap, decoration of the kind is apt to be grossly overdone, and to become vulgar by being far too ostentatious, and thereby proclaiming its spuriousness; whereas, by discreet reserve, it might perhaps pass for genuine. Assuredly, as far as design and artistic effect are concerned, it makes little or no difference whether the materials be genuine or fictitious, provided, of course, that they produce exactly the same appearance; for in such case, if you are not aware of the deception, you are cheated very agreeably into unsuspicious admiration; and on the other hand, should you happen to be informed of it,—why, then you admire the happiness and success of the artifice—or, as Ruskin would call it, the *lie*. I myself have seen a room fitted up with very superior taste in the Tudor-Gothic style, although all the architectural forms were no more than what some would denounce as *sham*; yet, most certainly there was no appearance of trumpery about it. Of such appearance, however, and of very trumpery taste, we frequently meet with a good deal where the materials are all genuine, and in such case their genuineness rather occasions regret than contributes to satisfaction. There is, besides, very considerable difference in artificial materials and modes of imitation, some being so good as to be scarcely distinguishable from what is imitated—perhaps not at all distinguishable by the eye alone; therefore the employment of them may very well pass for legitimate, notwithstanding that according to Mr. Ruskin's reasoning, the better the deception the greater the dishonesty; and yet even he must own that if there be no perceptible difference as to appearance, the mock answers all the purposes of the genuine material; nay, possibly, even better, for the latter may not be best of its kind, whereas the other may and ought to be after the choicest specimens of the real substance. There is a great deal of stone of so inferior a quality now used, that in a short time it acquires a positively squalid and trumpery look—not the venerable appearance of the gradual decay wrought by years, but that of mere filth and premature rottenness; yet, as the material answers to the name of stone, the buildings constructed of it are spoken of as if they were on that account entitled to more than ordinary respect, even be they ever so poor or bad in point of design. That, on the other hand, a building which is only coated with stucco may, both by general beauty of appearance and the superior taste displayed in it, quite put to shame many that are faced with stone, is proved by the Travellers' Clubhouse, more especially by its front towards Carlton Gardens. If, instead of inveighing in the outrageous manner he does against imitation altogether, without the slightest regard to its being well or ill executed, Mr. Ruskin had contented himself with reprobating the introduction of it in churches and other public edifices, which ought to be erected for durability throughout, no one could have contradicted him; more especially had he at the same time enjoined a very wholesome and necessary caution—namely, that design should be worthy of the material, and be such as greatly to enhance the value of the latter. But to froth and foam, and to call what at the very worst amounts to no more than trumperiness and paltriness, downright sinfulness and lying, is, if not actual insanity, sheer extravagance.—One thing is quite certain: John Ruskin may live to need a wig, but never will be guilty of such a practical *lie* as to wear one which at all resembles a natural head of hair.

IV. According to what has been reported of one of the recent meetings of the Institute, an observation was made to the effect that the greater part of architectural criticism proceeds from those who are not architects themselves. Such is undoubtedly the case, for a great deal of that sort of writing evidently betrays a very superficial acquaintance with the art;—and gives us, if nothing worse, very stale and second-hand opinions, furbished up to look "better than new," by being tricked-out with tawdry flowers of rhetoric, and all that brummagem sentiment which should be left to our *Lady Blarneys*. Still the profession acquiesce in such *soi-disant* criticism, inasmuch as they suffer it to be put forth with perfect impunity, without so much as attempting to gainsay it, or to substitute more wholesome criticism for it. If they are of opinion that the public are misled by incompetent critics, it assuredly becomes their duty to set it right; or, at any rate, they cannot reasonably complain of others doing what they themselves do not care to do, although they may all the while feel that they could do it very much better. Just the same channels for promulgating opinions are open to them as to others, of which, if they do not choose to avail themselves in order to correct what they consider false and mistaken criticism, the fault is entirely their own; and it is quite unreasonable in them to complain of mischief —if mischief it be—which they themselves have the power of checking. It is not enough that professional men put forth what is or ought to be sound instruction, in books addressed to their own class; for however valuable the information they contain, it does not reach the public, who are precisely those who require to be instructed—so far instructed, at least, as be able to take an intelligent interest in the *Art*—with which alone criticism concerns itself; its office being not to make men architects, but to make them competent judges of architecture, and to inspire them with a genuine relish for it. If professional men are above condescending to avail themselves of those ready means for addressing and instructing the public which are afforded by the popular form of journalism and periodical literature—a literature which finds its way among every class of readers,—so it must be; but to complain that others who may be less qualified, presume to do what they themselves do not care to do, shows too much of the dog-in-the-manger spirit. Far more to the purpose would it be to attack bad criticism boldly, and drive it out of the field at once.

V. Although an article in a periodical does not come before the public with the same dignity as a book, such productions have frequently excited far greater interest, and done much more for the particular views they have advocated, than many big books. Besides which, as it is not every one who has leisure to read books—at least, would not think of applying to them for further information on subjects to which his attention had not been previously awakened by something that had interested him in a briefer form—so neither is it every one who, however capable he may be of contributing something towards the general stock of information, has so much to say as would go any way towards forming a volume, or even a pamphlet. Besides which, what may be called floating criticism and opinion must be brought before the public in such manner that they are sure to get it without having to hunt it out. Many brilliant and shining articles on various topics, literary or other, which have appeared in our *Quarterlies*, and have made a sensation, would have probably fallen quite still-born from the press, had they been issued in the form of separate pamphlets on the same subjects. Many a one has read a paper of the kind when he had it actually in his hands, who would never have thought of seeking out anything of the kind. Such at least I know has been frequently the case with myself, and I have casually acquired an interest in what, but for its so coming before me, I should hardly have turned to,—wherefore I suppose it is pretty much the same with many others. Floating criticism does much for the *ventilation* of opinions, which, if confined merely to formal treatises and books, are apt to become musty and mouldy; and although of such criticism there may be a great deal that deserves to be rejected either as mere empty froth, or mere dregs and sediment, there will also be something worth preserving, and of being afterwards incorporated in works of authority and standard character. If professional men could greatly improve the tone of architectural criticism, why do they not do so? By merely censuring it, they also censure themselves —their own indolence or apathy in permitting the public to be misled by those who are merely ready-writers—in other words, mere scribblers.

RENNIE'S PATENT TRAPEZIUM FLOAT WHEELS.

Sir—I have read with much interest in the *Journal* for July and August last, an account of a series of 'Experiments on the Figure, Dip, Thickness, Material, and Number of the Paddles of Steamers, by Thomas Ewbank, Esq., of the City of New York, in the years 1845 and 1848,' extracted from the *Journal of the Franklin Institute*. As Mr. Ewbank has devoted much time to these pursuits, and is the author of a valuable work on 'Hydraulic Machinery,' his observations are entitled to attention.

The facts developed by his experiments may be briefly stated; they are as follow:—

1st. That with equal areas and equal dip, triangular blades may be rendered twice as effective as ordinary rectangular ones; and this, too, while the propelling surface of the smaller number of floats was only one-half that of the greater.

2nd. That as the propelling power of a paddle is greater at its greater or outer extremity, and diminishes to nothing at the surface, so its face should enlarge with the dip, and be nothing above—in imitation of the tails of fishes, the wings of birds, &c.

3rd. That the fewer the number of paddles on a wheel, the better, provided *one* be always kept in full play; and,

4th, That it would be more advantageous to point or fork them as proposed, to evade the jar of their striking the surface.

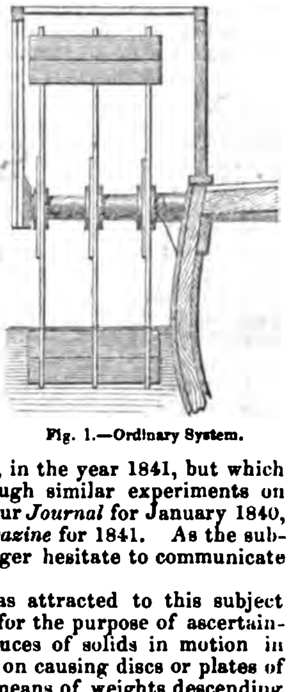


Fig. 1.—Ordinary System.

Mr. Ewbank concludes his paper by referring to the experiments made by me on H.M. steamer *African*, in the year 1841, but which he had not been able to find, although similar experiments on two other vessels were published in your *Journal* for January 1840, and subsequently in the *Nautical Magazine* for 1841. As the subject is now more interesting, I no longer hesitate to communicate the results.

In the year 1831,* my attention was attracted to this subject during the investigations undertaken for the purpose of ascertaining the laws of the friction and resistances of solids in motion in fluids such as air and water,—when, on causing discs or plates of metal to rotate round a fixed axle by means of weights descending through given spaces and times, it was found that when a certain portion (one-fourth) of a rectangular disc or fan was intercepted

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* See 'Philosophical Transactions' for 1831.

from the interior part of the rectangle, so as to approximate to the form of a duck's-foot, the resistance, whether through air or water, was the same—or, in other words, the resistance with *three triangular* or duck-footed floats was as great as previously with four rectangular floats. This apparent paradox was, however, accounted for on the principle of the interior or detrimental portion of the rectangular float being removed.

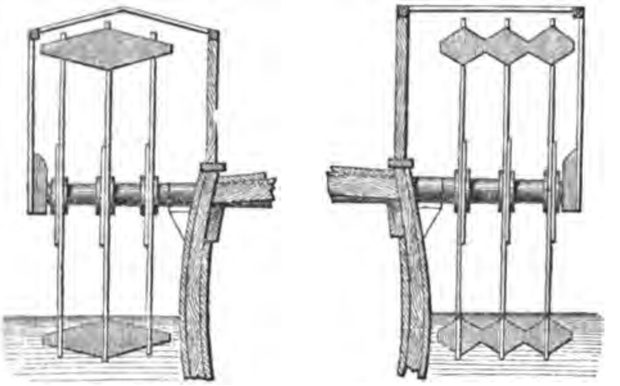


Fig. 2.—Modifications of Ordinary System.

A series of experiments on two other vessels was again made in the years 1839, 1840, and 1841, by applying different-shaped floats to paddle-wheels of different diameters and widths, and on steam vessels of different powers of from 6 to 90 horses; an abstract of some of which was published in your *Journal* for 1840.

The following were the particulars of the *African* when tried in 1837, previous to her being tried in 1841:—

	ft.	in.
Length between perpendiculars	109	11
Extreme breadth	24	10
Mean draught	9	4½
Depth	10	0

Nominal power of engines (by Maudslays and Field) 45 horses, or 90 horses together.

Number of strokes made by the engines per minute, 29 to 30.

Barometer gauge, 24 to 26¾ inches.

Area of immersed midship section, 150 square feet.

Mean diameter of the paddle-wheels, 14·7.

Area of the immersed rectangular floats, on the cycloidal or Galloway system, twelve in number, 7 feet in length, and 1 ft. 9 in. in breadth; thus presenting an area of from 57 to 60 sq. ft., being a ratio of 1 foot of float to $2\cdot\frac{4}{10}$ midship section.

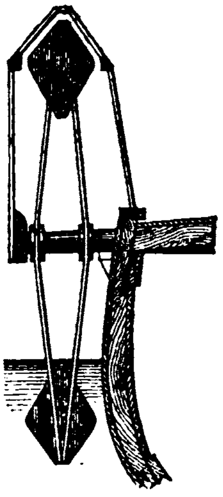


Fig. 3. Improved Trapezium System.

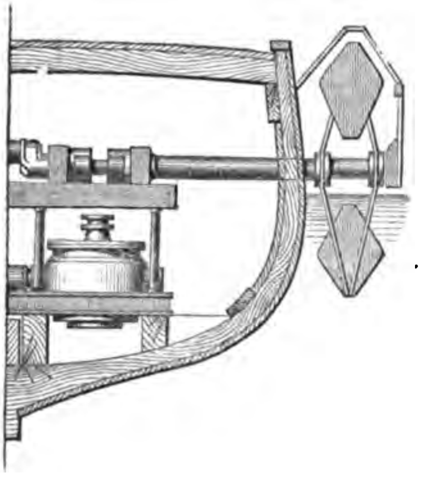


Fig. 4.—Improved Trapezium System, With Wheels of smaller diameter and greater Velocity.

When this trial was made in 1837, at the measured mile in Long Reach, her average speed of six trials each way was 9·174 statute miles per hour with her rectangular floats. Subsequently, she was employed for towing and other purposes, and had never undergone any other repairs than in her engines, and had never been in dry dock: her bottom was consequently foul, and covered with green weeds, when tried with the trapezium floats in 1841.

Experiments on H.M. Steamer 'African,' with Trapezium Floats.

First Trial, April 14, 1841.

All the rectangular floats, twelve in number on each wheel, were removed, and twelve trapezium floats were fixed to the interior and middle rings of each wheel:

Thus making the area of the immersed floats, 34 square feet.

Number of revolutions made by engines, 23½ per minute.

Mean speed of vessel in statute miles, 9·1.

Mean diameter of wheels, 17 feet.

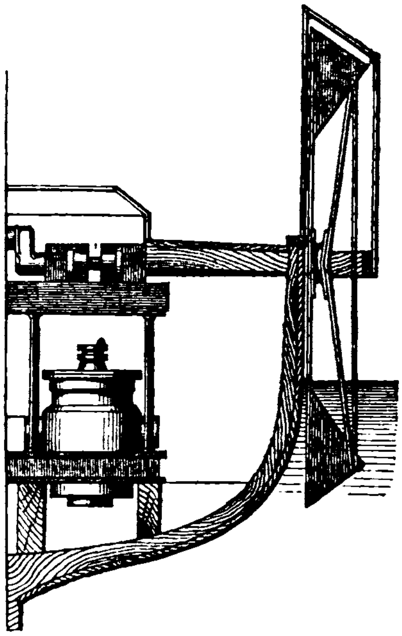


Fig. 5.—Improved Triangular System when the Vessel is Upright.

Second Trial, April 21, 1841.

Number of revolutions made by engines per minute, 23.

Speed in statute miles per hour (weather very windy), 8¾.

Third Trial.—Area of floats reduced one foot each, and reefed-up 4 in.

Number of revolutions made by engines per minute, 25½.

Speed of vessel in statute miles per hour ... ... 9·022.

Fourth Trial, June 8, 1841.

Number of revolutions made by engines per minute, 25.

Speed of vessel in miles per hour (weather windy), 8·8.

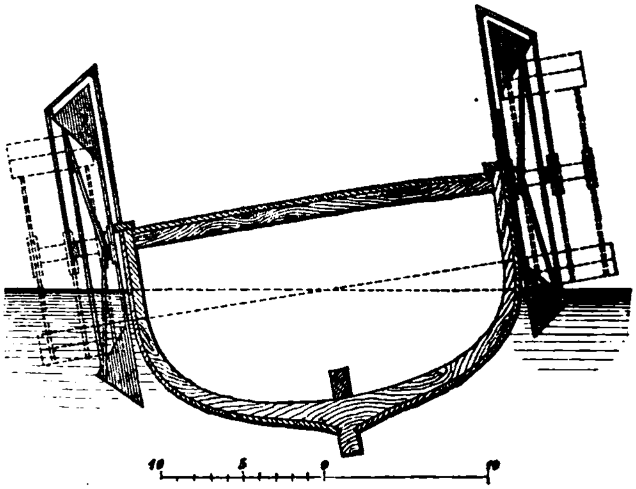


Fig. 6.—Improved Triangular System when the Vessel is Inclined.

Fifth Trial, June 9, 1841.—*Immersed float surface reduced to* 22 *sq. feet area, and reefed-up* 11 *inches; or reducing the diameter of the wheel* 22 *inches.*

Number of revolutions made by engines per minute, 27¼.

Speed of vessel in statute miles per hour ... ... 9·124.

The barometer stood at from 25 to 26 inches.

Which result was nearly equal to her former speed (viz. 9·174) in 1837, with rectangular floats of more than double the immersed area of the trapezium floats.

Experiments with Towing, as per the accompanying Table.

In June 1841, the *African* towed the *Numa* transport of 323 tons, at the rate of 5¼ statute miles per hour.

In July following she towed H.M. steam-frigate *Dee*, of 704 tons, and 200-horse power, 5 statute miles per hour,—which was only 1·6 miles per hour less than her greatest speed when propelled by her own engines, or 6·6 miles per hour.

Woolwich Yard, July 9, 1841.

'African,' Steam-Tug; Trials of her Towing Qualities with Mr. Rennie's Trapezium Wheels.

(Tonnage, 323 tons new measurement. Power, 2 × 45 horse engines = 90 horses' power.)

First Experiment—*Towed the 'Numa' Transport from Deptford to Greenwich.*

Date.	No. of Experiment.	Draft of Water of Tug.	Dip.	Draft of Vessel Towed.	Where tried.	Duration of Experiment.	Distance Run.	Rate per Hour.	Revolutions.	Remarks.
		ft. in.	ft. in.	ft. in.		h. m.	Knots.			
June 24	1	F. 9 0 A. 9 10	3 0	F. 12 8 A. 14 1	Woolwich to Deptford.	0 34	4⅛	7·4	27½	Without the Tow; two patent logs used.
"	2	"	"	"	Blackwall to Woolwich.	0 23	1⅞	4·8	24	The *Numa* in Tow; light wind ahead.
"	3	"	"	"	Barking to Gravesend.	1 50	7½	4·09	19 to 23	Pretty fresh breeze ahead in some of the Reaches, which accounts for the difference of speed of engines.
June 25	4	—	"	—	Gravesend to Woolwich.	1 6	8	7·3	27	But little wind; returning without the Tow.

Second Experiment—*Towed the 'Dee' Steam-Frigate from Woolwich to Sheerness.*

Date.	No. of Experiment.	Draft of Water of Tug.	Dip.	Draft of Vessel Towed.	Where tried.	Duration of Experiment.	Distance Run.	Rate per Hour.	Revolutions.	Remarks.
		ft. in.	ft. in.	ft. in.		h. m.	Knots.			
July 7	1	F. 8 9½ A. 9 9	2 10	F. 8 9 A. 8 0	Barking to Sea Reach	2 25	$11\frac{2}{10}$	4·4	23 to 24	Wind W.S.W.; *Dee* in tow; moderate breeze.
"	2	"	"	"	Sea Reach to the Nore; with 2nd motion.	2 0	$8\frac{84}{100}$	4·42	34 to 38	Strong breeze right aft, which assisted the Tow materially; steam difficult to keep up at 38 revolutions; throttle valves half open; 2nd motion in gear.
July 8	3	"	"	—	Lower part of Sea Reach to Barking.	3 15	$22\frac{1}{10}$	6·8	27¼ to 28	Fresh breeze ahead and on the bow throughout the run; 2nd motion not in gear.

The official report only differs by half-a-mile between the towing powers of the *African* with her rectangular floats in 1837, and the trapezium floats in 1841; so that considering that the area of the trapezium floats was merely adapted to propelling the *African* simply as regarded speed, these trials could hardly be taken as the criterion of their powers as applied to towing, when the areas should have been increased expressly for that purpose. But, comparing the whole of the experiments when tried in still water under the most favourable circumstances, and when tried in the *African* under the unfavourable circumstances of foul-bottom and difference of the powers of the engines, the conclusion is in favour of the trapezium floats. The truth of the principle is confirmed by Mr. Ewbank, and by the laws which govern the forms of the tails of fishes, the feet of aquatic birds, and the wings of birds and insects, whereby the means are so admirably suited to the ends; and the triangular form proposed by Mr. Ewbank for paddle-floats entirely confirms the view I took of the subject in the years 1839 and 1840.

I remain, &c.

George Rennie.

London, August 15, 1849.

DISCHARGE OF WATER FROM RESERVOIRS.

The Theory of the Contraction of the Movement of Water flowing from Apertures in thin Plates, in a Reservoir in which the Surface of the Water is maintained at a constant altitude. By J. Bayer, Lieutenant. (Translated for this *Journal* from Crelle's '*Journal für die Baukunst.*' Band 25.)

(*Continued from page* 246.)

10.

Discharge from Vertical, Elliptical, and Circular Orifices.

The equation between the co-ordinates x and y in an ellipse is—

$$y^2 = \frac{4b^2}{a^2}\,(2ax - x^2).$$

Substitute this value of y in the equation (H § 9), and there follows—

$$a. \qquad Q = k\sqrt{(4g)}\,.\,\frac{2b}{a}\int dx\,\sqrt{\{(2ax - x^2)\,(H + x)\}}.$$

The integration of this equation is practicable only in the case where H = 0, and the development by series has also difficulties, as no series can be found which for every value of H is sufficiently convergent. For this reason, it is necessary to transform the expression. Before proceeding to do this, we may however determine the integral corresponding to the value H = 0. In this case the equation (a) becomes

$$b. \qquad Q = k\sqrt{(4g)}\,.\,\frac{2b}{a}\int x\,dx\,\sqrt{(2a - x)}.$$

Put $\sqrt{(2a - x)} = z$, then

$$\int x\,dx\,\sqrt{(2a - x)} = 2\int z^4 dz - 4a\int z^2 dz = \frac{2}{5}\,z^5 - \frac{4}{3}\,a z^3.$$

Substitute for z its value, and take the integral between the limits—

Firstly, $x = 0$, and $x = 2a$: then

$$\int_0^{2a} x\,dx\,\sqrt{(2a-x)} = (2a)^{\frac{5}{2}}.\,2\left(\frac{1}{3}-\frac{1}{5}\right) = a^{\frac{5}{2}}\,.\,\frac{16}{15}\sqrt{2}.$$

Secondly, $x = 0$, and $x = a$: then

$$\int_0^a x dx\sqrt{(2a-x)} = a^{\frac{5}{2}}\left\{\frac{4}{3}(2^{\frac{3}{2}}-1)-\frac{2}{5}(2^{\frac{5}{2}}-1)\right\} = 2 . a^{\frac{5}{2}} . \frac{8\sqrt{2}-7}{15}$$

Thirdly, $x = a$, and $x = 2a$: then

$$\int_a^{2a} x dx\sqrt{(2a-x)} = a^{\frac{5}{2}}\left(\frac{4}{3}-\frac{2}{5}\right) = a^{\frac{5}{2}} . \frac{14}{15}.$$

Substitute these three values successively in equation (b), and we have—

I. For the quantity of discharge through an elliptical orifice, of which the highest point lies in the surface of the water,

$$c. \qquad Q = k\sqrt{(4ga)} . ab . \frac{32}{15}\sqrt{2}.$$

II. For the quantity of discharge when the orifice is a semi-ellipse, its lowest edge being the horizontal axis, and the extremity of the vertical axis $2a$ coinciding with the surface of the water,

$$d. \qquad Q = k\sqrt{(4ga)} . ab . \frac{4}{15}(8\sqrt{2}-7).$$

III. For the quantity of discharge by a semi-ellipse in the reversed position, the horizontal edge being uppermost, and at a depth a below the surface,

$$e. \qquad Q = k\sqrt{(4ga)} . ab . \frac{28}{15}.$$

The sum of the equations (d and e) gives the equation c.

In order to find a more convenient function for the development of the variable part of equation (a), by a series, let the origin of co-ordinates be transferred to the centre of the orifice. We have then the equation

$$y^2 = \frac{4b^2}{a^2}(a^2-x^2).$$

Let the altitude of pressure H′ be put for $H + a$; then the equation (H § 9) becomes for these values

$$f. \qquad Q = k\sqrt{(4g)}\,\frac{2b}{a}\int dx\sqrt{\left\{(H'+x)(a^2-x^2)\right\}}.$$

If, now, $\sqrt{(H'+x)}$ be expanded in a series, we have

$$\int dx\sqrt{\left\{(H'+x)(a^2-x^2)\right\}} =$$

$$\sqrt{H'}\int dx\sqrt{(a^2-x^2)}\left\{1+\frac{1}{2}\frac{x}{H'}+\frac{1}{2}\cdot\frac{1}{4}\cdot\frac{x^2}{H'^2}+\frac{1}{2}\cdot\frac{1}{4}\cdot\frac{3}{6}\frac{x^3}{H'^3}+\ldots\ldots\right\}.$$

Integrating the several parts of this expression, and taking the integral

1. Between limits $x = 0$ and $x = a$,

$$\int_0^a dx\sqrt{(a^2-x^2)} = \tfrac{1}{2}(\tfrac{1}{2}a^2\pi) \qquad \int_0^a x dx\sqrt{(a^2-x^2)} = \tfrac{1}{3}a^3$$

$$\int_0^a x^2 dx\sqrt{(a^2-x^2)} = \tfrac{1}{2}\cdot\tfrac{1}{4}(\tfrac{1}{2}a^4\pi) \qquad \int_0^a x^3 dx\sqrt{(a^2-x^2)} = \tfrac{1}{3}\cdot\tfrac{2}{5}a^5$$

$$\int_0^a x^4 dx\sqrt{(a^2-x^2)} = \tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6}(\tfrac{1}{2}a^6\pi) \qquad \int_0^a x^5 dx\sqrt{(a^2-x^2)} = \tfrac{1}{3}\cdot\tfrac{2}{5}\cdot\tfrac{4}{7}a^7$$

and

$$\int_0^a dx\sqrt{\left\{(H'+x)(a^2-x^2)\right\}} = \sqrt{H'}\left\{\tfrac{1}{2}a^2\pi\left(\tfrac{1}{2}-(\tfrac{1}{2}\cdot\tfrac{1}{4})(\tfrac{1}{2}\cdot\tfrac{1}{4})\frac{a^2}{H'^2}\right.\right.$$

$$\left.-(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6}\cdot\tfrac{5}{8})(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6})\frac{a^4}{H'^4}-(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6}\cdot\tfrac{5}{8}\cdot\tfrac{7}{10}\cdot\tfrac{9}{12})(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6}\cdot\tfrac{5}{8})\frac{a^6}{H'^6}-\ldots\right)$$

$$\left.+\,a^2\left(\tfrac{1}{3}\cdot\tfrac{1}{2}\frac{a}{H'}+(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6})(\tfrac{1}{3}\cdot\tfrac{2}{5})\frac{a^3}{H'^3}+(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6}\cdot\tfrac{5}{8}\cdot\tfrac{7}{10})(\tfrac{1}{3}\cdot\tfrac{2}{5}\cdot\tfrac{4}{7})\frac{a^5}{H'^5}+\ldots\right)\right\}$$

$$= a^2\sqrt{H'}\{S_1\}.$$

2. Between the limits $x = 0$ and $x = -a$, and we have

$$\int_0^{-a} dx\sqrt{\left\{(H'+x)(a^2-x^2)\right\}}$$

$$= \sqrt{H'}\left\{\tfrac{1}{2}a^2\pi\left(\tfrac{1}{2}-(\tfrac{1}{2}\cdot\tfrac{1}{4})(\tfrac{1}{2}\cdot\tfrac{1}{4})\frac{a^2}{H'^2}-\ldots\right)-a^2\left(\tfrac{1}{3}\cdot\tfrac{1}{2}\frac{a}{H'}+(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6})(\tfrac{1}{3}\cdot\tfrac{2}{5})\frac{a^3}{H'^3}+\ldots\right)\right\}$$

$$= a^2\sqrt{H'}\{S_2\}.$$

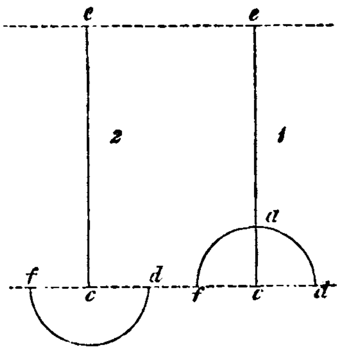
The first value assumed for the integral in equation f, gives for the quantity of discharge through an orifice (as 1),

$$g. \qquad Q = k\sqrt{(4gH')} . 2ab\{S_1\}.$$

The second value gives for the quantity of discharge through an orifice (as 2),

$$h. \qquad Q = k\sqrt{(4gH')} . 2ab\{S_2\}.$$

The altitude of pressure H′ here $= ec$.



By adding together equations (h and g) we have the quantity of discharge for a complete ellipse—

$$i. \qquad Q = k\sqrt{(4gH')} . 2ba\pi\left\{\tfrac{1}{2}-(\tfrac{1}{2}\cdot\tfrac{1}{4})(\tfrac{1}{2}\cdot\tfrac{1}{4})\frac{a^2}{H'^2}-(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6}\cdot\tfrac{5}{8})(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6})\frac{a^4}{H'^4}\right.$$

$$\left.-(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6}\cdot\tfrac{5}{8}\cdot\tfrac{7}{10}\cdot\tfrac{9}{12})(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6}\cdot\tfrac{5}{8})\frac{a^6}{H'^6}-\ldots\ldots\right\}.$$

This equation shows that the formula $Q = k\sqrt{(4gH')}$, when applied in the ordinary way, is nearly accurate only in the case where the sum of the series in the parenthesis is nearly equal to $\tfrac{1}{2}$—that is, when the altitude of pressure is so large that all the terms with H′ in the denominator disappear.

For $H'=0$, $H=a$. Putting these values in equation (i), we have for the quantity of discharge, in the case where the highest point of the orifice is in the surface of the water,

$$k. \qquad Q = k\sqrt{(4ga)} . 2ab\pi\{\tfrac{1}{2}-(\tfrac{1}{2}\cdot\tfrac{1}{4})(\tfrac{1}{2}\cdot\tfrac{1}{4})-(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6}\cdot\tfrac{5}{8})(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6})\ldots\}.$$

But the same quantity of discharge has been already determined by equation c. Put, therefore, the two equal to one another, and we find

$$l. \qquad \frac{16}{15}\cdot\sqrt{2} = \pi\left\{\tfrac{1}{2}-(\tfrac{1}{2}\cdot\tfrac{1}{4})(\tfrac{1}{2}\cdot\tfrac{1}{4})-(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6}\cdot\tfrac{5}{8})(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6})-\ldots\right\}.$$

Thus the sum of the series in the parenthesis $= \dfrac{16\sqrt{2}}{15\pi} = 0{\cdot}48018$.

Put in the equation (h) the altitude of pressure $H' = a$, and we have the same quantity of discharge which the equation (d) has already given. By the comparison of both we find

$$m. \qquad \frac{4}{15}(8\sqrt{2}-7) = 2\{S_2\}$$

$$=2\left\{\tfrac{1}{2}\pi\left(\tfrac{1}{2}-(\tfrac{1}{2}\cdot\tfrac{1}{4})(\tfrac{1}{2}\cdot\tfrac{1}{4})-(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6}\cdot\tfrac{5}{8})(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6})-\ldots\right)-\left(\tfrac{1}{3}\cdot\tfrac{1}{2}+(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6})(\tfrac{1}{3}\cdot\tfrac{2}{5})\right.\right.$$

$$\left.\left.+(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6}\cdot\tfrac{5}{8}\cdot\tfrac{7}{10})(\tfrac{1}{3}\cdot\tfrac{2}{5}\cdot\tfrac{4}{7})+\ldots\right)\right\}.$$

Thus $\{S_2\} = \frac{2}{15}(8\sqrt{2}-7) = 0{\cdot}5752$.

Substitute for the first series in (m) the value in equation (l), and we have

$$\frac{14-8\sqrt{2}}{15} = \tfrac{1}{3}\left\{\tfrac{1}{2}-(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6})\cdot\tfrac{2}{5}+(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6}\cdot\tfrac{5}{8}\cdot\tfrac{7}{10})(\tfrac{2}{5}\cdot\tfrac{4}{7})+\ldots\right\} = 0{\cdot}17907;$$

$$\text{or, } \tfrac{2}{5}(7-4\sqrt{2}) = \tfrac{1}{2}-(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6})\cdot\tfrac{2}{5}+(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6}\cdot\tfrac{5}{8}\cdot\tfrac{7}{10})(\tfrac{2}{5}\cdot\tfrac{4}{7})+\ldots$$

Put now in the equation (g) the altitude of pressure $H = a$, and compare it with equation (e): consequently,

$$n. \qquad \frac{28}{15} = 2\{S_1\} = 2\left\{\tfrac{1}{2}\pi\left(\tfrac{1}{2}-(\tfrac{1}{2}\cdot\tfrac{1}{4})(\tfrac{1}{2}\cdot\tfrac{1}{4})-(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6}\cdot\tfrac{5}{8})(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6})-\ldots\right)\right.$$

$$\left.+\,\tfrac{1}{3}\cdot\tfrac{1}{2}+(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6})(\tfrac{1}{3}\cdot\tfrac{2}{5})+(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6}\cdot\tfrac{5}{8}\cdot\tfrac{7}{10})(\tfrac{1}{3}\cdot\tfrac{2}{5}\cdot\tfrac{4}{7})+\ldots\right\}.$$

and therefore $\{S_1\} = \dfrac{14}{15}$.

When in the equation (f) the altitude of pressure $H' = 0$ is assumed, we find for the quantity of discharge through a semi-elliptical orifice of which the upper horizontal edge coincides with the surface of the water,—

$$Q = k\sqrt{(4g)}\,\frac{2b}{a}\int dx\sqrt{\left\{x(a^2-x^2)\right\}}.$$

But $dx\sqrt{\left\{x(a^2-x^2)\right\}} = a\,dx\left\{x^{\frac{1}{2}}-\frac{1}{2}\,\frac{x^{\frac{5}{2}}}{a^2}-\frac{1}{2}\cdot\frac{1}{4}\,\frac{x^{\frac{9}{2}}}{a^4}-\frac{1}{2}\cdot\frac{1}{4}\cdot\frac{3}{6}\,\frac{x^{\frac{13}{2}}}{a^6}-\ldots\right\}$.

And when the integral is taken between limits $x = 0$ and $x = a$, it follows that

$$\int_0^a dx\sqrt{\left\{x(a^2-x^2)\right\}} = 2a^{\frac{5}{2}}\left\{\tfrac{1}{3}-\tfrac{1}{7}\cdot(\tfrac{1}{2})-\tfrac{1}{11}(\tfrac{1}{2}\cdot\tfrac{1}{4})-\tfrac{1}{15}(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{6})-\ldots\right\}$$

$$= a^{\frac{5}{2}}\,.\,0{\cdot}4793;$$

and, therefore,—

$$o.\qquad Q = k\sqrt{(4ga)}\,.\,ba\,.\,0{\cdot}9586.$$

By comparing equations (o and d), we find for the proportion of the quantities of discharge through two orifices which are equal semi-ellipses, but in inverted positions,

$$Q_d : Q_0 = 1{\cdot}1504 : 0{\cdot}9586;\quad \text{or, } Q_d = 1{\cdot}200\,Q_0.^*$$

Ordinarily, the quantity of discharge through these orifices is computed by the formula

$$p.\qquad Q = 0{\cdot}617\sqrt{(4gH')}\omega = c\sqrt{(4gH')}\,.\,\omega;$$

where ω is the area of the orifice, and H' the altitude of pressure above the centre. In order to exhibit the deviation of this formula from the strict results of the Torricellian law, a small table is given below of the co-efficients of the quantities of discharge through circular orifices for different altitudes of pressure. For this purpose the equation (i) is employed, and in order to adapt it to the object in view, a is put $= b = r$, and for the altitude of pressure above the top of the orifice, $H = mr$; which gives $H' = H + r = (m+1)\,r$.

This value being substituted in the equation mentioned, gives

$$q.\qquad Q = (\tfrac{1}{4}\pi)^2\sqrt{(4gH')}\,r^2\pi\,.\,2\left\{\tfrac{1}{2}-(\tfrac{1}{2}\cdot\tfrac{1}{4})(\tfrac{1}{2}\cdot\tfrac{1}{4})(m+1)^{-2}\right.$$
$$\left.-(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{8}\cdot\tfrac{5}{8})(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{8})(m+1)^{-4}-(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{8}\cdot\tfrac{5}{8}\cdot\tfrac{7}{10}\cdot\tfrac{9}{12})(\tfrac{1}{2}\cdot\tfrac{1}{4}\cdot\tfrac{3}{8}\cdot\tfrac{5}{8})(m+1)^{-6}-\ldots\right\}.$$

When $H = 0$, the top of the orifice lies in the surface of the water, and $m = 0$ and $H' = r$; whence for this value of H', when the last equation is compared with the preceding,—

$$Q = 0{\cdot}5924\sqrt{(4gr)}\,r^2\pi;\qquad c = 0{\cdot}5924.$$

Put successively for m the numbers $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, 1......, and there will be found for the consequent values of the co-efficients c the following:—

Values of m	0	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	1	2	3	4	....
Altitude H'	r	$\frac{5}{4}r$	$\frac{3}{2}r$	$\frac{7}{4}r$	$2r$	$3r$	$4r$	$5r$	..$(m+10)r$
Co-efficient c	·5924	·6031	·6076	·6102	·6118	·6147	·6156	·6163	... $(\frac{1}{4}\pi)^2$...

The mere inspection of this short table shows that the co-efficient c in the equation (p) can be considered constant, and $= (\frac{1}{4}\pi)^2$ only when the altitude of pressure exceeds $10r$. For calculating the quantity of water for altitudes less than $10r$, the general equation (q) must be employed. For altitudes above $10r$ we may, however, put $Q = (\frac{1}{4}\pi)^2\sqrt{(4gH')}.r^2\pi$. In the equation ($q$) the co-efficient for great and small altitudes remains $= (\frac{1}{4}\pi)^2$, and thence it follows that the contraction is independent of the velocity.

It must here be observed that the above values of c in the praxis are capable of direct application only when the sinking of the level of the reservoir is very small. In the preceding investigations, the level in the reservoir was considered as constant; without this condition, the integration of equation (H § 9) would be much more difficult. The experiments, on the contrary, show, with small altitudes of pressure, a sinking of the level above the orifice—which indeed is only small, but in strictness does not agree with the theoretical suppositions. On these grounds, the formulæ, when applied for small altitudes measured immediately above the orifice, require a correction depending on the sinking of the level. On the other hand, for the altitude of pressure for constant water-levels—that is, for altitudes in large reservoirs measuring 1 to 1½ yards above the orifice—the correction is inconsiderable. With circular orifices, the sinking is probably much smaller than with rectangular orifices; for the upper edge of the orifice, when it coincides with the surface of the water, has for the first form only one point,—for the second form has its whole breadth, without any pressure.

The older experiments give, it is true, in contradiction to the above table, an increase of the co-efficient c for small altitudes; only it is very probable that the altitudes were measured immediately above the orifices, and therefore were found too small from the sinking of the water-level; and that, for the same reason, the increase of the co-efficient is a single inference from a measurement of the altitude too small from the sinking of the level.

The older experiments are in general but little adapted for investigation from theoretical inferences, as they partly were conducted within too narrow limits, partly were not capable of being compared together on account of the great diversity of the methods of experiment, of the apparatus, and generally of all the details.

It is, therefore, very possible, that notwithstanding such experiments, which for small decreasing altitudes give increasing co-efficients, the co-efficients of circular orifices, however, diminish with the altitude of pressure, and follow an analogous law with that which we shall hereafter find for square orifices. These doubts can only be removed by as accurate and general experiments as Poncelet and Lesbros conducted for rectangular orifices.

11.

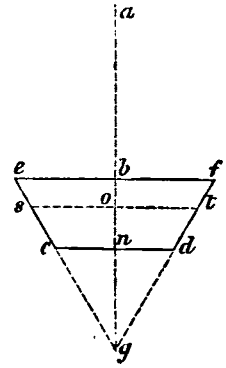
Discharge through Quadrilateral Orifices.

Let $efcd$ be an orifice of the form of a trapezium, of which the parallel sides are horizontal. Let $ab = H$, $ef = m$, $cd = l$, $bn = b$, $bo = x$, $st = y$, $bg = z$. Then

$st : ef = og : bg$; and $st = \dfrac{ef\,.\,og}{bg}$; or,

$$y = \frac{m(z-x)}{z}.$$

When $x = bn = b$, y or $st = cd = l$; and therefore $l = \dfrac{m(z-b)}{z}$.



Obtain from this equation the value of z, and put it in the above expression for y, and it follows that

$$y = \frac{mb-mx+lx}{b}.$$

Put this value of y in the equation (H § 9), and designate by k' the co-efficient for orifices of quadrilateral and like forms, and we have generally for the quantity of discharge

$$a.\qquad Q = k'\sqrt{(4g)}\int\frac{mb-mx+lx}{b}dx\sqrt{(H+x)}.^*$$

Put $\sqrt{(H+x)} = u$, and $\int u\,dx = \omega$. Then $\int y u\,dx = \omega y - \int dy$.

But $\int u\,dx = \int dx\sqrt{(H+x)} = \frac{2}{3}(H+x)^{\frac{3}{2}}$; and $dy = \dfrac{l-m}{b}\,dx$.

Therefore, $\int y\,dx\sqrt{(H+x)} = y.\frac{2}{3}(H+x)^{\frac{3}{2}} - \frac{2}{3}\dfrac{l-m}{b}\int dx(H+x)^{\frac{3}{2}}$.

But $$\int dx(H+x)^{\frac{3}{2}} = \frac{2}{5}(H+x)^{\frac{5}{2}}.$$

Hence, finally, substituting for y its value

$$\int y\,dx(H+x) = \frac{2}{3}\,\frac{mb-mx+lx}{b}(H+x)^{\frac{3}{2}}-\frac{2}{3}\cdot\frac{2}{5}\,\frac{l-m}{b}(H+x)^{\frac{5}{2}}.$$

Take this integral between limits $x = 0$ and $x = b$, and the equation (a) gives for the quantity of discharge

$$b.\qquad Q = k'\sqrt{(4g)}\,.\,\tfrac{2}{3}\left\{l(H+b)^{\frac{3}{2}}-mH^{\frac{3}{2}}+\tfrac{2}{3}(l-m)\frac{H^{\frac{5}{2}}-(H+b)^{\frac{5}{2}}}{b}\right\}.$$

---

* The area of the semi-ellipse is $ab\pi$, and $ab = \frac{1}{2}(ab\pi)\,.\,\frac{2}{\pi}$. Substitute this value of ab in equation (o), and omit the area and the co-efficient; and then the velocity becomes $V_0 = \sqrt{(4ga)}\,.\,\frac{1{\cdot}9172}{\pi}$. By a similar method are found the velocities for all other orifices. When in all the formulæ, $a = b$ for the radius of the orifice, the quantities of discharge and velocities for circular orifices are determined.

* The numerical value of k' is constant only for the square and at equal altitudes of pressure. It varies, as we shall see hereafter for other rectangular forms of the orifice, according to a proportion depending on the heights or vertical sides of these orifices.

When in this equation $H = 0$, the upper edge m of the orifice is in the surface of the water, and we find by reduction

$$c. \qquad Q = k' \sqrt{(4gb)} \cdot \tfrac{2}{3} b \left\{ l - \tfrac{2}{5}(l - m) \right\}.$$

When in equation (b) $m = l$, the trapezium becomes a rectangle, and the quantity of discharge is

$$d. \qquad Q = k' \sqrt{(4g)} \cdot \tfrac{2}{3} l \{ (H + b)^{\frac{3}{2}} - H^{\frac{3}{2}} \}.$$

If here $H = 0$, the upper edge of the orifice is in the surface of the water, and

$$e. \qquad Q = k' \sqrt{(4gb)} \cdot \tfrac{2}{3} lb.$$

Put the height of the orifice for the breadth, and the breadth for the height; and we have

$$f. \qquad Q = k' \sqrt{(4gl)} \cdot \tfrac{2}{3} lb.$$

Now, for the two equations (e and f), it follows that for equal rectangles, when the upper side is in the surface of the water, the quantity of discharge varies as the square root of the height of the orifice.

If in the last equations $b = l$, the orifice is a square, and we have

$$g. \qquad Q = k' \sqrt{(4g)} \cdot \tfrac{2}{3} l \{ (H + l)^{\frac{3}{2}} - H^{\frac{3}{2}} \}.$$

Divide this equation by $k' \times$ the area of the orifice, that is by $k'l^2$, and we have for the velocity the same result as (E § 8).

(To be continued.)

BRITANNIA TUBULAR BRIDGE.

The preparations at the Menai Straits for performing the important and perilous operation of hoisting this enormous fabric to its permanent position are on a scale of immense magnitude. This will be the more readily understood when it is stated that the total dead weight to be lifted 100 feet above high-water mark is upwards of 2,000 tons, or equivalent to the elevation to that height of upwards of 30,000 men. The stroke of the hydraulic presses employed for the purpose is six feet—that is to say, they are only capable of raising six feet in one lift. The tube of 2,300 tons has consequently to be sustained while the presses are lowered and a fresh hold obtained. This sustentation, owing to the immense magnitude of the labour, will be effected by building up successive layers of masonry, at every six-feet lift, under the tube to support it securely in its ascent—during which, arrangements will be made for another six-feet hoist, until the whole 100 feet are finished. Were it not for this process of building up, the operation would only occupy about a day; but as it is, it will take a fortnight. The precaution has been adopted by Mr. Stephenson and Mr. Clarke to guard against the probability of casualty, seeing that should any accident occur, the labour of years and the outlay of half-a-million would be inevitably sunk. To insure security, however, some contrivances are adopted by which the supporting chains as they rise, are continually to be followed up by wedges of wood, so that in the event of any accident arising to the lifting machinery, no injury, it is expected, would happen to the tube.

The mechanical contrivances for the purpose are the largest in the world, and the most powerful ever constructed. Favoured by Mr. Clarke, one of the able engineers of the works, we are enabled, from a close personal inspection and the advantage of that gentleman's explanations, to give a description of the vast apparatus for hoisting the huge burthen. The machine used to effect this is an enormous hydraulic press; its construction is of the most simple character, and consists only of an exceedingly thick and heavy iron cylinder, like a mortar. A strong piston or plunger, also of iron, called the ram, works up and down within this cylinder, and is fitted with a leather collar at the shoulder, so as to render it water-tight. Water is forced into the cylinder by a force-pump, through a small orifice which may be compared to the touch-hole of a gun; and this water gradually forces up the piston. The whole secret of the immense power of these machines consists simply in the prodigious force with which the water is driven into them, and which, in the present instance, is so great that it would throw the water to the height of nearly 20,000 feet, which is more than five times the height of the neighbouring noble pinnacle of Snowdon, and 5,000 feet higher than the monarch mountains of Mount Blanc! It, in fact, resembles the piston of a steam-engine, but, instead of using steam at 30 lb. or 40 lb. pressure to the inch, water is used at a pressure of 800 lb. or 900 lb. The cylinder, of course, is of almost adamantine strength, to enable it to sustain and withstand this pressure. The sides of the largest of these presses used in raising the bridge are 11 inches thick. The weight of the cylinder, which is of cast-iron in one piece, is 16 tons alone; but the whole machine complete is 40 tons. The ram or piston working within it is 20 inches in diameter, and if worked to its utmost power, this press would alone be quite capable of raising one of the tubes. The most marvellous thing above all is this, that in spite of its proportions, its stupendous action is guided and controlled with the most perfect ease and precision by one man. This hydraulic giant was constructed by Messrs. Easton and Amos, engineers, of Southwark. It stands on two beams, on a lofty kind of eyrie, at the top of one of the towers, whence a grand and open view is obtained of the Straits seaward, while its elevation above the ravine is upwards of 200 feet. The press is composed of wrought-iron, rivetted together at the top of the side towers, where, with its assistant machinery, it occupies a large chamber to itself, about 29 feet above the level to which the bridge has to be raised. The sensations experienced on looking down from this lofty elevation over the rushing stream of the Straits, and the great tubes and machineries strewn round about below are of a peculiarly impressive character. In addition to this large press there are two smaller presses, with rams 18 inches in diameter, placed side by side at a similar level in the Britannia tower, and which act in conjunction with the large press.

The chains, by which the power exerted by the presses in their lofty position is communicated to the tubes at the base of the tower, resembles the chains of an ordinary suspension bridge, and are similar to those of the bridge at Hungerford. They are manufactured by the patent process of Messrs. Howard and Ravenhill, of London, and consist of flat links, 7 inches long, 1 inch thick, and 6 feet in length, with an eye at each end, and are bolted together in sets of eight and nine links alternately. The weight of these chains employed in lifting the 2,000 tons is about 100 tons, far exceeding that of the well-known equestrian statue of the Duke of Wellington at Hyde-park, which has hitherto been regarded as one of the greatest "lifts" of the age. These chains are attached to the tube at two feet from the end, and in order to get sufficient purchase at the part, three strongs frames of cast-iron are built into each end of the tube. The innermost end only stiffens and supports the sides while the tube is resting on its ends. The two outer frames are the lifting frames; the chains are attached to them by three sets of massive cast-iron beams, placed across the inside of the tube, one above another, their ends fitting under deep shoulders or notches in the lifting frames, where they are secured by screw bolts. As an additional security, two very strong wrought iron straps pass over the upper pair of beams, and descend into the bottom cells beneath the frames, where they are strongly keyed. The weight of these lifting frames and cast-iron beams is 200 tons, and it is a matter of wonder even among the engineers themselves how machinery can be made strong enough to raise the ponderous load. The way in which the chains are connected with the press is by an exceedingly thick and heavy beam of cast-iron, strengthened by wrought-iron ties across the top. It rests like a yoke upon the shoulder of the ram, and is called the cross-head of the press; the two chains pass through square holes at either end of the cross head, and are securely gripped at the top of it by an apparatus called the clams, consisting of two strong cheeks of wrought-iron, drawn together by screws like a blacksmith's vice. The beams on which the presses stand, the cross-heads, and all the parts that are subjected to a very heavy strain, are either constructed of, or strengthened by, wrought-iron, which is found to be less brittle and more trustworthy than cast-iron. As the tube is 12 feet longer, allowing 6 feet at each end, than the distance between the towers in which the presses work, recesses or grooves are left in the face of each of 6 feet deep, in order to receive the additional length, and of sufficient width to allow the end of the tube to slide up easily within them. These recesses extend from the bottom of the towers to nearly the height of the hydraulic machines; it is in the low end of these recesses, on a soft bed of timber, placed to receive it, that the great tube, since its successful floating, has been lying in state across the estuary of the Straits, until these vast mechanical equipments for ballooning it to its permanent level were completed.

Mr. Stephenson's Report, of the 9th ult., to the Chester and Holyhead Railway Company, on the present prospects of the Britannia Bridge, is given at page 287 of our present number.

SEA WALLS.

Account of the Effect of the Storm of the 6th of December, 1847, *on four Sea Walls, or Bulwarks, of different forms, on the coast near Edinburgh; as illustrating the principles of the construction of Sea Defenses.* By William John Macquorn Rankine, A. Inst. C.E. —(Paper read at the Institution of Civil Engineers.)

There are few branches of engineering with respect to which greater uncertainty and difference of opinion exist, than that of the construction of sea walls and breakwaters. The question has been frequently before the Institution, and in its archives there is much useful information on the subject. The valuable paper of Lieutenant Colonel H. D. Jones, read in 1842,[1] may be particu-referred to, as its conclusions are to a certain extent verified by the facts which have come under the author's observation. Conceiving that every addition, however small, to the facts recorded respecting the efficiency of such works, must tend to bring the principles of their construction nearer to certainty, the author felt it to be his duty to lay before the Institution, transverse sections of four sea walls, upon a portion of the coast of the Frith of Forth, near Edinburgh, having an exposure towards the north and north-east, and to give an account of the effect upon them of one of the most violent storms on record in this climate, which took place on the 6th of December, 1847.

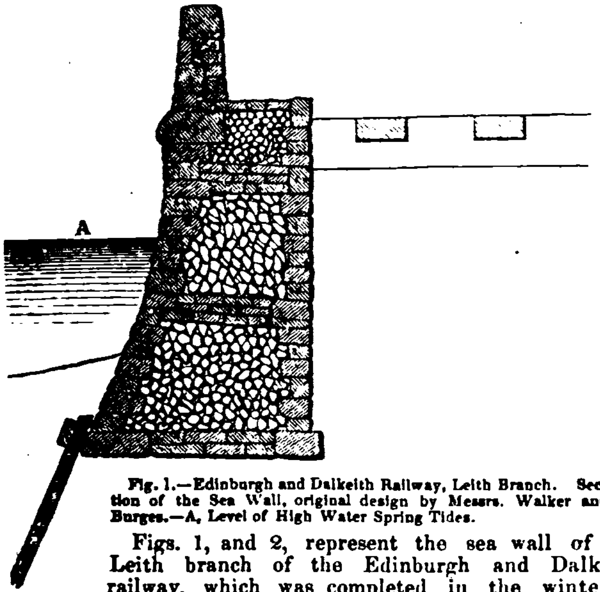
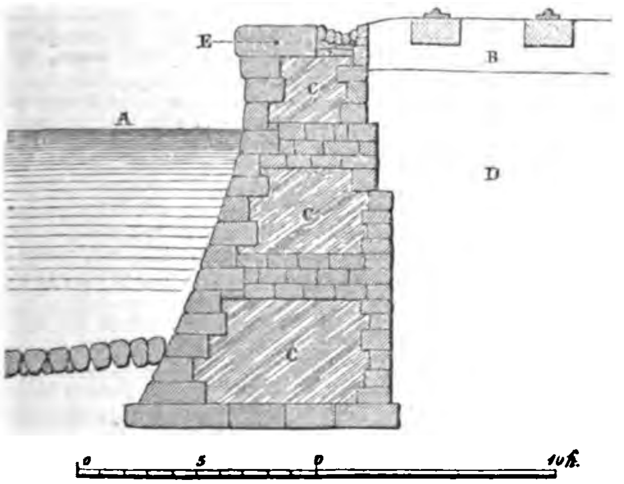


Fig. 1.—Edinburgh and Dalkeith Railway, Leith Branch. Section of the Sea Wall, original design by Messrs. Walker and Burges.—A, Level of High Water Spring Tides.

Figs. 1, and 2, represent the sea wall of the Leith branch of the Edinburgh and Dalkeith railway, which was completed in the winter of 1837. Fig. 1 is the transverse section, as originally designed by the consulting engineer, Mr. Walker. Fig. 2 is the transverse section, as the wall was actually built.



Scale of Feet, Figs. 1 and 2.

Fig. 2.—Edinburgh and Dalkeith Railway, Leith Branch. Section of the Sea Wall as executed in 1837.—A, Level of High Water Spring Tides; B, Ballast; C, C, C, Concrete; D, Sand; E, Dowel.

The author was resident engineer of the railway whilst this wall was executed, and it is the only one of the four walls the formation of which he can describe from actual inspection during the progress of the work; the other three sections are, therefore, to be regarded rather as giving the external form, and the general style of building of the walls they refer to, than as affording minutely accurate information respecting the details of their construction.

The deviations from the original design and specification were chiefly in matters of detail, and will be apparent on an examination of the two sections. The most important were the following:—

The hearting was composed of concrete, instead of rubble. The parapet was omitted, as no bulwark of ordinary height could have kept off the spray, which sometimes rises 20 feet above the wall. A small wall was added at the landward side of the embankment, so as to retain the sand in a sort of trough; for, until this was done, it was found that the spray, collecting in pools on the surface of the embankment, after a gale, washed away the material in large quantities; but after the formation of the trough, the water subsided by filtration through the sand, without doing any damage. As boulder stones were abundant on a neighbouring part of the beach, they were used to form a nearly horizontal pitching to secure the foundation against being undermined, instead of using the sheet piling shown in the section, fig. 1.

It was found, from the effects of a violent gale which took place during the progress of the work, that the coping stones, which weighed about half-a-ton each, were liable to be lifted by the sea, thus exposing to destruction the courses of smaller stones beneath them. They were therefore connected together by cylindrical cast-iron dowels, 1¾ inches in diameter, and 12 inches long, placed in the line of the centre of gravity of the stones, and penetrating 6 inches deep into holes made to fit them, in each stone. This mode of connection has answered its purpose perfectly, not a single coping stone having been lifted by the most violent storms. With the exception of the alterations and additions just mentioned, the wall was executed almost exactly according to the original design of the consulting engineer.

The total length of the wall is about 750 yards, and its height is 13½ feet above the beach at the most exposed part, diminishing to about 6 feet at the ends; this gives only 4 feet above the level of high water of equinoctial spring tides. The least thickness is 5 feet, the greatest thickness is 10 feet; the back of the wall is vertical; the face has a batter of about 5 inches in a foot, at the lower part, and towards the upper part it becomes curved, and overhangs slightly at the top.

The whole of the masonry is of white sandstone from Craigleith, quarry. The foundation course is composed of large flat stones, 12 inches thick, laid horizontally, at an average depth of 4 feet below the surface of the beach. The stratum on which it rests is clean sea sand, with a slight mixture of fine gravel; firm when the tide is low, but when saturated with water, it is so moveable that the author has found stakes, which had been driven 2 feet deep into the beach to mark the line, shifted during a stormy night 3 feet from their former place, without losing their vertical position, or rising out of the sand; yet the foundation of the wall has never shown the slightest symptom of insecurity. This is one amongst many instances of the safety of a foundation on pure sand when it has no outlet to escape laterally.

The face of the wall was built in courses, from 6 inches to 12 inches in thickness, of squared hammer-dressed stones, averaging 2 feet in depth; the back was built of coursed rubble, averaging about 18 inches in depth, and the interior was filled with concrete, composed of gravel from the beach, laid in courses 12 inches in thickness, as the masonry was finished. There are two courses of bond stones as shown in the section. The coping stones are 14 inches thick, and average 3 feet in length.

At first, the joints of the face were protected by scraping out the mortar for a depth of 2 inches, and pointing them with cement; but as it was found that the sea sometimes broke off and extracted large pieces of the cement, even after it had set, it was considered advisable to lay the remainder of the face stones in cement, for a depth of 4 inches inwards, whilst building the wall.

In order to promote the accumulation of sand and gravel at the base of the wall, several timber groynes, formed of planks set on edge between a double row of piles, were placed at right angles to it.

The whole of the masonry was constructed by workmen in the employment of the company, under the immediate direction of Mr. Somerville, upon whom the style of execution reflects great credit.

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[1] See 'Journal,' 1842, Vol V., p. 318.

The gross average cost of the wall was somewhat below *twelve shillings per cubic yard.*

Almost immediately after the completion of this work, the most violent north-east gale occurred which had been known on that part of the coast for twenty years; but the wall, though exposed to the full force of the waves, did not sustain the slightest damage. Ten years afterwards, on the 6th of December, 1847, a more violent storm occurred, which damaged or partially destroyed almost every other sea defense on the neighbouring coast; yet the sea wall of the Leith Branch Railway escaped without injury. The horizontal pitching at the foot of the wall was alone damaged to a slight extent, by some of the stones being lifted out of their places by the waves; but they were generally deposited near their original sites, so that the necessary repairs could be made at a trifling cost.

The sections (figs. 3, 4, and 5) represent sea defenses between Newhaven and Granton, the foundations of which rest chiefly on shale, or on sandstone, which strata crop out on that part of the coast.

Fig. 3.

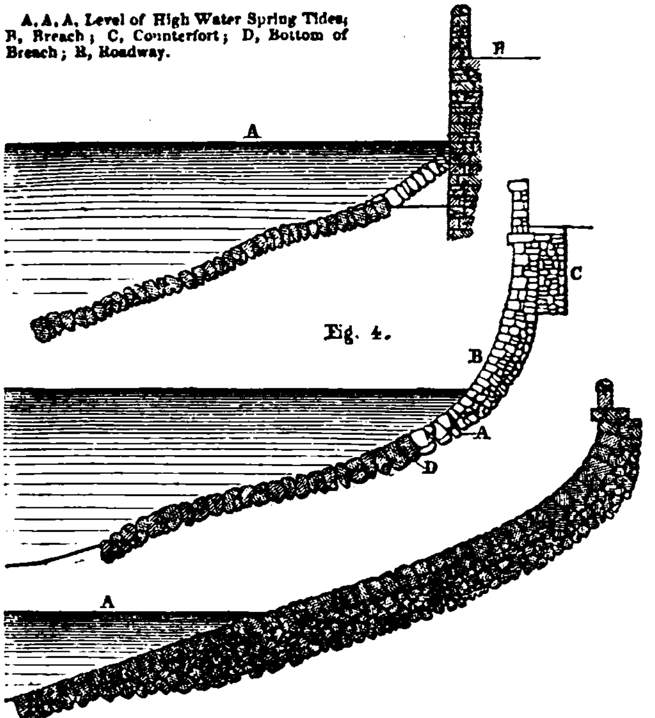

Fig. 5.

Scale to Figs. 3, 4, and 5, $1\frac{1}{16}$ to the Foot.

Fig. 3, represents the cross section of a much older sea wall and bulwark, on the turnpike road between Newhaven and Trinity. As this wall was not breached at any point by the storm of the 6th of December, the author is not able to give its thickness, nor the depth of its foundation. The face is nearly perpendicular, and it is built entirely of rubble, laid in mortar, with a pointing of cement in the joints of the lower courses. The roadway is about 8 feet above high water of spring tides, and the parapet rises 4 ft. 6 in. higher. The foundation of this wall is protected by a dry stone pitching, sloping at angles of from 30° to 40°. The only effect of the storm was, that the upper part of the pitching, at several points, was carried away, to the extent shown in the section. The vertical wall was not damaged, except at one point, where a fishing-boat being thrown upon the road by the waves, overturned an iron railing, which at that spot filled a small opening in the parapet.

Fig. 4, is a section of the sea wall of a portion of the Edinburgh, Leith, and Granton Railway. This wall is 2 ft. 6 in. thick; its section approaches to the form of a hyperbola. For a depth of about 7 feet below the base of the parapet, it is nearly perpendicular, and has counterforts of the form shown in the section. Below the point marked A, it becomes a dry stone bulwark. The effect of the storm of the 6th December upon this structure was to form two long breaches, by which the building was entirely demolished, with the exception of the lower portion of the dry stone bulwark (marked by a darker colour in the section), and several of the counterforts, which were left standing alone. This result was obviously occasioned by undermining; the stones between the point A and the bottom of the breach being extracted by the waves, the upper part of the wall, having no independent foundation, fell into the sea.

Fig. 5 represents the sea wall of the Edinburgh, Leith, and Granton Railway, at and near Granton. This is a sloping bulwark of a nearly parabolic form. It is built dry, except the string-course and parapet, and consists of stones, which are, as the section shows, much larger and heavier than those employed in building any of the walls previously mentioned, most of those in the lower part of the slope weighing full half-a-ton each. The stones of the heavy string-course, on which the parapet rests, are connected by means of a flat malleable iron bar, measuring 2¼ inches by ⅝-inch, laid along their upper surfaces, and attached to the stones by iron spikes ⅝-inch in diameter. The coping stones are connected with each other, and with the dado of the parapet, by T-shaped iron cramps. The damage done to this wall by the storm, was comparatively trifling; it consisted in the overturn of a few yards of the parapet and string-course, and of the dry building immediately beneath; the iron connecting-bar being bent and broken.

The efficiency of the surface of a wall to resist the action of the waves, obviously depends on two circumstances; first, the power with which the moving particles of the water act on the stones at the surface; and secondly, the force with which those stones resist removal. The object to be attained is to render the moving power of the water as small as possible, and the resisting force of the stones as great as possible, relatively to each other.

Without entering into the theory of waves, which involves the highest branches of mathematical analysis, it is sufficiently obvious to daily observation that the oscillation of each particle of water, in a wave moving freely, is partly vertical, and partly horizontal; that when a sufficient depth of water exists in front of a wall, or a line of cliffs, the mutual action of the direct and reflected waves, produces a series of points of greatest agitation; and at those points the horizontal oscillation is either null, or so small, as compared with the vertical, that practically the motion of the particles may be considered merely as an oscillation up and down. A vertical surface is, therefore, that which offers the least possible impediment to the natural motion of the particles of water, under such circumstances, and upon which, consequently, they act with the least power; and a horizontal surface, being perpendicular to the motion of the particles, is that upon which they act with greatest power.

It is also obvious, that when waves encounter a sloping bulwark, or a sloping beach, the vertical part of the oscillation is gradually converted, as the waves proceed, into an advancing and retreating oscillation, parallel to the slope; that being the only direction in which the particles can move, without destroying the surface of the beach or bulwark; and this oscillation has a powerful tendency to overturn and to remove any obstacle which projects above the line of the slope. Hence it is, that large stones, extracted during storms, from the seaward slopes of breakwaters, have frequently been swept entirely over to the landward side; and from the same cause it also arises, that the coping and upper portions of a curved bulwark, such as that in fig. 5, are liable to be overthrown, by the concussion of the body of water directed against them, by the lower part of the slope.

The force with which a stone resists removal is composed of three parts; the first arises from its own weight, and is obviously greater the flatter the slope, and is greatest of all when the surface is horizontal;—the second arises from the pressure of the superincumbent masonry; and this is as obviously greater the steeper the slope, and greatest in a vertical wall;—the third is the adhesion of the mortar, or cement; and as this depends, to a certain extent, on the pressure from above, it also is greatest in a vertical wall. These principles appear to be entirely in accordance with the facts which have been narrated.

In such structures as the pitching at the foot of the walls in figs. 2, 3, and 4, and the lower part of the slope of fig. 5, the resistance to the action of the waves arises, almost altogether, from the weight of the stones, and therefore increases as the slope approaches the horizontal; but as the moving power, exercised by the particles of water, also increases, it is clear, that the stability of bulwarks so constructed depends altogether on the use of sufficiently large and heavy stones, such as those employed in fig. 5. Hence, in figs. 2, 3, and 4, the stones of the pitching not being sufficiently heavy, were partially displaced.

In fig. 4, the destruction of the slope occasioned the fall of the wall which rested on it; but in figs. 2, and 3, where the pitching was not used to support the wall, but merely to protect the foundation, the wall suffered no injury in consequence of its removal. In fig. 2, where the pitching was laid on the natural level of the sand, the stones displaced were deposited near their original site; but in fig. 3, where the slope was comparatively steep, they rolled down with the receding oscillation.

The walls (figs. 2 and 3) being vertical, or nearly so, approach the form of section which gives at once to the particles of water the least amount of displacing power, and to the masonry the greatest amount of the resistance, arising from the pressure of the superincumbent materials, and the cohesion of cement and mortar; and they afford an illustration of the stability which may be attained with such a form of section, in a structure built of comparatively small stones.

Owing to the extremely small elevation of the wall (fig. 2) above the surface of the water, it was necessary that the coping should be sufficiently massive to resist, by its weight alone, any force tending to displace it; but in fig. 3 such a coping was not necessary, as the top of the wall was above the reach of the action of the waves.

The author has endeavoured, in drawing general conclusions respecting the construction of sea walls, to avoid going beyond the limits warranted by the facts he has stated. His conclusions may be received with caution, or with dissent; but he trusts that the facts will be considered worth recording.

Remarks made at the Meeting after the reading of the foregoing Paper.

Major-General **Pasley** referred to an opinion expressed by him at a meeting of the Institution in 1842,[2] when he stated, that from "his observations of the action of the sea upon various parts of the coast, he conceived, that a perpendicular wall, constructed of large ashlar work, well cemented, would assume the character of a rock, and all the prejudicial action of the receding wave would be avoided." The correctness of this opinion had been confirmed, in his mind, by the result of an examination he had made of a sea wall, built by Mr. Brunel, along a portion of the South Devon line, upon which he had reported, when he was Inspector-General of Railways. The wall to which be alluded was nearly vertical; it was so situated, that it was only exposed to any very violent action of the sea for about three days at a time, during spring tides, and then only when a heavy gale of wind blew at the same time. This however had once occurred, and it was then reported that extensive damage had been done. He found, however, that although at the part within the estuary of the Exe a portion of the parapet had been destroyed by a barge striking against it, the only serious damage which had occurred was to the earthwork withinside the wall, which had not been protected by masonry; the waves had been thrown over in such masses, as to plough up the earth and to wash it away. That portion of the sea wall which was constructed of ashlar work, was not injured at all; but a part which was constructed of dry stone masses, or boulders, of considerable weight, was entirely destroyed. The damage was soon repaired, by covering the earth slopes withinside the wall with stone pitching, and substituting good sound ashlar work for the dry stone wall, and since that time no injury had been sustained. His previous opinion, in favour of vertical sea walls, was thus, he contended, fully confirmed.

Mr. **Brunel** confirmed General Pasley's account of the extent of injury sustained by the sea walls on the South Devon line, on the occasion alluded to, and begged to renew his thanks for the assistance afforded him by the General, in refuting *ex parte* and unjust statements, which had been made at the time, and were calculated to produce prejudicial effects. With respect to any comparison between vertical and sloping walls for sea defenses, he must repeat his objections to drawing general conclusions from one class of evidence, or to laying down general rules to suit all cases. In this particular instance, upon the South Devon line, a nearly vertical wall was more applicable, from the position, the depth of the water, and the general circumstances. His intention had been to build the wall with a perfectly vertical face; a slight batter was however given to it; the coping, also, which projected from 2 feet to 2 ft. 6 in., was found effectually to turn the wave down again; the recess of 6 feet, or 8 feet, caused by setting back the parapet wall that distance from the face of the main wall, received the mass of the wave, and the high parapet finally prevented any considerable quantity of water being projected over the wall. The principal injury had, therefore, been received by the slopes withinside the wall, and where no parapet was built, as within the estuary of the Exe the waves had destroyed the slopes; but no other damage was done. As it was always useful to give an account of even comparative failures, he would state, that with respect to that part of the work which was composed of dry stone, it had been formed of blocks of a hard conglomerate, which were found in large quantities on the shore; the wall was about 25 feet high, by about 10 feet thick, and the blocks, when used, were only roughly shaped, so as to give them a kind of bed, that they might be laid together, without cement, like cyclopæan masonry. The whole had been destroyed, as General Pasley had described, while a wall built close beside it, of small ashlar masonry set in mortar, resisted perfectly the action of the same storm. Mr. Brunel ascribed the destruction of the dry stone wall to the roughness of the surface, and the want of cement between the blocks, allowing the sea to enter and to dislocate and destroy the mass. It was necessary to have pitching at the base of sea walls, in order to counteract the action of the receding waves, which was always powerful where the water was only from 4 feet to 6 feet deep. On the southern coast he had constructed bulwarks in advance of the wall, to act as breakwaters, and as groynes, to collect the beach, in order to prevent the scour, which so frequently undermined and destroyed walls, whose foundations were even carried down to a considerable depth. A rock foundation would not always save them, for he had seen the surface completely rubbed away by the scour of the shingle, so as to render it necessary to underpin the wall, and to build an apron upon the rock, to prevent the recurrence of the same action.

Mr. **Green** said, that as a somewhat analogous instance, he might mention the Dymchurch wall, to which so much damage was done by the sea in the year 1803, that he was subsequently sent there, at the recommendation of the late Mr. Rennie, to carry out improvements in that extensive embankment, which protected from the sea a tract of not less than 50,000 acres of marsh land, lying between the town of Hythe and the port of Rye. The wall, or embankment, was constructed entirely of earth; the face next the sea was defended by "arming," which consisted of a facing of coppice wood, held down to the earthwork by oak stakes and laths, in a very ingenious manner; but the front of the embankment had been laid at slopes of different inclinations, and in very irregular longitudinal directions. In some parts, the front slope formed nearly an angle of 45° with the horizon, or at an inclination of 1 horizontal to 1 perpendicular, varying in other parts between that slope and 3 horizontal to 1 perpendicular. The top of the embankment was in many parts at least 30 feet wide, and 20 feet above the level of extraordinary spring tides, and a great portion of it formed the public road from Hythe to Dymchurch and New Romney. It was customary to make large depôts of brush and coppice wood, for the occasional repairs of the embankment, on the top of the more elevated and widest parts of it; but occasionally, the force of the sea was so great, at those parts having the steepest slopes, that the waves broke over the top, and carried the large stacks, of 200 wagon loads of coppice wood, from the top of the embankment down into the marshes behind it, In executing the repairs and the reconstruction with which he was entrusted, Mr. Green's first object was to make the line of the face of the embankment as nearly as possible that of the general line of the shore, and to remove all sudden projections into the sea; and secondly, to bring the front slope of the embankment to an uniform inclination of 7 horizontal to 1 perpendicular, the top of the embankment being only 6 feet higher than the level of extraordinary spring tides. The general inclination of the beach on the shore, from high water downwards, was, in that part of the shore, about 8 horizontal to 1 perpendicular; but the face of the slope was defended by the coppice-wood arming, as before, as the expense of facing it with stone would have been beyond the means of the proprietors of the lands. The plan pursued was found to answer extremely well, as, in the greatest storms, the surge of the sea never reached the top of the embankment. This and other experience, convinced him of the propriety of so forming sea embankments, as to offer the least possible resistance to the direct force of the sea. He had since successfully constructed many other sea embankments, on the same principle, and had been fully confirmed in his opinion.

Mr. **Borthwick** said, that in the year 1833, Mr. Walker reported upon the state of the Dymchurch wall, and recommended a general amendment of its condition, which, he believed, was partly carried into effect, by the construction of a sloping pitched bank, with a vertical wall at the top. Mr. Elliott's paper, which was read at the Institution in the session of 1847,[3] stated, that even that plan had been modified, and a general line had been adopted, with a pitched slope, at an average inclination of about 8 horizontal to 1 perpendicular.

Mr. **Rendel** knew the position where the walls described by Mr. Rankine were situated, as well as those on the coast of Devonshire, mentioned by General Pasley and Mr. Brunel. In his opinion there could be no comparison between the two cases. The former were situated in an estuary, sheltered by Inchkeith and the land of Fife, having, at the same time, a long shallow foreshore; whilst the latter were placed in exposed positions, with considerable depth of water, and heavy waves breaking upon them. A substantial wall, built of proper proportions, of good smoth-faced material, with strong hydraulic lime or cement, would stand well if it were nearly vertical; and a slope would also stand, if well packed with dry stones. The surface, however, must be such as to prevent the stones from offering such opposition to the waves, as to permit them to be loosened and torn up. In practice this was generally a question of relative cost, and in most cases a nearly vertical wall, well built in mortar, was found to be the cheapest. The great difficulty was to protect the toe of the wall, and to prevent it from being undermined; for even when the foundation was carried down to the rock, the beach, which had previously accumulated to a considerable depth, was not unfrequently carried away, and the surface of the rock was abraded to such an extent, by the travelling of the shingle, as to loosen the lower courses of the wall. In all such cases it was necessary, either to place a paved apron, or to construct groynes, for the purpose of collecting the shingle. The latter was perhaps the most effectual mode, if the litoral currents were well examined and taken advantage of, in settling the direction

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[2] See 'Journal,' 1842, Vol. V., p. 319.

[3] See 'Journal,' 1847, Vol. X., p. 261.

and position of the groynes. No conclusions, as to the best forms for breakwaters, could be deduced from examples of walls built like these, four-fifths up the shore. The cases were not in any degree similar, and it was necessary to be very careful not to assume any similarity of action, or of effect, between the long heavy deep waves to which breakwaters were exposed, and the comparatively shallow and broken-up waves to whose action the sea walls near Edinburgh were subjected.

Mr. Scott Russell confirmed Mr. Rendel's view. The value of the arrangements shown in the sections depended entirely upon the nature of the foreshore, the depth of the water, the length of the reach for the sea to rise upon, and the direction of the exposure. It appeared to him, that the mass of masonry in the wall, (shown in figs. 1, and 2,) was so great, the depth of the water was so small, and it was comparatively so little exposed to the sea, that the form of the wall was of little importance, and the circumstance of its standing proved nothing. In the wall shown in fig. 3, on the other hand, the perpendicular part was nothing more than a parapet, being protected by a sloping wall, up to the level of high water. The thinness of the wall in fig. 4, compared with that of fig. 2, rendered any comparison uninstructive, as it was manifestly insufficient, and the foundation, which was only a loose rubble wall, was evidently inadequate; there was also a greater depth of water and more action of the waves, than in the case of the wall in fig. 3. The wall shown in fig. 5, was precisely of the form to endanger the stability of the parapet; and it had given way, as might have been expected. It was similar to that on the Dublin and Kingstown Railway, of which a great part was thrown down by a storm, although it was built of large blocks of granite. The general conclusions he was disposed to draw from the facts stated, and from similar instances which had come under his own observations, were, that a vertical wall, if it was composed of good masonry, united by strong hydraulic lime, or cement, not carried to a height exceeding 30 feet, and not exposed to the action of a heavy Atlantic swell; but protected by a long foreshore, or shallow water, would answer perfectly well, unless the foundation gave way. He might give as examples the quay walls of Liverpool, which were all built nearly vertical; they were also examples of excellent rubble work, which had resisted perfectly all the action to which they were subjected. In the case of exposure to a heavy breaching sea, or deep water, with large waves, it was necessary to begin to break the water as early as possible, and for this purpose a considerable slope would be found safer, and eventually cheaper, especially with such materials as were, usually, most conveniently to be found for such purposes.

Mr. J. Thomson wished that Mr. Rendel had extended his observations, and had told them for what positions he considered each kind of wall was best adapted; for although he thought that the promulgation of any empirical rules must be prejudicial, yet there were conditions under which certain forms of construction had been proved in practice to be bad, and it was very desirable to have such examples brought before the meetings. Mr. Thomson thought that the foundation upon which the wall or the slope was to be placed was a principal consideration; if it was hard and sound, a vertical wall would, under ordinary circumstances, and with proper precautions, most probably stand well but if it was soft and liable to be washed away, a slope, with a long pitched foreshore, must be preferable. The situation, also, must be considered. If a sea defense was required to be built on the beach, near low-water mark, where the half tide would set upon it with all its destructive force, a vertical wall was not desirable, however well the same wall might succeed if it were placed out of the direct influence of the half tide. With respect to the material, Mr. Thomson had found that coursed rubble formed an excellent durable vertical sea wall, if laid in strong hydraulic mortar, or any cement, so that a smooth face could be given to the masonry, affording no salient points for the power of the water to be exerted upon; and even in slopes, it was more desirable to attend to having close joints, and smooth-faced stones, than to selecting those of large dimensions.

Major-General Pasley thought that the depth of the water against the foundation should be considered, as from the experience of the divers who operated under his directions upon the wreck of the *Royal George*, it appeared that at certain depths the water was comparatively still, when it was much agitated at the surface. It might be received as a rule, that the waves had little or no force below the level of low water; and even at a depth of 6 feet below the tide level, he thought that the force of the waves would be innocuous.

Mr. Rendel, V.P., said, it was well known that at a depth of about 12 feet below low-water mark, there was no injurious action of the waves, however deep the action of the tidal current might be.

Mr. Bateman agreed that the specific gravity of materials employed under water should be considered; yet he thought that their structure and qualities were of more importance. Some stones became softened, others readily disintegrated, others were chipped away, or their surfaces worn away by the travelling over them of sand and shingle and others again appeared to be worn down by the action of the water alone. These were all to be avoided for submarine constructions. He had seen some sea walls built of basaltic rock, which possessed great strength and solidity, standing well at an inclination of 3 to 1; but the most remarkable example he recollected was that of the Loch Foyle embankment, the face of which was pitched with a clay slate stone. By the action of the waves, small laminated portions were carried off, and were forced like wedges into the interstices between the larger stones; the whole face by this means became so smooth that not a crevice could be detected, and the waves rolled over the surface innocuously, having nothing to lay hold of in their passage. In fact, this material gave naturally, as perfect a surface as engineers endeavoured to obtain artificially, by laying large dressed blocks of stone, at a considerable expense.

Mr. Murray agreed to the preceding remarks as to the abrasion of materials; it proceeded in some cases to such an extent, as to be a subject of serious consideration to the engineer. The faces of several glacis, or sea slopes, of 4, or 4½ to 1, which he had constructed of hard limestone, had been so worn down and scooped out by the action of the shingle when travelling over it, that constant repairs became necessary. In the harbour of Walker, there was a glacis faced with sandstone full 3 feet in thickness. During the progress of the works, the small chippings of the stones formed a very sharp shingle, which being carried by the waves over the finished portion, wore it away, and injured it so extensively, that the sandstone pitching was obliged to be taken up and be replaced by whinstone, and this, in spite of men being employed to clear the shingle from the surface of the glacis. It was of the utmost importance to the duration of masonry in such situations, that the action of the sand and shingle, under the influence of the tides and currents, should be carefully observed, as by the judicious erection of groynes, it was practicable to accumulate masses of sand or shingle, which would act effectually as a protection for the works, or they might be made to deflect the travelling material into the deep water. This principle had been adopted with great success at the new harbour works at Sunderland, which he had mentioned on a previous occasion.[4] The coasts of Holland exhibited many interesting examples of sea defenses of various kinds. There the groynes were constructed of fascines, straw, and sand, and yet with these simple materials, which the Dutch engineers had been compelled to use, from the absence or great cost of more durable substances, very effective structures were raised, which protected the coast, and cost very little for repairs.[5]

Mr. Rankine wished to explain that he had not read Mr. Scott Russell's paper on Sea Walls[6] before he had written the paper under discussion; if he had done so, he should have referred to some parts which were confirmed by his observations on the walls described. He begged it to be understood, that in giving this description, he had not pretended to lay down universal rules for the construction of breakwaters in deep water, from effects that had been produced upon walls founded on the beach. He concurred in the principle, that an engineer ought to be guided by circumstances in designing works; but he conceived that cases sometimes occurred where the locality permitted the engineer to create such circumstances as he required; for instance, at Cherbourg, the want of a natural beach, on which to found the vertical face of the seaward side of the breakwater, was supplied by the flat summit of a stone embankment; it however remained to be shown by experience, whether that artificial foreshore was sufficiently extensive for its purpose. Mr. Rankine thought Mr. Scott Russell somewhat underrated the power of the waves against the vertical wall at Trinity (fig. 3). The fact that a fishing boat had been thrown over and had been lodged upon the road, which was 8 feet above the high water level of spring tides, showed that the waves had acted on it throughout its whole height, and the exposure had been still further increased at the points where the pitching had been carried away. He also pointed out that the vertical wall (fig. 3) was not exposed to a less depth of water than the curved wall (fig. 4), but rather to a greater depth, and an increased action of the waves.

Mr. C. H. Smith said it appeared to him that in almost all engineering works, the specific gravity or weight of the stone was of the utmost importance, especially for low buildings which were occasionally under sea water, and where there was, perhaps, a rapid current, or in other situations subject to the influence of powerful waves; such circumstances would require a heavy quality of stone to be used, because the weight of all bodies when submerged was reduced by that of the bulk of water displaced. The lightest stone he had ever found in masses sufficiently large for building purposes, weighed only 103 lb. per cubic foot; and if this was used in sea water, its weight would be reduced about 66 lb., which was the weight of a cubic foot of sea water, and therefore it would be like building on land, with a material weighing but 37 lb. per cubic foot. The heaviest building stones that he had met with, were the dark grey varieties of sandstone from the vicinity of Swansea, from Abercarne, from the Forest of Dean, and from Dundee; some of these were even heavier than granite, weighing upwards of 170 lb. per cubic foot, and in his opinion, they would be quite as durable. There was also a remarkably heavy stone found in some of the western islands of Scotland, particularly in the island of Tiree; it was composed of carbonate of lime, with a large quantity of hornblende in small nodules. He conceived that such stones were peculiarly adapted for the building of docks, harbours, breakwaters, sea embankments, and indeed for all purposes where the violent action of water was to be contended against. In situations where the stone was constantly or alternately under sea water, sandstone was preferable to limestone, because it was not so likely to be acted upon by the *Saxicava rugosa*, the *Pholas*, or any other boring molluscæ, which frequently pierced calcareous stones to the depth of several inches, thus changing a smooth face to an extremely rough one, and consequently, by increasing the friction, rendering the stones more likely to be disturbed by the action of the waves. The sea walls or embankments in the neighbourhood of Leith, were constructed with Craigleith stone, which was a very good material for

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[4] See 'Journal,' 1847, Vol. X., p. 189.

[5] See 'Journal,' 1847, Vol. X., p. 83.

[6] See 'Journal,' 1847, Vol. X., p. 125.

many purposes; but he believed that some of the rocks in the neighbourhood of Dundee would furnish a preferable kind of stone for such works, because the Dundee stone weighed from 25 lb. to 30 lb. per cubic foot more than the Craigleith stone, and it could be procured in blocks of much greater size at the same cost.

Mr. J. R. M'Clean said that the Barrow and Piel sea embankments of the Furness Railway, which were each about one mile in length, were somewhat peculiar in construction. The situation was generally well sheltered; but during the equinoctial gales, the banks were exposed to a heavy sea. The embankments were formed of sand, faced with a thickness of 12 inches of clay puddle, into which a thickness of about 4 inches of broken stone was beaten, so as to form a clay concrete bed to receive the pitching, or stone facing, which was 12 inches in depth. The portion of the embankment above the level of the equinoctial tides, was faced on each side with sods 6 inches in thickness, cut from the "salting." The grass, although on a slope of one to one on the inner side, was very strong and luxuriant, and the parapet thus formed afforded a complete shelter for the railway. The cost of the stone facing, including the puddle concrete, was 1*s.* 6*d.* per superficial yard, and that of the sodding was 3*d.* per superficial yard. This form of embankment was, in his opinion, better adapted to the situation, and was constructed at less cost than an upright wall would have been. He agreed with the statement made by Mr. Green, that the greater the slope of the face of the embankment, the less would be the disturbance to the foreshore; and he thought that the necessity for pitching and putting down groynes to protect the foreshore, when an upright wall was built, proved, in a great degree, the correctness of this principle; more especially when the foreshore was composed of alluvial deposit, or other matter of a light description.

The Rev. the Dean of Westminster directed the attention of engineers to the shape of the Cob Wall, which formed the extremity of the pier at Lyme Regis, Dorset. It was a nearly vertical wall, with a rounded end, built of Portland stone, and the stones were fastened together with oak dowels; it projected about a furlong into the sea, at a depth of 10 feet at low water, and was exposed to all the force of the Atlantic; but it was placed at such an angle to the run of the sea that it appeared to divide the waves, deflecting one portion innocuously past, to expend itself gradually upon the beach, leaving still water within the port, and turning aside the other portion in such a manner along the flank of the wall, that the body of water might interpose between the masonry and the succeeding wave, whose force was thus in a great degree expended before reaching the wall. Thus the greater the original wave, the greater was the resisting force of the mass of water, forming as it were a cushion for receiving the succeeding wave; and though the shingle beach had sometimes been driven in during heavy gales, no injury had ever been done to the masonry of the wall. There might be local or engineering peculiarities in the construction of this pier, which had, perhaps, escaped him; and he suggested that it would form a good subject for a communication to the Institution.

Mr. Walker agreed in the impracticability of laying down abstract rules for the forms of construction of sea defenses, suitable for all situations, when so much depended upon the local position, the force acting upon them, the direction of that force, and the quality and dimensions of the material of which the defenses were constructed. The engineer must, in all cases, after considering the whole of the circumstances, combine his plan in accordance with scientific laws and practical experience, without attempting to fit an empirical formula to all cases, however dissimilar. In many instances, nearly vertical walls cost less than long slopes, and this would be the case when the materials were expensive, from the distance they had to be conveyed. On the other hand, whenever the materials were close at hand, and so situated that an inexpensive kind of labour sufficed for placing them, long slopes would be least expensive. Combinations of the two systems had frequently been proposed, as in the original design for the Plymouth Breakwater, which was, that it should be composed of rough hewn blocks, thrown down upon a base of 70 yards wide, in a depth of 5 fathoms, rising to a width of 10 yards on the top, at 10 feet above the level of low water of spring tides, up to which point the materials were supposed to form a slope of about 3 to 1, and above it a nearly vertical wall of hewn stone was to have been built. The action of the sea upon this work, in carrying a large quantity of the stones from the seaward slope entirely over the breakwater, and lodging them on the beach, showed that the inclination should be increased; accordingly, slopes of 3 to 1 for the land-side, and of 5 to 1 for the sea-side, were adopted, and had been since adhered to in the subsequent works, a long foreshore being at the same time formed. At the western extremity, a buttress of hewn stone at a less inclination than the other parts had been constructed under the directions of Mr. Walker; great pains were taken with the construction, the whole being bounded vertically from the bottom to the top, as well as horizontally, by dovetailing the stones and crossing the joints in both directions, in order to render it nearly a monolythic mass. The result of this was, that it had perfectly resisted all the action of the sea for the last six or seven years, when considerable injury had been received by the other ports. At Dover, the part of the works now executing for the commencement of the Harbour of Refuge, was a wall with an inclination of only ⅛ horizontal to 1 vertical, in order to enable vessels to load and unload alongside it, and the main body of the work would be only at a small slope. At the Channel Islands, where fine materials were close at hand, but labour was expensive, a long slope was intended to be adopted up to the level of low water, and then a nearly vertical wall. At Harwich, all the defenses were laid at a long slope, having respect to the cost of materials and labour. Great discrepancy of opinion existed as to the rising of seas against nearly vertical walls. From lengthened observation, Mr. Walker was induced to believe that in very deep water, where the direction of the wall coincided with that of the prevailing wind, the waves would not rise high upon it; but when the face was at a right angle to the sea, it would strike heavily and rise high. This subject had been recently treated very ably by Sir Howard Douglas,[7] and his arguments in favour of long slopes were based upon sound scientific reasoning, and practical examples, which entitled them to much respect. Mr. Walker must repeat, that in practice, engineers must not expect to apply successfully any general rules in all cases; but must act from the dictates of their own reason, and the experience of former works under similar circumstances.

[7] See 'Journal,' 1847, Vol. X., p. 215, 251, 281.

COALS FOR THE STEAM NAVY.

Second Report on the Coals Suited to the Steam Navy. By Sir Henry De La Beche, C.B., F.R.S., and Dr. Lyon Playfair, F.R.S.*

The manner of conducting the experiments is so fully described in the last Report, that it would be unnecessary again to notice it in detail. It may, however, be desirable to remark, that the inquiry has been conducted to the best of our ability, with the view to its practical utility.

The main points to which attention has been directed are—1. The evaporative value of the fuel: 2. Its mechanical structure: 3. The bulk or space which it occupies in stowage: and 4. The chemical identification of the coals operated upon. With regard to the experimental determination of the evaporative value of the coals, the same processes have been followed as described in our first Report. Every attention has been been paid to the peculiar characters of each fuel as exhibited during its burning.

It is well known that particular coals require special modifications of the grate, and even of the boiler, to obtain their maximum result. To acquire this knowledge, it would have been necessary to try every different kind under such varying conditions; and it would have been useless, unless a series of experiments had been made, to ascertain the special circumstances most favourable to the coal under examination. The expenditure of money and time which such a course would have involved, rendered its realization quite impracticable. It was, however, possible so to regulate the draughts of air as to produce those most favourable to the peculiar characters of each coal.

To obtain these conditions, each coal was subjected to experiment for three successive days, the draught being differently arranged for each day. This course was also pursued in the experiments for the first Report. It would have been easy, and it might have given the experiments a fictitious appearance of additional value, to have performed all the work of the three days under the same conditions, as the results would have been accordant. But such agreements, while they confirmed the accuracy of the experiments, would have been of no practical value, since they would not have furnished the data necessary to determine the evaporative powers of the coals under varying circumstances of altered draught. The experiments have, therefore, been tried with different draughts, either in the proportions of 4 : 6 : 8, or when circumstances rendered it advisable of 1 : 2 : 4. By experiments with the varying draughts, it became easy to ascertain when the gases escaping from the coals were most economically consumed. The mean of the three days' trial gives, however, more correctly, the average evaporative value in steam-vessels, where the exact draught depends, to a certain extent, on circumstances over which the engineer has little immediate control.

The coals most liable to be influenced by the different adjustments for the admission of air, are those which, from their bituminous characters, are most apt to generate a large quantity of gaseous products on the first application of heat, such as the coals from the Northumberland, Durham, and Lancashire coal-fields: and it has therefore been found, that the experiments made with them, under different areas for the admission of air, vary much more considerably than with the less bituminous coals of the South Wales coal-field. It has even been found necessary in the highly gas-giving coals, such as the Cannel coal of Wigan, to allow air to enter behind the fire-bridge, so as to complete the combustion of the escaping gases.

Experiments were made at the suggestion of the late First Lord

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* An abstract of the first Report was given in the C.E. & A. Journal, 1848, Vol. XI., p. 273.

of the Admiralty, to ascertain how far mixtures of anthracite with more bituminous coals were likely to prove advantageous in the manufacture of artificial fuel. The apparatus used in the manufacture of the contract fuel for Her Majesty's dockyard, under the patent of Mr. Warlich, having been placed at our disposal, various mixtures were made and tried under the boiler. It was, however, ascertained, that the advantages of these additions were not such as to recommend their adoption. The cementing tar, though partially carbonised by the heat of the coking ovens in which the prepared fuels are heated, was so much more combustible than the dense and difficultly burning anthracite, that the latter remained after the combustion of the former, and it therefore either accumulated on the bars in the state of powder, obstructing the draught, or, falling through the grate, escaped combustion. If thrown again on the fire, it choked the air-way, and impeded the proper action of the fuel. The evaporative power of the fuels thus prepared, was certainly found to increase according as the proportion of fixed carbon was augmented; but this would appear to arise from the fuel then assuming more of the characters of the anthracite, or coke, from which it was made. The results of the experiments pointed to the necessity of keeping an uniform character in the fuel manufactured.

With these observations we would draw attention to the following abstract of the coals examined:—

Table I.—*Showing the Economic Values of the Coals.*

Names of Coals employed in the Experiments.	Economic evaporating power, or number of pounds of water evaporated from 212° by 1 lb. of Coal.	Weight of 1 cubic foot of the Coal as used for Fuel.	Weight of 1 cubic foot of the Coal as calculated from the Density.	Ratio of B. to C., or of the economical to the theoretical Weight.	Difference per cent. between theoretical and economical Weight.	Space occupied by 1 ton in cubic feet (economic Weight)	Cohesive power of Coals (per centage of large Coals)	Evaporating power of the Coal after deducting for the combustible matter in the residue.	Weight of Water evaporated from 212° by 1 cubic foot of Coal.	Rate of Evaporation, or number of lbs. of Water evaporated per Hour.
	A.	B. lb.	C. lb.	D.	E.	F.	G.	H.	I. lb.	K. Mean.
WELSH COALS.										
Thomas's Merthyr ..	10·16	53·0	82·29	·644	55·26	42·26	57·5	10·72	538·48	520·8
Nixon's Merthyr.. ..	9·96	51·7	82·29	·628	59·16	43·82	64·5	10·70	514·93	511·4
Hill's Plymouth Work	9·75	51·2	84·78	·603	65·68	43·74	64·0	10·18	499·20	531·6
Aberdare Co.'s Merthyr	9·73	49·3	81·78	·603	65·78	45·43	74·5	10·27	479·68	489·5
Gadly Nine-feet Seam	9·56	54·8	83·16	·658	51·75	40·87	76·0	10·46	523·88	517·3
Neath Abbey	9·38	59·3	83·57	·709	40·92	37·77	50·0	9·65	556·23	546·1
Gadly Four-feet Seam	9·29	51·6	82·79	·623	60·44	43·41	68·5	10·73	479·36	400·0
Llynvi	9·19	53·3	80·35	·668	50·56	42·02	..	9·58	429·82	399·5
Rock Vawr	7·68	55·0	80·21	·685	45.83	40·72	65·5	7·88	422·40	397·5
LANCASHIRE COAL.										
Balcarres Arley	8·83	50·5	78·17	·646	54·79	44·35	76·0	9·09	445·91	454·1
Blackley Hurst	8·81	48·0	78·90	·608	64·37	46·66	65·0	9·00	422·88	500·8
Blackbrook Little Delf	8·29	51·0	78·16	·652	53·25	43·92	61·5	8·55	422·79	440·4
Rushy Park Mine ..	8·08	47·0	80·04	·587	70·31	47·65	67·0	8·35	379·76	419·1
Blackbrook Rushy Park	8·02	55·3	80·15	·689	44·93	40·50	80·5	8·26	443·50	481·2
Johnson and Wirthington's Rushy Park ..	8·01	50·0	80·10	·624	60·20	44·80	69·0	8·16	400·50	454·5
Laffak Rushy Park ..	7·98	52·6	84·07	·625	59·82	42·58	75·5	8·16	419·74	415·0
Balcarres Haigh Yard .	7·90	50·8	80·10	·634	57·67	44·13	80·0	8·23	401·32	398·3
Cannel (Wigan)	7·70	48·3	76·80	·628	59·00	46·37	95·0	8·06	371·91	381·1
Balcarres Lindsay ..	7·44	51·1	78·61	·650	53·83	43·83	70·0	7·58	380·18	431·5
Balcarres Five-feet ..	7·21	49·0	79·11	·619	61·44	45·71	44·5	7·35	353·29	489·5
Johnson and Wirthington's Sir John	6·32	51·6	81·73	·631	58·39	43·41	82·0	6·62	326·11	362·7
NEWCASTLE COAL.										
Andrew's House, Tanfld	9·39	52·1	78·86	·660	51·36	42·99	..	9·80	489·21	351·2
Newcastle Hartley ..	8·23	50·5	80·27	·629	58·95	44·35	78·5	8·65	415·61	308·0
Hedley's Hartley.. ..	8·16	52·0	81·79	·635	57·28	43·07	85·5	8·71	424·32	300·8
Bate's West Hartley ..	8·04	50·8	78·17	·649	53·87	44·13	69·5	8·26	408·43	406·8
Buddle's West Hartley	7·82	50·6	77·11	·656	52·89	44·09	80·0	8·01	395·69	413·3
Hasting's Hartley . ..	7·77	48·5	78·04	·621	60·90	46·18	75·5	7·96	376·84	404·5
Carr's Hartley	7·71	47·8	78·23	·611	63·66	46·86	77·5	8·13	368·58	344·3
Davison's West Hartley	7·61	47·7	78·36	·608	64·27	46·96	76·5	7·83	362·99	402·9
North Percy Hartley ..	7·57	49·1	78·29	·627	59·45	45·62	60·0	7·72	371·68	423·5
Haswell CoalCompany's Steamboat Wallsend	7·48	49·5	79·36	·623	60·32	45·25	79·5	7·85	370·66	291·8
Derwentwater's Hartley	7·42	50·4	78·79	·639	56·32	44·44	63·5	7·66	373·96	451·1
Original Hartley.. ..	6·82	49·1	77·98	·629	58·81	45·62	80·0	6·98	334·86	428·4
Cowpen & Sidney ditto	6·79	47·9	78·67	·608	64·28	46·76	74·0	7·02	325·24	350·4
SCOTCH COALS.										
Wellewood	8·24	52·6	79·78	·659	58·57	42·58	80·0	8·39	433·42	438·5
Eglinton	7·37	52·0	79·84	·651	51·48	43·07	79·5	7·48	383·24	406·2
Staveley (Derbyshire)..	7·26	49·9	79·79	·625	59·90	44·88	88·5	7·40	362·27	466·2
Conception Bay (Chili)	5·72	..	80·54	..	..	..	..	5·96	..	425·0
Lyon's Patent Fuel .	9·58	61·1	74·73	·817	22·30	36·66	..	9·77	585·33	409·1

The annexed abstract of the working tables will give a general view of the relative value of the coals experimented upon. A coal, for example, may appear by this table to possess a high evaporative power, and yet it may burn so sluggishly, and require so much attention from the stoker to procure its maximum result, that the mere inspection of its evaporative value would give it a higher rank than that to which it is entitled. It is impossible, however, in an abstract to detail all the special characteristics of a coal, and therefore such a table only gives a certain amount of information, and does not render unnecessary a detailed description.

Table II. *Mean Composition of Average Samples of the Coals.* Table III. *Calorific Values.*

Names of Coals employed in the Experiments.	Specific Gravity.	Carbon.	Hydrogen.	Nitrogen.	Sulphur.	Oxygen.	Ash.	Per centage of Coke left by each Coal.	Quantity of Lead reduced by one part of Coal.	Oxygen removed from Litharge by one part of Coal.
WELSH COALS.	A.	B.	C.	D.	E.	F.	G.	H.		
Thomas's Merthyr ..	1·30	90·12	4·33	1·00	0·85	2·02	1·68	86·53	32·96	2·56
Nixon's Merthyr.. ..	1·31	90·27	4·12	0·63	1·20	2·53	1·25	79·11	33·20	2·57
Hill's Plymouth Works	1·35	88·49	4·00	0·46	0·84	3·82	2·39	82·25	34·06	2·64
Aberdare Co.'s Merthyr	1·31	88·28	4·24	1·66	0·91	1·65	3·26	85·88	34·12	2·65
Gadly Nine-feet Seam	1·33	86·18	4·31	1·09	0·87	2·21	5·34	86·54	34·16	2·65
Neath Abbey..	1·31	89·04	5·05	1·07	1·60	..	3·55	61·42	31·20	2·42
Gadly Four-feet Seam	1·32	88·56	4·79	0·88	1·21	..	4·88	86·23	34·24	2·66
Llynvi	1·28	87·18	5·06	0·86	1·33	2·53	3·04	72·94	32·24	2·50
Rock Vawr	1·29	77·98	4·39	0·57	0·96	8·55	7·55	62·50	28·92	2·24
LANCASHIRE COAL.										
Balcarres Arley	1·26	83·54	5·24	0·98	1·05	5·87	3·32	62·89	29·40	2·28
Blackley Hurst	1·26	82·01	5·55	1·68	1·43	5·28	4·05	57·64	29·58	2·29
Blackbrook Little Delf	1·26	82·70	5·55	1·48	1·07	4·89	4·31	58·48	28·68	2·22
Rushy Park Mine ..	1·28	77·76	5·23	1·32	1·01	8·99	5·69	56·66	28·98	2·25
Blackbrook Rushy Park	1·27	81·16	5·99	1·35	1·62	7·20	2·68	58·10	30·86	2·36
Johnson and Wirthington's Rushy Park ..	1·28	79·50	5·15	1·21	2·71	9·24	2·19	57·52	28·90	2·24
Laffak Rushy Park ..	1·35	80·47	5·72	1·27	1·39	8·33	2·82	56·26	26·88	2·08
Balcarres Haigh Yard .	1·28	82·26	5·47	1·25	1·48	5·64	3·90	66·09	28·16	2·18
Cannel (Wigan)	1·23	79·23	6·08	1·18	1·43	7·24	4·84	60·33	29·74	2·33
Balcarres Lindsay . ..	1·26	83·90	5·66	1·40	1·51	5·53	2·00	57·84	26·20	2·05
Balcarres Five-feet ..	1·26	74·21	5·93	0·77	2·09	8·69	9·21	55·90	25·96	2·01
Johnson and Wirthington's Sir John	1·31	72·86	4·93	1·07	1·54	8·15	11·40	56·15	23·80	1·84
NEWCASTLE COAL										
Andrew'sHouse,Tanfld.	1·26	85·58	5·31	1·26	1·32	4·39	2·14	65·13	31·06	2·41
Newcastle Hartley ..	1·29	81·81	5·50	1·28	1·69	2·58	7·14	64·61	31·86	2·47
Hedley's Hartley.. ..	1·31	80·26	5·28	1·16	1·78	2·40	9·12	72·31	30·36	2·35
Bate's West Hartley ..	1·25	80·61	5·26	1·52	1·85	6·51	4·25	..	28·92	2·24
Buddle's West Hartley	1·23	80·75	5·04	1·46	1·04	7·86	3·85	..	29·54	2·29
Hasting's Hartley ..	1·25	82·24	5·42	1·61	1·35	6·44	2·94	85·60	28·56	2·21
Carr's Hartley	1·25	79·83	5·11	1·17	0·82	7·86	5·21	60·63	30·90	2·40
Davison's West Hartley	1·25	83·26	5·31	1·72	1·38	2·50	5·84	59·49	30·12	2·33
North Percy Hartley ..	1·25	80·03	5·08	0·98	0·78	9·91	3·22	57·18	29·10	2·25
Haswell CoalCompany's Steamboat Wallsend	1·27	83·71	5·30	1·06	1·21	2·79	5·93	61·38	28·80	2·23
Derwentwater's Hartley	1·26	78·01	4·74	1·84	1·37	10·31	3·73	54·88	29·10	2·25
Original Hartley.. ..	1·25	81·18	5·56	0·72	1·44	8·03	3·07	58·22	26·62	2·06
Cowpen & Sidney ditto	1·26	82·20	5·10	1·69	0·71	7·97	2·33	58·59	28·66	2·22
SCOTCH COALS.										
Wellewood	1·27	81·36	6·28	1·53	1·57	6·37	2·89	59·15	28·38	2·20
Eglinton	1·25	80·08	6·50	1·55	1·38	8·05	2·44	54·94	24·32	1·88
Staveley (Derbyshire)..	1·27	79·85	4·84	1·23	0·72	10·96	2·40	57·86	28·08	2·18
FOREIGN COALS.										
Conception Bay (Chili)	1·29	70·55	5·76	0·95	1·98	13·24	7·52	43·63	25·62	1·97
Sydney, N. S. W. ..	..	82·39	5·32	1·23	0·70	8·33	2·04	..	..	..
Port Famine..	..	64·18	5·33	0·50	1·03	22·75	6·21	..	..	..
Chirique..	..	38·98	4·01	0·58	6·14	13·38	36·91	..	..	..
Laredo Bay	..	58·67	5·52	0·71	1·14	17·38	16·63	..	..	..
Sandy Bay, 1 (Patagonia	..	62·25	5·05	0·63	1·13	17·54	13·40	..	..	..
Sandy Bay, 2 (Patagonia	..	59·63	5·68	0·64	0·96	17·45	15·64	..	..	..
Talcahuano Bay	..	70·71	6·44	1·08	0·94	13·95	6·92	..	..	..
Vancouver's Island ..	..	66·93	5·32	1·02	2·20	8·70	15·83	..	..	..
Colcurra Bay (Chili) ..	..	78·80	5·50	1·09	1·06	8·37	5·68	..	..	..
Lyon's Patent Fuel ..	1·13	86·36	4·56	1·66	1·29	2·07	4·66	..	31·38	2·43

With regard to the manner in which the fuels included in the annexed tables were selected, for examination, the same plan was followed as that adopted prior to the former Report. Careful inquiries were made at the different ports in the neighbourhood of the coal-fields, as to the kind of coal exported for steam purposes; information from steam-ship companies, in the habit of using the coals of that district was collected, and the local character of the fuel was ascertained. Circulars were then forwarded to the owners of such coals, explaining the object of the inquiry, and requesting them to furnish two tons for experiment. In most instances these were immediately responded to, and the requisite quantity was sent; in a few cases the owners did not furnish the supply necessary. It was not consistent with our instructions to make purchases, as it is usual that the coal experimented on should be delivered free of charge. It is, therefore, possible, that in the coal-fields examined, excellent varieties of fuel may not be included in our list, and this may have arisen either from the circumstance of the owners not responding to our request, or from deficient information furnished to us in our original inquiries. We have constantly endeavoured to rectify any omissions of this kind, when pointed out, and the investigation being still in progress, the opportunities for so doing will receive every attention. It is in accordance with this view that we have included in this Report various coals from the South Wales coal-field which have been sent to us since the publication of the first Report. The examination has been made, as far as possible, by districts, and, in accordance with this arrangement, the Lancashire and Newcastle coal-fields have principally engaged attention in the present Report.

The peculiar quality of the coals employed in the experiments is ascertained by chemical analysis. The character of the economic and chemical experiments differ essentially in one respect—viz., that while in the former many hundred weights are employed in the experiments, in the latter only a few grains are required. It is, therefore, essentially necessary to take precautions that these few grains represent the average state of the coal. In order to ensure this result, a large quantity of the coal is reduced to powder and is well mixed, by passing through sieves of various sizes. The larger fragments remaining on the wider meshes are reduced to powder, so as to enable them to pass through the finer sieves, and be completely mingled with the remainder. The quantity of coal to be examined is taken from this carefully averaged sample. It is found by experiment, that perfectly accordant results are obtained, when small quantities are operated upon, and that imperfect combustion, and therefore discordant numbers, always attend the use of large quantities. These analytical results are placed in Table II. In that table also will be found some valuable analyses of coals from foreign stations, which have from time to time been sent to us from the Admiralty.

TABLE IV.—*Showing the Expansion of Water in the Boiler at different Temperatures.*

Temperature of Water Fahr.	Ratio of Apparent to Real Weight.	Actual Weight of Water in Boiler when filled to Normal Point.	Difference between Actual and Apparent Weight.	Temperature of Water Fahr.	Ratio of Apparent to Real Weight.	Actual Weight of Water in Boiler when filled to Normal Point.	Difference between Actual and Apparent Weight.
°		lb.		°		lb.	
70	1·0000	4730·000	0·000	170	0·9940	4701·620	28·380
80	0·9996	4728·108	1·892	180	0·9923	4693·579	36·421
90	0·9992	4726·216	3·784	190	0·9901	4683·173	46·827
100	0·9987	4723·950	6·050	200	0·9879	4672·767	57·233
110	0·9983	4721·960	8·040	202	0·9869	4668·037	61·963
120	0 9979	4719·097	10·903	204	0·9859	4663·397	66·603
130	0·9974	4717·795	12·205	206	0·9849	4658·577	71·423
140	0·9971	4715 283	14·717	208	0·9839	4653·847	76·153
150	0·9967	4714·012	15·988	210	0 9829	4649·117	80·883
160	0 9954	4708·242	21·758	212	0·9819	4644·387	85·613

Another more simple means of identification, which it is convenient to record, is obtained by estimating what has been termed the calorific value of the coal. This depends upon the circumstance, that within certain limits of error, the calorific value of a coal may be expressed by the quantity of oxygen required to consume it. This amount is experimentally determined by the quantity of lead which the coal reduces when heated with an excess of litharge, that oxide yielding the amount of oxygen necessary for the combustion of the coal. Properly considered, all combustible matter should be viewed as adding its increment to the calorific result, and as such should be allowed its value; but as the amount of sulphur in coals, although increasing the calorific unit, is objectionable in many respects, it may be considered advisable to correct the table for the quantity of lead reduced by it. This correction is not, but may, be very simply made for Table III. by the following formula $\frac{L - (s \times 0{\cdot}77)}{5}$ in which L is the quantity of grains of lead reduced by 5 grains of coal, s, per centage of sulphur as shown in column E. of Table II.

The correction has not been made, as it is thought better to give the actual result of experiment, and because the correction is within the errors of repeated experiments. In most cases, the error arising from iron pyrites is within 0·1 to 0·19 per cent. of the total lead found, and as this quantity is less than the difference between three successive experiments, it obviously falls within the limits of error, and may be safely rejected, so far as the practical result is concerned.

It may be desirable to state that the next Report will include the remainder of those coals which it is thought expedient to examine. The investigation continues to be conducted in the same manner as formerly, our own superintendence being freely given as heretofore, and the actual practical experiments being confided to Mr. J. Arthur Phillips. Mr. How conducted the chemical analyses, until his removal to Edinburgh, after which they were undertaken by Mr. T. T. Philipps.

TABLE V.

Air Thermometer Centigrade.	Number of Unities of Heat abandoned by one Pound of Water in descending from T to 0°	Air Thermometer Fahrenheit.	Number of Unities of Heat contained in One Pound of Water at T°.	Mean Specific Heat of Water between 0° and T cent., or between 32° and T Fah.	Specific Heat of Water from T to T + *d* T.	Latent heat of Vapour Saturated to the Temperature T. Centigrade.	Latent heat of Vapour Saturated to the Temperature T. Fahrenheit.
°		°					
0	0·000	32	32·000	..	1 0000	606·5	1091·7
10	10·002	50	50·003	1·0002	1·0005	599·5	1079·1
20	20·010	68	68·018	1·0005	1·0012	592·6	1066·7
30	30·026	86	86·046	1·0009	1·0020	585·7	1054·2
40	40·051	104	104·091	1 0013	1·0030	578·7	1041·6
50	50·087	122	122·156	1·0017	1·0042	571·6	1028·9
60	60·137	140	140·246	1·0023	1·0056	564·7	1016·4
70	70·210	158	158·381	1·0030	1·0072	557 6	1003·7
80	80·282	176	176·507	1·0035	1·0089	550·6	990·1
90	90·381	194	194 685	1·0042	1·0109	543·5	978·8
100	100·500	212	212 900	1·0050	1·0130	536 5	965·7
110	110·641	230	231·153	1·0058	1·0153	529·4	952·9
120	120·806	248	249·450	1 0067	1·0177	522·3	940·1
130	130·997	266	267·794	1·0076	1·0204	515·1	927·2
140	141·215	284	286·187	1·0087	1·0232	508·0	914·4
150	151·462	302	304·632	1·0097	1·0262	500·7	901·2
160	161·741	320	323·133	1 0109	1 0294	493·6	888·5
170	172·052	338	341·698	1·0121	1·0328	486·2	875·1
180	182·398	356	360·316	1·0133	1·0364	479·0	862·2
190	192·779	374	379 002	1·0146	1·0401	471·6	848·9
200	203·200	392	397·760	1·0160	1·0440	464·3	835·7
210	213·660	410	416·588	1·0174	1·0481	456·8	822·2
220	224·162	428	435·480	1·0189	1·0524	449·4	808·9
230	234·708	446	454·474	1·0204	1·0568	441·9	795·4

TABLE VI.—*Correction for Expansion and Contraction of Water in the Tanks, taking 70° as the Normal Temperature.*

Temperature Fah.	Actual Weight of an Unity of Water.	Temperature Fah.	Actual Weight of an Unity of Water.	Temperature Fah.	Actual Weight of an Unity of Water.
°		°		°	
40	1·001464	54	1·001196	68	1·000178
42	1·001451	56	1·001094	70	1·000000
44	1·001439	58	1·000992	72	·999763
46	1·001426	60	1·000890	74	·999527
48	1·001414	62	1·000782	76	·999290
50	1·001401	64	1·000534	78	·999054
52	1·001294	66	1·000356	80	·998818

In acknowledging the kind and liberal support which has been extended to us by those desirous of promoting this inquiry, we would wish more especially to call attention to the disinterested and important aid afforded by Mr. Samuel Hocking, to whose great knowledge of Cornish boilers we are indebted for much valuable information, and for having personally superintended the setting of the boiler employed in these researches. ●

REVIEWS.

A Report on Indian River Navigation; addressed to the Committee of Gentlemen formed for the establishment of Improved Steam Navigation upon the Rivers of India. By JOHN BOURNE, C.E. London: Allen. 1849.

Mr. Bourne went out to India with Mr. Macdonald Stephenson, as one of the engineers of the East Indian Railway, and had thus the opportunity of examining the Lower Ganges. This has led him to devote his attention to the subject of Indian river navigation, the drawing up of a plan for that purpose, and the publication of the present pamphlet. Certainly the subject is one of very great importance, and which has been very much neglected, as we have heretofore shown; and it speaks but ill for the Indian government that steam navigation should be at its present low ebb. For the non-extension of railways they have an excuse, that the preliminary trials are not yet made; but steamboats have long been tried, and have been found successful. As yet, there are only steamboats on the Ganges, though it is known they will run on the Indus, and on the Assam river or Burrampooter.

The true answer to any objections is, that no proper facilities are given for private enterprise in India. It is worse off than here; and instead of the steamboat being used in India, as in

North America, for a great instrument in the spread of civilization and population on the great rivers, it barely supplies the wants of a small part of the teeming population. We say this is the true cause, and not the natural difficulties; for if there were anything like fair-play for steam enterprise, steamboats would already be plying in every deep reach of the Indian rivers, leaving the bars and shallows for future treatment. The Ganges and the Indus, at any rate, are not much worse off for navigation, if not indeed much better, than many European and American rivers. There is already a great boat navigation,—and therefore there is traffic, the great feeder of steam navigation.

We must not, however, forget, as Mr. Bourne seems almost to have done, that steam navigation is in progress on the Ganges,—that improved boats are introduced, and the time of transit very much reduced. The great complaint is, that more is not done, and that no new company can have any assurance of facilities and encouragement from the government. It must work its way alone, as the other companies have done,—no great harm if left entirely free.

Mr. Bourne gives some very interesting information as to the condition of the Indian rivers,—partly from his own researches among the geographical manuscripts in the India House, and which, as here arranged, is most acceptable to the public.

There is hardly a considerable river in India, which is not, as Mr. Bourne shows, capable of navigation; and the illustrations, marked on his map of India, most powerfully demonstrate the necessity and utility of steam navigation, which would supply arterial communications throughout India. The Ganges is but the beginning; and there is sufficient encouragement and justification for an energetic government to give every aid for the extension of steam communication, for it would be eminently beneficial, in a political, social, and financial point of view. We think it is to be regretted the author has not included the Burrampooter among his illustrations. The Assam Tea Company kept a steamer upon it for some time.

Besides the main stream of the Ganges and Jumna, as far as Delhi, some of the branches can be made available for navigation, as the Gunduck, the Soane, the Gogra, the Goomty, the Upper Ganges, and the Chumbul. The Chumbul can be navigated by low-draft steamers past Gwalior to Kotah, during all seasons of the year; and during the rains boats can get up to the foot of the Vindhya mountains, near the north bank of the Nerbudda.

Upon the subject of the Ganges, we may observe the traffic is great, and the rates remunerative, as is shown by Mr. Macdonald Stephenson's Reports, the 'Practical and Theoretical Considerations on the Management of Railways in India,' by Mr. Hyde Clarke, and in the present work. It is not, as on the western rivers of North America, to create a traffic, but to profit by traffic already existing. Steamers only are wanted. We must however observe, that the great traffic at present is goods traffic, the prices for passenger traffic in the present depressed financial rates of India being too high for the bulk of the population. This, however, is an evil which the progress of steam navigation will remedy; and one great result of extended communication will be a rise in prices and wages throughout India.

Of the Godavery, the account here given is long and interesting; and the more so to English readers, as it appears extraordinary how such a fine river can remain unnavigated where English rule prevails. In August 1840, the Secretary of the Madras government proposed to put a steamer on it, to facilicate the transport of troops; but the general and home governments have as yet done nothing.

The Nerbudda account is likewise interesting, as showing the want of precise information and of engineering enterprise in India. Mr. Bourne says—

> "The Nerbudda river, falling into the sea near Broach, to the north of Bombay, constitutes the northern boundary of the Deccan, and runs through a country which, though naturally productive, has been but little opened to commerce. The Tapty, which pursues a course parallel to that of the Nerbudda, falls into the sea at Surat, nearer Bombay. The districts of Broach and Surat are both known to furnish cotton of a superior quality; and by the establishment of an efficient system of navigation upon the rivers, the production of cotton would be largely increased. The navigation of the Nerbudda, however, is rendered difficult by rocks and falls, which obstruct the channel, and also by the strength of the current: but the magnitude of these difficulties appears to have been much exaggerated by loose and groundless generalizations; and although the evidence upon the subject is conflicting, it appears that the river could, at a small expense, be rendered navigable from near Jubbulpore to the sea—a distance of between 400 and 500 miles in a direct line—by boats of considerable burden. In a letter from the Honourable Court of Directors of the East-India Company (Marine Department), dated March 8, 1840, it is stated, 'On reference to Capt. Ouseley's report, we find it asserted that, with the exception of the Dabree falls, there is no place from Bharagurha, near Jubbulpore, to the mouth that might not be rendered passable for such boats as are now used,—30 to 40 feet long, and 8 to 10 feet wide. All rapids could, with trifling expense, be rendered navigable. Sir J. Malcolm cites Matthews' opinion in favour of the same object between Hernphal and Mokree; and we think that, whilst the native surveyor's opinion remains substantially uncontradicted, it ought to be further investigated.'
>
> The Dahree falls are 40 feet high; and they could only be surmounted by an inclined plane, or by locks. An inclined plane of timber would be an inexpensive structure, as the finest teak timber grows in abundance upon the river banks.
>
> From the sea to 11 miles above Tulluckwarra, a distance of 110 miles, there is no impediment to the navigation. There the Mokree falls, which are 6 feet high, occur, but they can be avoided by a side channel. The river, however, is obstructed by occasional rocks and rapids; but, by an inconsiderable amount of blasting, these impediments could be speedily removed. At the Hernphal or Deer's Leap, the channel is contracted to a width of 40 yards, and the current is very rapid. At the Sarsa Darah falls there is a side channel available, by which the falls may be avoided. The Dahree falls of 40 feet, and perhaps, also, the Mundhar falls, of 10 feet high, would have to be overcome by inclined planes, up which the vessels would ascend, after the fashion of a patent slip, or in the manner followed on some of the American canals.
>
> It will be obvious from this recital that the Nerbudda presents difficulties in the navigation, such as do not exist in the Godavery or the Ganges, arising mainly from the rocky nature of its bed; but this very peculiarity makes the Nerbudda an improveable river, inasmuch as any amelioration consequent upon the removal of rocks, or the deepening or widening of the channel, would be permanent and decisive. Of the importance of opening the Nerbudda to navigation no doubt can exist; and the practicability of accomplishing the necessary improvements at a moderate expenditure appears, from the reports of various engineer officers who have surveyed or sailed down the river, to be equally certain. To what point a steamer of adequate power could ascend the river in its present condition appears doubtful; but the most judicious course would probably be for the steamer to ascend the river as far as is practicable with safety, and for the obstructions to be cleared away progressively, from the mouth of the river upwards, the steamer ascending higher every successive trip, in proportion as the obstructions were removed. The lower part of the Tapty is freer from impediments than the lower part of the Nerbudda; and a steamer of the kind proposed could ascend to Talneir, in longitude 75°,—the minimum depth of water up to that point being 2 feet over the fords."

Of the availability of the Indus there can be no doubt, as during the late wars steamers have got up as high as Lahore. Mr. Bourne calculates upon an effective velocity of ten miles an hour in getting up the stream; but we are very strongly inclined to believe he has rated the speed of his steamers too high.

For the supply of coal India has great advantages; whereas the Mississippi steamers are obliged to be satisfied with wood, sometimes green. Our author says—

> "The supply of coal for the steamers established upon the various rivers of India forms an important part of the general question; but the point is fortunately one which is easily disposed of, as coal has been found near the sources of the several rivers which it is proposed to navigate; and the stations on the upper portions of the rivers can consequently be supplied from local sources—the coal being floated down in the rains, and stored in appropriate situations. At the mouths of the several rivers supplies of English coal would be available; and it would be desirable to use English coal as far as possible, since its quality is better ascertained than that of the local deposits. The Burdwan coal sells in Calcutta for 21*s.* per ton; but the English coal is dearer, being seldom lower than 26*s.* or 28*s.* per ton. For the supply of the stations on the upper parts of the Ganges and Jumna the coal found in the vicinity of Hurdwar could be used, and the coal found on the Soane, and other localities contiguous to the river, could also be used for the intermediate stations. For the upper stations of the Godavery and the Wurdah river the coal-fields of Beitool and Seuni could be rendered available; and on the Nerbudda, near Hossungabad, and also near Jubbulpore, coal of excellent quality is abundantly found. In the range of hills, denominated the "Salt Range," stretching across the Punjaub from Attock toward Seharunpore, coal, it is said, is abundantly found; and these deposits would, in all probability, be available for the supply of steamers on the several rivers of the Punjaub. In Cutch also, near the mouth of the Indus, coal has been discovered; but it would be preferable, in the outset at least, to use English coal for the purpose of *ascending* the rivers, although the coal procured from native sources were used during the descent. The lower parts of the several rivers having in general a slow current and the aid of ascending tides, offer but few difficulties to the ascent of coal-boats for a moderate distance, by tracking or by sails; so that the whole of the lower stations upon the several rivers could be supplied with English coal at a moderate rate of charge, while the upper stations, to which access from the sea is difficult, would be supplied from local sources, which the researches of the Coal Committee at Calcutta show to be available in the several localities of which mention has been made."

A supplement gives the authorities on which the text of Mr.

Bourne is founded, as to the capabilities of the Indian rivers; and they will be perused with interest, as showing the labour he has taken in the investigation of his subject. A postscript likewise proposes an English colony in Cashmere; an undertaking which will not be carried out by the government—but why not?

Mr. Bourne's plan is thus stated:—

> "Since my return to England I have proceeded to mature the conception which suggested itself to me upon the spot; and I find, that whereas the most suitable of the present Ganges boats carry only a cargo of about 60 tons upon a draft of about 3 feet of water, and realise a speed of only 6 or 7 miles an hour, while they are unable to surmount or get off banks in the river by any prompt or effectual process, it is practicable to construct a vessel under other arrangements which shall carry 250 tons of cargo upon 12 inches draft of water, with a speed of 15 miles an hour, and which at the same time shall be capable of running over the shoals on appropriate wheels provided for that purpose. Messrs. Boulton and Watt's letter, offering to construct a vessel upon this plan which shall realise all my anticipations, is appended hereto."

Upon this we may observe, that Mr. Bourne has not explained his boats and engines; and we have nothing on which to judge of their capabilities, but his simple assertion and the letter of Messrs. Boulton and Watt, which does not enable us to form an opinion: but this does not affect the gist of the pamphlet, which is the practicability of steam navigation on the Indian rivers,—about which there can be no doubt.

As to the company for working the plan, in case the government does not take it up—which it is to be hoped they will not, as they will spoil it—Mr. Bourne says,—

> "There would not be much difficulty, I imagine, in the successful institution of an efficient Company for carrying forward inland Steam Navigation in India, provided the government granted it a charter for the exclusive use of the improved vessels in India for a specified term, and agreed to surrender to it, at a valuation, the government steamers upon the Ganges, with the business attaching thereto."

We consider this claiming rather too much, for we cannot conceive what specific right Mr. Bourne's company could have to get the business of the government steamers. There are two companies on the Ganges, which have done much good, and who would have the natural title to a pre-emption of the government business. Mr. Bourne has omitted, too, that these companies have called on the government to give up all interference in the commerce of the Ganges, as it virtually promised to do on the introduction of steam navigation on that river. Nothing could be more unfair than to perpetuate the government competition, which would be the effect of Mr. Bourne's proposition. Indeed, from the way in which he has mentioned it, and from the general tenour of the pamphlet, which, although it alludes to, does not describe the steamboat enterprise of the Ganges, the English public might think there was no commercial steam navigation on the Ganges, and that a new company can start without rivalry. A little care in the future editions will set this matter straight.

Illustrations of the New Palace of Westminster. First Series, 4to.
London: Warrington and Son. 1849.

After some stoppage, this work is now brought to a close at its Sixth Part, and as much of it as has appeared may be bound up as the First Series,—which "first" is almost of assured certainty the "last" also, there being barely enough to form a volume, and very little indeed of Mr. Barry's edifice has as yet been illustrated. That the work has failed as a speculation there can be no doubt, for, contrary to what was reasonably enough to be expected, it has excited no interest. Its ill-success may be attributed partly to its not being placed in the hands of a regular publisher, and partly to injudicious management as regards the work itself, which seems to have been undertaken without any sort of foresight or forethought. System in it there is none whatever, nor is so much as any one portion of the building shown so as to be sufficiently intelligible; while, owing to a singularly perverse choice of subjects, very much less is shown than might have been in the same number of plates, for no fewer than five out of the seventeen, or nearly one-third of them, are devoted to one and the same subject—namely, the Victoria Porch, of which we have, first, an external elevation on its west side, then an interior view, which lets us see little more than a repetition of what was previously seen through the open arch of the exterior; then, again, a second interior of the north side of the porch, which is very little more than a repetition of the other, they being perfectly alike as to general composition and design, and without other difference than what arises from the carriage entrance into the Royal Court in the one, and the door forming the Royal Entrance in the other. At all events, by taking the view in a somewhat diagonal direction, both sides might have been shown in the same plate just as well, or even better, inasmuch as the combination would have been more pictorial. Besides having two plates where one would have sufficed, there are two others inflicted upon the purchasers that might very well have been spared, for although they reckon as subjects, they are in a manner merely duplicate ones, since they represent no more than some of the figures in the niches over the afore-mentioned entrances,—therefore afford no further information with regard to the structure itself, as might have been done by giving two plates of architectural details of the Royal Porch. Had those figures any particular merit, there would have been something like reason for occupying two plates by exhibiting them separately; but either they are greatly libelled by incorrect drawing and very insipid engraving, or they are in themselves exceedingly so-so performances,—such, perhaps, as may pass well enough as mere architectural embellishment and filling-up, but utterly unworthy as works of art. Poor St. George seems to have been modelled from a coalheaver, dressed-up for the occasion, and who felt himself particularly awkward in his unwonted *toggery*.

Great promise-makers are generally great promise-breakers; and such is the case here, for performance has fallen very far short indeed of what was at first promised. The Introduction said—and what is an awkward circumstance, still says—"It is proposed not only to give copious illustrations and embellishments, but to omit no description, historical or architectural, which may be interesting or useful." Nevertheless, in flat contradiction to such declaration, illustration is so far from being copious, as to be, on the contrary, exceedingly scanty and defective. First, as regards the plan of the edifice, no information whatever is afforded—not even so much as by verbal description—relative to any other floor than the principal one; whereas, in a work professing to explain fully (or *copiously*) so very complicated a structure, there ought most assuredly to have been a plan of each floor; and not only that, but also one or two special detailed plans, on a larger scale, of some of the more important parts of the principal floor itself,—such, for instance, as the Peers' Lobby and the House of Peers, and its side corridors,—of the Royal Entrance, Staircase, and Gallery,—and so on.

In the next place, notwithstanding the promise of "copious illustration," there is not a single section through any part of the building, although a dozen drawings of the kind would have been barely sufficient. Shall we then say that they have been omitted as coming under the category of neither "useful" nor "interesting"?—or are they reserved as delicacies that are kept back for the next course or Series—what we have already got being intended merely as a sort of "stay-stomach" and whet to our appetites? A *stay-stomach* it ought to be, for we shall have to stay a good while before the next Series is served up.

The old proverb about the devil and cooks holds good here, and is here fully exemplified, for the meat furnished by Mr. Barry—that is, the New Palace of Westminster—has been awfully badly cooked, and served-up very slovenly; no doubt to his great mortification, unless he be gifted with more philosophy than we ourselves could exercise in a similar case. A publication of the kind, it may very naturally be presumed, is not intended exclusively for home consumption; yet what must foreign architects think of Mr. Barry's edifice as it is here shown? It must surely strike them that it shows very little in proportion to its enormous cost. The publishers seem to have set about the work very inconsiderately—without the least sort of properly-devised scheme for it. Whether it was to be divided into separate series or not, and whether the Illustrations were to be copious or otherwise, methodical arrangement and sequence ought to have been observed for them. The edifice should first have been described *structurally* by plans, elevations, and sections, so as to convey, if not exactly a complete, a tolerably clear conception of it as a whole; then, more in detail, by drawings of some of the principal features, and architectural and sculptural ornaments on a larger scale. Such indispensable technical illustration being gone through, that might properly enough have been made to form a distinct series; leaving pictorial illustration, or perspective views of different parts of the exterior and interior, for another series: or even did no such second one ever appear, what had been given would still have been complete and satisfactory in itself. Now, on the contrary, even supposing it should be carried on any further, the work will always be a confused jumble of subjects. One reason for our fancying that it is stopped altogether is, that had not such been the case, the publishers would have cautioned their subscribers not to bind up this First Series until the whole had been completed, in order that the plates might be ultimately arranged in proper sequence.

Another very serious defect, to which we have not yet adverted, is that there is no general architectural description of Mr. Barry's edifice—not so much as any attempt at one; and the particular descriptions accompanying the plates are for the most part so exceedingly meagre, that they explain nothing, and amount to just nothing; which, if not mortifying to the architect himself, is assuredly highly unsatisfactory to architectural readers.

PUBLIC AND SCIENTIFIC LIBRARIES.

1. *De la Nécessité de créer des Bibliothèques Scientifiques-Industrielles.* Par M. MATHIAS. Paris: 1848.
2. *The British Museum and the National Gallery.* By JAMES FERGUSSON, Architect. London: Weale, 1849.

On a late visit to Paris, M. Mathias, the eminent engineering publisher, put into our hands a small work of his on special libraries for the mechanical classes of France; and it has therefore seemed to us a good occasion to resume our remarks on the want of libraries in England. The circumstances of France and England are very different, though each labours under great wants. In France, each town of the standing of what would be called a borough-town here, has a free public library—sometimes very considerable for the unimportance of the town. This library, made up from the spoils of suppressed convents, colleges, and castles, contains works more antiquated than modern, and which, however valuable to the student of philosophy or humanity, has little or nothing useful to the practical man. New books, where grants are made for such, are as commonly works of amusement as of information, but very rarely technical. In England, these town libraries are wanting; but the greater wealth of the population and the spirit of association supply other resources, for there is hardly a small town without its literary or mechanics' institution, and perhaps with both. These libraries are much smaller than in France, much less useful to the scholar, but much more available for the instruction of the working classes, as they contain many late and practical works. The establishment of a philosophical class, with a special library, has a tendency to increase the number of practical works. The price of admission to these institutions, rarely above a pound a-year, and sometimes as low as sixpence or a shilling a-quarter, places them within the means of the industrious classes. Some institutions, with subscriptions of a shilling a-quarter, have four or five thousand volumes. The libraries belonging to churches, chapels, schools, book clubs, and agricultural societies, extend the literary resources of the population; while the number of small private libraries is great, and embraces most members of the working classes. The poor women who work at brush-making have their book as they sit at work.

In our larger towns are to be found the special libraries of various societies; and there are likewise the larger collections of the wealthy students of particular arts. On the whole, we believe the library accommodation of England to be more available to the body of the population than is the case in France; but the provision for literary purposes is less, and there is not that completeness or extension of library accommodation which is to be desired. Above all, we consider special mechanical libraries are deficient.

Although it is perfectly true the price of subscription is low, still it is an undesirable deduction from the resources of those who are provident, and it deters the less energetic from beginning and prosecuting a course of study. Sometimes it happens an industrious man is thrown out of work: then is the time when he can read more, but when he is obliged to give up his subscription. Sometimes he may wish to refer to works in another library in the town, but can only afford one subscription. It is true it is held by some that nothing is valued unless it is paid for—a doctrine the career of the public museums fully denies; but it is further questionable whether it is sound policy to place any restraint on the means of instruction, and even a subscription of four shillings a-year may be that restraint to the apprentice, or distressed workman.

On every ground it is desirable to have free public libraries, and it is much less difficult to create them than is imagined. Indeed, it is the want of facilities on the part of the law which prevents them from being formed. All the resources are available, if they can but be made use of. As it is now, the libraries of institutions are precarious in their duration: an institution decays—it is abandoned, and its library, the accumulation of years, is dispersed.

There wants, first, a power of mortmain for books devoted to public uses: once so devoted, they should never be allowed to relapse to private use; and by a provision for that end, a constant accumulation of literary stores would be ensured. There should, therefore, be every facility for the establishment of inalienable public libraries. It might be desirable to give the privilege of inalienability to existing institutional libraries, in consideration of their giving limited facilities of admission for free-reading students. Thus, the library of the City of London Institution, with its ten thousand volumes, or of the London Mechanics' Institution, might be made inalienable on their admitting the public into a reading-room between the hours of twelve and four: such readers not being allowed books purchased within two years. This would not interfere with the privileges of subscribers, but would be a boon to many of the public, and would extend library accommodation.

There are many who would freely give or bequeath books to libraries, if they had but this guarantee of inalienability; and we feel assured, that were a legal provision made, no market-town would be long without its public library.

After books, the next thing is a room in which to hold them; and there is no parish which cannot give them housing, either in a town-hall, school, workhouse, or vestry-room; to which the public could have access the greater part of the day or evening, the room being only occasionally required for the discharge of other business.

The shelves and other fittings would be given by the tradesmen and mechanics of the town, who would not be behindhand in doing their share of a common deed. Such a work once set going, all would bear a hand,—some would give books, some labour, some materials, some money.

A further step is a catalogue; and this could very well be made by the willing labour of the young men.

A librarian comes next. If such officer were chosen by the town council, vestry, or inhabitants, his salary would not be grudged; but for a small evening library, the work might be done by some of the readers in turn.

A subscription might be charged for the privilege of taking books out of the library; or the privilege should be made a condition of serving in turn, for a limited time, as librarian, secretary, or catalogue-maker.

Thus, by a simple organization, free public libraries may be established throughout the country; and a very short act of parliament suffices. A plan of this kind was put into the hands of Mr. Wyld, M.P., and by him brought before the Committee on Public Libraries in the last session; but the consideration of it was got rid of by Mr. Ewart, the chairman of the committee, who did not seem to wish any independent member should have the chance of investigating the question of public libraries. It is to be hoped Mr. Wyld, Mr. Hamilton, or some other member, will bring in a bill for public libraries next session.

So far as to general public libraries. Like remarks will apply to special public libraries. In many towns there are medical libraries or book clubs, but no provision for their inalienability. In all towns there should be such a library, for it is desirable even the youngest and poorest practitioner should have access to the latest discoveries in medicine, and the best information. Medical periodicals do much for the spread of knowledge, as is shown by the rapid extension of the use of ether, chloroform, glycerine, and the Fallopian process. Periodicals, however, and other standard books, must be put within the reach of all; and if acknowledged public medical libraries were set up, many besides medical men would be the contributors to them, for all have as deep an interest in the preservation of health and life. In a large town, the library could be kept in the hospital, by the house surgeon; in a small town, in the union workhouse, under the care of the master.

There are likewise law libraries in some towns,—so should there be in all; and no attorney or magistrate would decline to subscribe if he had full assurance of the perpetual preservation of such an establishment. A good collection of reports year after year is of the greatest value to the lawyer.

These two are libraries which must be of general extension; but special libraries suited to the mechanics and workmen of each town will vary. The Potteries ought surely to have a library of English and foreign works on the objects of their manufacture. Birmingham, Wolverhampton, and Walsall, want books on machinery. All manufacturing towns, moreover, want books giving them information as to the exertions of their foreign rivals, and as to the state of the markets throughout the world. Indeed, hardly any measure better adapted for the promotion of our trade could be devised than the establishment of special libraries. In large towns they might be devoted to particular trades. Thus the Clockmakers' Company of London have a fine library of English and foreign books on clock and watch making.

Wherever common schools, or schools of design, hospitals, or literary institutions, have been set up, a large amount of public support has been given to them; and there can be no doubt that libraries would share in English liberality and munificence. Let the example be set, and we shall not want a Soane, a Vernon, a Grenville, or a Hope.

To return to France, M. Mathias is urging, and we hope with success, the adoption of his suggestions as a means of promoting the interests of our rivals in trade; and it behoves us to take similar measures. At present, Paris does not seem so well provided as London. M. Mathias cites three special scientific libraries. That of the Conservatoire des Arts et Métiers is, he says, the only one which has practical works suited to mechanics. It is open free—but with a degree of illiberality which is it seems not peculiar to England—in the day time only, so that the working classes have not full facilities. The library of the Societé d'Encouragement pour l'Industrie Nationale is a subscription library, like that of our Society of Arts. The collection is a good one. He names, further, as a special library, that of the Royal Society of Agriculture, but omits the medical libraries.

In London, we can easily number the following:—The library of the Society of Arts, that of the Institution of Civil Engineers, of the Institute of British Architects, of the United Service Institution, of the Clockmakers' Company; besides those of Sir John Soane, the Royal Agricultural Society, the College of Chemistry, the Chemical Society, and those of the Colleges, and of the Literary and Mechanics' Institutions. The Royal, the London, the City of London, the London Mechanics', the Westminster, the Western, and the City of London Mechanics' Institutions, have, among others, considerable collections of books suitable to practical men.

We cannot, however, speak of libraries in London without thinking of one of the national blots—the British Museum, which is a libel on this great industrial nation. Since Mr. Fergusson's *exposé*, there is no excuse for the non-execution of a catalogue, and the non-provision of an evening reading-room. A supply of useful English and foreign books suitable to practical men we shall be content to wait for, as we have little hope of seeing the library complete in those respects. We can only bear testimony from our own experience, and the inconvenience to which we have been subjected in attempting to get information for this *Journal*, as to the incompleteness of the library as a national library in essential books on engineering, architecture, and the allied subjects. We can speak quite as strongly as Mr. Fergusson on this head. We must be content, too, to wait for some more liberal ordeal than the caprice of Sir Henry Ellis for the admission of respectable men into the Museum library. We know of many gross cases of the refusal of competent parties.

M. Mathias, as an earnest of the practicability of his suggestions, has appended to his work a priced catalogue of a select special library, classified under each head. This catalogue will be found very useful to those of our readers who may wish to obtain the latest French work under each head. The estimate of M. Mathias for an adequate scientific industrial library, is 1,340*l.*, including 1,035 distinct works, and 3,165 volumes, of which, two-thirds are in octavo. A larger library for 1,600*l.* would include some of the old works. He proposes for a town of 100,000 people, a library of 850 volumes, costing 760*l.*; and so he gives estimates for each class of library.

We do not expect the government to give money, but we do urge that no time should be lost in giving legislative facilities for the establishment of inalienable public libraries; so that the liberality of individuals and corporations, of masters and workmen, may have free scope for its exercise.

Rules and Regulations of the Architectural Lending Library, 22, Brompton Crescent, Brompton. Established 1849. Librarian, J. Matthias Dodd, Architect.

Much as we are disposed to favour the scheme, a library of the kind being at present a great desideratum, we cannot refrain from remarking that the locality chosen for it almost cuts off all reasonable hope of success. The exceedingly great inconvenience attending the situation must, we think, strike every one; for, in fact, the situation is such, that it does not give the experiment at all a fair chance, so that should—as is intimated—the Library be closed at the end of a twelvemonth for want of a sufficient number of subscribers, the failure of the undertaking will be attributed to there being very little disposition on the part of the profession and students to support an establishment of the sort; whereas, it will be more likely to have been occasioned by the difficulties thrown in the way of their making use of it.

Not only should the establishment be within town, and in some tolerably central situation, but the Library itself should be more than a repository for the books, it being highly desirable that there should be adequate accommodation for consulting them on the spot. It would frequently happen that a person wanted merely to refer to a single subject or so, in a large work of engravings; or else, if, as very likely, unacquainted with a work, want to look it over before borrowing it, in order to ascertain whether it would be worth his while to have it sent him. The mere carriage of large folios backward and forward will, in the course of a year, make a considerable addition to the subscription money; wherefore it would be particularly unsatisfactory to subscribers to find themselves quite disappointed in a book of the kind, after they had ordered it from the Library merely in consequence of the promise made by its title. We fear, therefore, that owing to his not having provided the requisite facilities for his Library being made use of, the proprietor has engaged in a scheme whose success, though possible, is by no means probable, while its failure is likely to prevent any other attempt of the kind being made,—at least, for a long while to come.

LAW OF PATENTS.

From the Report of the Committee on the Signet and Privy Seal Offices, appointed by the Lords of the Treasury to inquire into the circumstances connected with the offices of the Clerks of the Signet and of the Lord Privy Seal.

Patents of Invention.—The Treasury Minute constituting our committee directs our attention only to the practice of the Signet and Privy Seal Offices. But in considering the subject of passing letters patent through those offices, it was very difficult, if not impossible, to exclude altogether from consideration the other stages through which they had to pass, inasmuch as the several successive stages are intimately connected with each other, and form links in a continuous chain; and in deciding upon the expediency of reforming any office, whose functions are connected with those of other offices, it is necessary to see what the functions of those offices are before any decision can be safely made. In the evidence, therefore, annexed to this Report, it will be found that we have extended our inquiry into the general process of passing patents of invention, and though we do not desire to exceed the limits of the duty with which we are intrusted, we think it right to offer some general observations on the subject.

Origin and Nature.—It is impossible to ascertain with certainty when grants of letters patent for the sole use of inventions were first made in this country, but there is reason to believe that this prerogative of the crown is very ancient. The crown derives this prerogative from the common law, and not from any statute. It is vested in the crown as the depository of the supreme executive power of the state, to be exercised on the behalf and for the benefit of the public. No statute is to be found relating to grants for the sole use of inventions prior to the statute of 21 Jas. I. c. 3, called the Statute of Monopolies. That statute was passed for the purpose of restraining the crown from making extravagant and illegal grants of monopolies. It declared all monopolies whatsoever to be contrary to law and void, excepting "letters patent and grants of privilege of the sole working or making of any new manufacture to the first inventor thereof." The only other public acts relating generally to patents are the 5 and 6 Will. IV. c. 83, 2 and 3 Vic. c. 67, and 7 and 8 Vic. c. 69, which provide remedies for deficiencies in the old law.

Mode of Granting.—The grants of the crown must be made by charters or letters patent under the Great Seal; and the command given to the lord chancellor to make a patent for an invention is always by means of a writ, or bill, sealed with the privy seal, because the Queen cannot herself make her letters patent except by means of her ministers, who act according to her legal commands, and therefore when the patent is written, the words by "Writ of Privy Seal" are inscribed, to show by what authority the lord chancellor seals the grant.

The present practice in regard to the granting of patents for inventions is, that in the first instance, a petition to the Queen is left at the office of the secretary of state for the home department. The secretary of state refers that petition to the attorney or solicitor-general to consider and report thereon, in order that the crown may be advised respecting the legality of the grant sought for, and the expediency of granting it. Upon the petition being left at the chambers of the attorney or solicitor-general, the title of the invention inserted in the petition is compared with the descriptions which are contained in all the subsisting caveats in the office. If the invention be not affected by any of those caveats, the patent is allowed to proceed; but if the title appears to relate to an invention which comes within the general description contained in any of the caveats, notice of the petition is sent to each party who has entered such a caveat.

A caveat against a patent is, in substance, a request in writing that a patent for a specified purpose be not granted without notice to the party who enters the caveat. Caveats may be entered at the chambers of the attorney or solicitor-general, at the Patent Bill Office, at the Signet Office, at the Privy Seal Office, and at the Patent Office of the Great Seal.

The following are the proceedings on a caveat before the attorney or solicitor-general at the report, or first stage:—

The parties to whom notice has been sent are allowed seven days, within which they must enter their opposition, if they intend to oppose the patent. If no opposition take place within that time, the patent proceeds, as of course. If the patent be duly opposed, the proceedings are arrested, and the applicant for the patent must obtain an appointment for a hearing before the attorney or solicitor-general, and a summons is served upon the opposing party.

After hearing the parties separately, if the attorney or solicitor-general be of opinion that the Queen ought to be advised to grant the prayer of the petition, he reports in favour of the petitioner, and the report is left at the Home Office in order to obtain the Queen's warrant. If the opposition be successful, no report is made, and the application drops.

The Queen's warrant contains her Majesty's authority to the attorney or solicitor-general to prepare a bill for the intended patent. When completed, it is taken to the Patent Bill Office, which is an office of the attorney and solicitor-general, where all bills for patents to pass the Great Seal are prepared. Upon the receipt of a warrant for a bill, the engrossing clerk will prepare the bill as a matter of course, according to the established form, if no caveat have been entered against it in that office.

Any person may oppose a patent at this stage, whether he have opposed at the previous stage or not; but as a necessary preliminary, he is required to deposit the sum of 30*l.* as a security for the costs, which his neglect to oppose earlier causes the applicant for a patent to incur. The hearing at this stage is conducted in precisely the same manner as at the report. If the opposition be successful, all further proceedings are stayed; if not, the bill is passed and submitted to the Queen for signature.

The bill, thus completed, is the Queen's Bill, and is passed to the Signet Office, where it is filed, as the warrant to the clerk of the signet for issuing the Signet Bill to the Lord Privy Seal.

The Signet Bill is in like manner filed at the Privy Seal Office, as the lord privy seal's warrant for his proceedings. Though caveats may be entered both at the Signet and Privy Seal Offices, opposition is now never made at either of these stages of a patent. Friday is the only public sealing day at the Privy Seal Office; but a bill may be sealed, at a private seal, or any other day on payment of an additional fee of 2*l.*

After the delivery of the Privy Seal Bill, the proceedings for obtaining a patent take place on the common law side of the Court of Chancery, where there are several officers whose duty it is to prepare, seal, and enrol, letters patent.

The grant of a patent may be again opposed before the lord chancellor. In that case the applicant for the patent must prepare a petition stating all the facts and proceedings, and praying that letters patent may be made and sealed in pursuance of the writ of Privy Seal. The material allegations of this petition must be supported by affidavit, to be sworn before a master in chancery, and the petitioner's opponent must be served with a copy of the petition and of the lord chancellor's answer to it. Upon application for that purpose, a day is fixed for a hearing before the lord chancellor, who generally refers the matters of the petition and opposition to the attorney or solicitor-general for a special report. The parties are then again heard by the attorney or solicitor-general upon this reference, and if they are satisfied with his report, the lord chancellor makes an order in accordance therewith. But if either party be dissatisfied with the report, he must prepare a petition to the lord chancellor stating his exceptions to the report, and the lord chancellor will then, after again hearing the parties, dispose of the petitions as he may think just.

If a patent be not opposed at the Patent Office of the Great Seal, it is sealed in pursuance of the writ of Privy Seal. If the patent be opposed and the lord chancellor decides on granting it, it will be sealed as soon as his lordship's order for the purpose has been drawn up. A recepi is first written in the margin of the Privy Seal Bill, stating the day when the lord chancellor received the bill. The clerk of the patents then engrosses the patent, copying it verbatim from the Privy Seal Bill. He also prepares a docket for the lord chancellor's signature, containing the name of the party to whom the patent is granted, the title of the invention, the extent and duration of the grant, the time allowed for specification, and the date of the grant. The recepi and docket are signed by the lord chancellor; the latter instrument being the warrant to the sigillator or sealer, who affixes the Great Seal to the patent after satisfying himself that it corresponds with the docket. The patent having been sealed, all the documents are taken back to the Patent Office, where the patent is put into a box and delivered to the patentee.

Every patent for a new invention contains a proviso that the patentee shall describe his invention by an instrument in writing, under his hand and seal, termed a specification, and this specification must be enrolled in chancery within a given time after the date of the patent. In default of which the patent becomes void.

Up to the 1st of January last there were three offices in which specifications might be enrolled, viz.:—The Enrolment Office, the Petty Bag Office, and the Rolls Chapel Office.

The patents themselves, together with the Privy Seal Bills and dockets, are enrolled at the Enrolment Office, where the rolls are kept for two years and then sent to the Petty Bag Office, whence, after the lapse of a certain number of years, the Patent Rolls and Privy Seal Bills are finally sent to the Rolls Chapel.

By an act passed in the last session of parliament, 11 and 12 Vic. c. 94, it is enacted, that from and after the 1st of January, 1849, all specifications shall be enrolled in the Enrolment Office. Since that period, therefore, the necessity for enrolling specifications in the other two offices no longer exists.

Recommendations respecting Patents of Invention.—After considering the evidence, we have come to the conclusion that the number of successive stages through which (as will be seen from the foregoing detail), a patent for a new invention must pass before its final completion, is productive of great trouble, delay, and expense to the party seeking the grant, without any corresponding benefit to the public. The fullest opportunity should, no doubt, be afforded to all persons whose interests may be affected by the grant of an exclusive privilege to manufacture some particular article, to show that good grounds exist why the privilege should not be granted to the party applying for a patent.

The object of granting a patent for an invention is, not merely to secure to an inventor the fair reward of his labour and ingenuity, but also to benefit the public by encouraging such inventions, and it is essential that the crown should have some tribunal to refer to for advice before making such grants. With these objects in view, it has not appeared to us that any better course can be devised than a reference to the attorney or solicitor-general, to inquire into the merits of the circumstances set forth in the petition, and report thereon to the crown.

The inquiry would appear, for the most part, to involve considerations rather of a legal than of a scientific nature. But should questions arise, on an opposed petition, where a more than ordinary familiarity with scientific subjects might seem requisite for the due comprehension of the matter under investigation, the attorney or solicitor-general would always have the power, which they now possess and exercise, of calling in some man of practical science, unconnected with the parties before him, and unprejudiced in the matter in dispute, to aid him in coming to a just decision. We think, however, that ample opportunity having been given for making opposition at this stage of the proceedings, no adequate advantage is derived from a second opposition at the Patent Bill Office. It seems, moreover, that oppositions at that stage are of unfrequent occurrence. If this opinion should be adopted, and the proceedings of the Patent Bill Office be dispensed with, we would then recommend that some public notice, by advertisement in the *Gazette* or otherwise, should be given that a patent for a particular object has been applied for, not naming the applicant, or giving more than a very general description of the object of the invention; and that a sufficient number of days should be allowed from the date of the advertisement before proceeding with the petition, in order that a fair opportunity for opposition may be afforded to parties desirous of opposing the grant sought for.

We would also recommend that an outline description, such as is now required to be deposited with the attorney or solicitor-general in cases of opposed patents, should be required to be lodged, under seal, with every petition on its first presentation at the Home Office. It is not proposed that this outline description or specification should supersede the specification now required to be enrolled in chancery, nor that it should be required to enter into the details of the invention; but that it should be considered binding as to the principles of it.

With these provisos we are of opinion that a patent when granted might take its date from the day on which the petition is presented; instead of, as at present, from the day on which the patent is sealed.

We would further suggest for consideration, whether, after the report of the attorney or solicitor-general recommending the grant of the patent, a Queen's Bill, carrying the recommendation into effect, might not be prepared at the Home Office, and submitted by the secretary of state for her Majesty's signature. We see no reason why it should be engrossed on parchment; we think, on the contrary, it would be far more convenient if it were prepared after the manner of an ordinary sign manual warrant.

We are of opinion that the Queen's Bill, when duly signed, should be passed at once to the lord privy seal, without the intervention of the Signet Office; that the Privy Seal should be affixed to that instrument upon the authority of an instruction to that effect from the secretary of state; and that the two transcripts prepared in the Patent Bill Office, which now form the Signet and Privy Seal Bills, should be dispensed with.

We, at the same time, recommend that the public seal days, in the Privy Seal Office should be extended to two days in the week.

If the proceedings in the Patent Bill Office and in the Signet Office be entirely dispensed with, the fees now payable at those offices must of course cease to be levied. It becomes, therefore, necessary to revise the charges to which letters patent are liable in passing through their several stages previously to their arrival at the Great Seal.

In the case of patents for inventions, the confining the opposition before the attorney and solicitor-general to one stage only, will probably render necessary a more rigid investigation at that stage than is required under the present system, and will throw increased responsibility upon the reports of those officers. We consider that, under these circumstances, the attorney and solicitor-general would have a fair claim to a higher fee for the single hearing and report than is allowed them at present. We recommend, therefore, that one fee of 10 guineas should be allowed to the attorney or solicitor-general for the hearing and report together (including the fees to their clerks), instead of the separate fees they now receive, amounting to 3*l.* 5*s.* for the hearing, and 4*l.* 4*s.* for the report.

We further recommend that, in lieu of requiring successive payments of fees and stamp duties at the several public offices, a stamp should be affixed to the Queen's Bill in the department in which it is prepared. In the case of patents of appointment to office, the amount of this stamp might be a small per centage on the salary of the office. In the case of patents for inventions, we would recommend a stamp of uniform value, without reference to the number of names included in the grant. Should it be determined to extend the power of granting patents under the Great Seal of the United Kingdom to Ireland and Scotland, we are disposed to recommend that, for a patent extending over the United Kingdom, the Channel Islands, and the colonies, a stamp of fifty pounds should be required.

But, if it should be thought inexpedient to debar inventors from taking out patents for England alone, in that case we recommend that a stamp of thirty pounds should be imposed on patents for England, with the Channel Islands and colonies; with an addition of twenty pounds for Scotland and Ireland, or of ten pounds for either Scotland or Ireland separately. We are inclined to believe that such an arrangement would afford satisfaction to patentees, and would, at the same time, compensate the revenue for the loss which it would sustain by the adoption of the course we have recommended. We do not feel ourselves authorised to make any suggestions in regard to the proceedings before the lord chancellor.

We have, however, had our attention called to the subject of the specifications and their mode of enrolment, which is intended to be for the information of the public.

It is of great importance to a party applying to take out a patent for an invention, to ascertain what patents in relation to the same object have been previously taken out; otherwise, after he has incurred considerable expense in perfecting his invention and obtaining a grant, some previous patent may be discovered which may vitiate his patent by destroying its originality. For this, and other reasons, it would seem very desirable that specifications should be made more available to the public than they are at present.

It has already been stated that specifications have been hitherto enrolled in three different offices, searches in all of which must frequently be made before a party seeking to obtain a patent for a new invention can satisfy himself that no similar patent has at any time previously been granted; and, from the absence of indices or proper classification, these searches must always be attended with great uncertainty, and often with great expense. The difficulties of such a search are enhanced by the specifications being copied on rolls in an engrossing hand.

We are of opinion that these specifications should be entered in book-form in a common hand, and that proper indices should be made of them. They would then become very valuable references for the public.

Another point to which we have had our attention very much directed is the necessity of a patent going through three distinct and separate processes in order to be made available for the three kingdoms. By the 24th article of the Act for the Union of the two kingdoms of England and Scotland, 5 and 6 Anne, c. 8, it is enacted, "That a seal in Scotland after the Union be always kept and made use of in all things relating to private rights or grants, which have usually passed the Great Seal of Scotland, and which only concern offices, grants, commissions, and private rights within that kingdom."

By article 8, sec. 3, of the Act of Union with Ireland, 39 and 40 Geo. III., c. 67, it is enacted, "That the Great Seal of Ireland may, if his Majesty shall so think fit, after the Union, be used in like manner as before the Union, except where it is otherwise provided by the foregoing articles, within that part of the United Kingdom called Ireland."

These enactments preclude the lord chancellor, though keeper of the Great Seal of the United Kingdom of Great Britain and Ireland, from granting a patent which can extend to Scotland or Ireland. An inventor, therefore, in order to secure to himself the full benefit of his invention, must, in many cases, take out a patent under each of the three Great Seals of England, Ireland, and Scotland; thereby, in addition to the increased trouble and delay, very considerably raising the expenses of his patent.

The fees and other charges incurred in taking out a patent for England, the Channel Islands, and the colonies amount, on an average, to about 150*l.* But in order to secure a patent for the three kingdoms, a patentee must incur an expenditure of probably three times that amount.

The following is the course pursued with regard to patents in Ireland and Scotland:—

In Ireland.—1st. Petition to the Queen or to the lord lieutenant of Ireland. If to the Queen, it is referred to the lord lieutenant. In either case the petition is referred by the lord lieutenant to the attorney-general for Ireland for report.—2nd. On the receipt of the attorney-general's report a draft of a Queen's letter is prepared and forwarded to the Home-office in London.—3rd The Queen's letter, which contains the authority for the grant, is signed by her Majesty, countersigned by the secretary of state, entered at the Signet Office, and sealed with the Signet, and returned to the lord lieutenant.—4th. On the receipt of the Queen's letter, a warrant is prepared for the lord lieutenant's signature, directed to the attorney or solicitor general, authorising him to draw up a fiant containing a grant from the Queen to the parties applying.—5th. The fiant is submitted for his excellency's signature, and the Privy Seal is affixed.—6th. It is forwarded to the clerk of the crown, who prepares the necessary document thereon, to be passed under the Great Seal of Ireland.

Caveats against grants of patents may be lodged with the attorney or solicitor general for Ireland; but previously to a hearing, the opposing party is required to lodge 50*l.* to cover the expenses of the inquiry.

In Scotland.—1st. Petition to the Queen, which is left at the Home-office in London.—2nd. Reference of petition to lord advocate of Scotland for report.—3rd. Report of lord advocate.—4th Queen's warrant, prepared at the Home Office, directing preparation of the patent.—5th. The patent is prepared in the office of the director of Chancery, and carried at once to the office of the keeper of the Great Seal, to have the seal affixed.

The same proceedings in regard to opposition take place before the lord advocate as before the attorney or solicitor general at the first stage in England.

It appears that previously to the passing of the Acts of Union, patents extending over the three kingdoms were sometimes passed under the Great Seal of England alone, and we see no real practical inconvenience which would arise from permitting such a course to be pursued at the present time. We would suggest that all patents for new inventions might be granted as of course for the United Kingdom of Great Britain and Ireland, and that the proceedings for obtaining a patent should take place in this kingdom only. The specification in that case should be required to be enrolled in each of the three capitals.

The proceedings for a patent, whether in England, in Scotland, or in Ireland, must originate by petition to the crown; and it would seem that Scotch and Irish inventors almost invariably take out patents in England, if not previously to, at all events immediately after, taking out their Scotch or Irish patent. The advantage therefore, that would arise from the course recommended, in the saving of fees and other charges, and of time and trouble, would be at least as great to the Scotch and Irish patentee as to the English. Cases, however, may occur in which it might be advisable to have the opinion of the crown lawyers in Ireland or in Scotland previously to her Majesty being advised to grant her letters patent.

We would therefore suggest, that if it should be determined to give the power of granting patents under the single Great Seal of the United Kingdom, which should have effect in the three kingdoms equally, a discretionary power should be given to the secretary of state, enabling him, should he see fit so to do, to refer the petition to either the attorney or solicitor-general for England, the attorney-general for Ireland, or the lord advocate of Scotland.

If the views which we have formed with regard to the abolition of patents in some cases, and the simplification in all of the process of passing them, shall be approved of, the retention of the Signet Office as a distinct branch of the department of the secretary of state will become unnecessary.

Abolition of Signet Office recommended.—We therefore recommend that the Signet Office be abolished, and whatever business may remain to be transacted connected with the Signet be transferred to the Home-office, together with such of the records, &c., now deposited in the Signet Office as may be necessary for the purposes of official reference. The remainder might be consigned to the custody of the Master of the Rolls, or to the State Paper Office. The amount of business thus transferred to the Home-office could not be very considerable.

Recommendation respecting Privy Seal Office.—It would still be necessary to retain an establishment for the office of the Lord Privy Seal, though the duties of that office would be much reduced, and would not occupy the time of more than one clerk The business of the Signet and Privy Seal Offices is at present conducted in the same house in Abingdon-street, for which a rent is paid by the public. The abolition of the Signet Office would render the retention of this house unnecessary. If apartments could be provided for the future accommodation of the Lord Privy Seal's department in some one of the public buildings in Whitehall, it would be a great convenience in the transaction of the business of that office.

We think it desirable to refer to the Act of 1 Vic., c. 73, by which the Queen is enabled to confer certain powers and immunities on trading or other companies by means of letters patent. The operation of that act will not be in any way affected by the changes proposed in this Report, which have reference only to the mode of passing letters patent.

In concluding our Report, we beg leave to express a hope that the interests of individuals who may be affected by our recommendations and suggestions may be duly considered, and that compensation may be awarded to those whose tenure of office gives them a title to claim it.

MINTO.
G. CORNEWALL LEWIS.
H. RICH.

On the Manufacture of Enamelled Copper at Canton.—When the copper has been shaped into the desired form, it is to be cleansed, but not scoured, and afterwards wetted with water, and sprinkled with the enamelling composition intended to form the ground, which may be either white or coloured. The article is then put in a muffle heated by means of dry Nankeen coal (this is found to be the best fuel). When the ground has been produced, the article is withdrawn from the muffle, and covered with an iron bell, in order that it may cool shortly; the ground may be then ornamented in the same manner as porcelain, and again passed through the muffle. Several specimens of enamel, and colours upon enamel, have been deposited at the Royal manufactory at Sevres, in order that the manufacturers in France may be made acquainted with the art.

IMPROVED LOCOMOTIVE BOILER.

On an Improved Locomotive Boiler. By Mr. RAMSBOTTOM, of Manchester.—(Paper read at the Institution of Mechanical Engineers, Birmingham, July 25th, Charles Beyer, Esq., V.P., in the Chair.

Without discussing the merits of the various arrangements and dispositions of the working parts of locomotive engines, the author of the present paper proposes to make a few observations respecting the most vital part of these machines, that upon which the satisfactory performance of all the details must necessarily depend—namely, the Boiler.

Before proceeding to the immediate subject of this paper, it is proposed to point out one or two objections to locomotive boilers as at present constructed, which experience has brought under the author's notice; and then to describe a form of boiler which appears to him in some degree calculated to remedy the defects which will be referred to.

It is scarcely necessary to observe that the absolute power of a locomotive, or any other steam-engine, is strictly proportioned to the quantity of steam which the boiler of such engine can produce in a given time; and chemists are generally agreed that the quantity of atmospheric air required (or oxygen which is the supporter of combustion), as well as the quantity of fuel, is in direct proportion to the quantity of water evaporated; or in other words, to produce more steam, it is not only necessary to supply more fuel, but also more atmospheric air in proportion to the quantity of steam produced.

It is well known that some of the locomotive engines built at the present day have from two to three times as much heating surface as those built about eight or ten years ago, and consequently when performing a proportionately increased amount of duty, they require from two to three times the quantity of air forcing through the fire in the same time.

The working parts of these engines have also been increased in dimensions; the cylinders from 12 inches to 15 and 16 inches diameter, the stroke from 16 inches to 20 and 24 inches, and the driving-wheels from 4 ft. 6 in. to 6 feet diameter, and in many cases even more.

Notwithstanding all these enlargements and improvements, there are however two elements which have been but slightly changed—namely, *the diameter of the blast-pipe*, and the diameter of the *cylindrical part of the boiler;* and as the whole of the steam (after having performed its office in the cylinders) is driven in a forcible jet up the chimney for the purpose of producing the necessary draught through the fire, and as the power required to produce this jet is so much taken from the gross power of the engine, it follows that the smaller the blast-pipe is in proportion to the total heating surface of the boiler, the greater will be the resistance to the action of the piston, and the greater the loss of power on this account.

From observations made upon engines under the author's immediate superintendence, it appears that whilst the heating surface of locomotive boilers has been increased from 400 square feet (in the year 1842) to 987 square feet (in the year 1846), the blast-pipe has not been in the slightest degree enlarged, but on the contrary in the latter case has been reduced in area in the proportion of 12¼ to 8¼ square inches. So that upon dividing the total heating surface or *area of production*, as it may be termed, by the size of the blast-pipe, or *area of eduction* (assumed as unity), the following very instructive results are obtained:—

No. of Engine.	When built.	Area of Blast Pipe.	Heating Surface.
24	1842	1	4608
20	1842	1	5044
25	1845	1	7961
30	1846	1	12960

In the last case, then, it appears that the heating surface has been increased nearly *three-fold* in proportion to the size of the blast-pipe, as compared with Engine No. 24; and the reason will be obvious when it is stated that the Engine No. 30 is only of the same diameter as the first-named (No. 24), and consequently that the flue-room (which as a general rule will be as the square of the diameter of the boiler), has been but slightly increased, the extra heating surface having been mainly obtained by enlarging the fire-box, by putting in a mid-feather, and by increasing the length rather than the number of tubes.

It is not necessary to inquire how far the diameter of the cylinders may affect the size of the blast-pipe, nor to ascertain the amount of power which the blast-pipe absorbs, though it may be stated that experience proves it to range from 10 to 20 per cent. of the gross power of the engine, according to the number, diameter, and length of tubes, and also the speed of the engine. It may be remarked, however, that on the average a degree of exhaustion is required in the fire-box under ordinary circumstances equal to a column of water 4 inches in height, and the degree of exhaustion in the smoke-box must of course be greater than this by the resistance offered by the tubes to the passage of the heated gases from the fire-box to the smoke-box.

From experiments made about 2½ years ago upon an engine with a total heating surface of 987 feet, carrying 147 tubes of 1¾-inch external diameter and 13 ft. 10 in. long, the author found that the latter force was at all velocities *three times* as great as the former; or in other words, that 66 per cent. of the total force of the blast was required to overcome the resistance offered by the tubes to the passage of the heated gases, leaving 33 per cent. only to operate upon the fuel; and it is this evil which results from the comparatively limited flue area of the boilers as at present constructed, to which attention is now more particularly called, and which it is proposed to remedy in the manner now to be explained.

From what has been said it will readily be inferred that there is some difficulty in materially increasing the power of locomotive engines, as the necessary amount of heating surface cannot be obtained without increasing the diameter or the length of the boiler, or making it oval, to all of which plans there are some objections: but by the method now proposed it will be easy to enlarge both the fire-box and tube surface from 35 to 40 per cent., without increasing either the diameter of the boiler or its length, as will be now shown.

It is proposed to construct the copper fire-box with an arched roof, the top of which shall be nearly as high as the top of the cylindrical part of the boiler This box may of course be made any length without sensibly reducing the strength of the roof, and will require none of the stay-bars which are so essential to the security of the flat-roofed box, and which for a moderate sized engine weigh not less than 400 lb.

With such a box the whole of the cylindrical part of the boiler can be filled with tubes, and of course the whole of the longitudinal stays be removed; and in the present instance there are 225 tubes of 2 inches external diameter, the shell of the boiler being 3 ft. 8 in. diameter and 10 feet long; the total heating surface of the fire-box is 80 feet, and of the tubes 1,177 feet, making a total heating surface of 1,257 feet. Such an arrangement involves the necessity of keeping the boiler full of water, and it is therefore requisite that a separate steam-chamber should be provided. This consists of a cylinder which is 13 feet long and 20 inches diameter, fixed over and parallel to the cylindrical part of the boiler, or, as it may now be termed, the generator. This tube, which has a cubic capacity of 28¼ feet, is connected at each end with the generator. It is proposed that the water shall occupy about one-fourth of the capacity of this tube, leaving a clear space of say 21 cubic feet for steam; this is rather more steam-room than most modern boilers possess, and for reasons which are afterwards mentioned, the author thinks it will be sufficient, although it may readily be increased by slightly enlarging the diameter of the steam-chamber, which as at present shown, is not so high as the ordinary steam dome by about 12 inches.

It has been proved experimentally by Mr. Robert Stephenson that the generative power of the copper fire-box is three times as great per unit of surface as that of the tubes; and independent of this authority, locomotive engineers are generally agreed that the great bulk of the steam generated in a locomotive boiler is formed upon the surface of the copper fire-box, and the first 18 or 20 inches length of the tubes. As the whole of the steam has to rise through the body of the water with which it is for the time mechanically mixed, and as the specific gravity of these mixed fluids will be much less than the comparatively *un*mixed water at the smoke-box end of the boiler, it follows that there will be a brisk circulation through the generator and steam-chamber. The mixed steam and water will be driven into the upper vessel, and will there be effectually separated; the former passing off to the cylinders by the longitudinal pipe, which has a number of small holes upon its upper surface, and the latter running again into the generator through the vertical connection at the front end, and thus keeping up the circulation.

That the specific gravity of the mixed steam and water at the fire-box end is often reduced to at least one-half that of water alone, is proved by the fact that the water-gauge will frequently show a downward current through the glass tube, even though the circulating fluids be one-half water and one-half steam, showing as it does that the column of the mixed fluids in the boiler is specifically lighter than the column in the glass gauge; and from this fact it is also evident that this great expansion is confined to the water in the vicinity of the fire-box, since if it extended to the whole mass, the boiler would not contain the requisite quantity.

From the circumstance that no bubble of steam can rise into the steam-chamber between the points marked A and B, it is concluded that this boiler will not be so liable to prime as the common one, and therefore that the steam-chamber as shown is sufficiently large. As to the water surface, which in this boiler it may be objected is smaller than in others, it is conceived that the great facilities this boiler will give to the engineer for raising steam, will leave him comparatively at liberty to put in water when and where he chooses, and consequently that but little difficulty need be apprehended on this point. It is evident however that the objection may be fully met by constructing the outer fire-box with a pyramidal roof in the way so common.

In conclusion, the author would express his conviction that this boiler, combining as it does a great increase of heating surface, *and corresponding increase of flue area*, with a relative diminution of bulk and weight, and great simplicity of construction, is calculated to remove some of the difficulties experienced by locomotive engineers, and to promote the best interests of the railway world in general.

Remarks made at the Meeting after the reading of the foregoing Paper.

The CHAIRMAN said, that in the unavoidable absence of Mr. Ramsbottom, he would observe that his object in the foregoing paper was to obtain a considerably larger area of flue-room than in the present locomotive boilers, and to make a boiler of a large heating-surface with less weight.

Mr. SLATE was of opinion that for the weight the engine carried, it would have a considerably greater effective heating-surface than any previous form of boiler; but he thought the boiler would have as great a tendency to prime as any other.

Mr. COWPER was also of opinion there would be a great tendency to prime in the proposed boiler; the surface from which the steam had to rise was the entire surface of the fire-box and tubes, and all the steam had to pass through the two openings into the steam-chamber, and it appeared to him the water would be carried up there in a complete state of froth.

Mr. MCCONNELL, while agreeing to a certain extent as to the liability of the boiler to prime, thought it might be obviated by having a more continuous communication between the generator and the steam-chamber; perhaps the steam-chamber could be fixed close upon the top of the generator, and a continuous longitudinal opening be made, communicating between them throughout their entire length. He thought the proposition of Mr. Ramsbottom was a very good one, as it was a received opinion that the proportion of the flue-room to the fire-grate surface could not be too large, supposing that full advantage was taken of the flue surface before the heated air reached the chimney. Whether long tubes or short tubes as applied to locomotives were most advantageous, was a question not yet decided, and he thought they had scarcely data enough to determine as to the advantage of long tubes on the ground of economy. It was a very important matter to determine what length of tubes was most advantageous for use in proportion to the area of the fire-grate.

Mr. C. COWPER was not aware whether there was any authority respecting the proportionate heating power of the tubes and the fire-box, besides the experiment of Mr. Stephenson alluded to in the paper.

Mr. MCCONNELL remarked, that it appeared from experiments made by Mr. Stephenson and Mr. Beyer, that a very considerable heat was lost in the smoke-box even at the end of the longest tubes that were used; and he thought that the air in the centre of the tubes might have a considerably higher temperature than the air at the sides of the tubes, and that much of the heat might be carried through by a stream of air like a solid bar in the centre of each tube, without ever coming in contact with the sides of the tube, and consequently without being communicated to the water of the boiler. He had been informed that it was found to be a useful practice in marine and stationary boilers, to create a disturbance in the currents of air passing through the flues, for the purpose of mixing up the particles as much as possible; and a similar advantage might probably be obtained by mixing the air in the tubes of locomotive boilers.

Mr. GIBBONS said, he had observed a similar advantage from mixing the particles of air in heating the air for his blast furnaces near Dudley; the pipes through which the air was passed for the purpose of heating it were bent like a syphon, so as to cause all the particles of air to come in contact with the sides of the pipes, and the air was found to be heated much more efficiently by these bent pipes than by straight pipes.

Mr. ALLAN said, he had tried an engine with a ⅝-inch iron rod fixed in the centre of each tube; the rods were as long as the tubes and supported at intervals by short projecting pins to hold them in the centre of the tubes. The engine had been worked with them for some time between Birmingham and Liverpool, but no difference was found in the working and consumption of coke, as compared with the same engine doing the same work without the rods in the tubes; the result was found to be exactly the same in both cases.

Mr. C. COWPER remarked that the rods in the tubes would have the effect of contracting considerably the flue area, and increasing proportionately the amount of power requisite to draw the air through the tubes, and consequently the rods in the tubes would cause a loss of power to the engine from the increased resistance to the blast. He thought therefore the rods must have caused an equal amount of gain to neutralise this loss, by bringing the air into more effective contact with the sides of the tubes, as the result showed no loss on the whole.

Mr. **McConnell** thought it was certain at least that the use of the rods did no harm; and it must either be considered that there was no advantage in a large flue area, or that there was considerable advantage in mixing the air in passing through the tubes.

Mr. **Slate** was of opinion that even on the ground of economy a large number of tubes was advisable, because with the violent and frequent action of the pieces of coke the tubes were soon worn out; whereas by increasing the number of tubes the velocity of the draught would be diminished, and the tubes would be less worn and would last longer.

The **Chairman** remarked that the larger the area of the flue, the better it was for the engine, as it must offer less resistance to the blast-pipe; but he was not certain what this resistance actually amounted to.

Mr. **Cowper** said that Mr. Daniel Gooch had found from his indicator cards, that the resistance of the blast-pipe amounted to 11 or 12 lb. per square inch, at a moderate velocity of about 30 miles an hour.

Mr. **McConnell** observed that as a certain quantity of heated air had to be conveyed from the fire-box to the chimney, and a certain area of heating surface was also required, there would be an important reduction effected in the resistance of the blast-pipe by increasing the number of tubes, so as to increase the area of passage and reduce the length of the tubes, diminishing proportionately the resistance of the air passing through the tubes.

The **Chairman** said he was present when the experiments were tried that were mentioned by Mr. Ramsbottom, to ascertain the difference between the degree of exhaustion in the smoke-box and in the fire-box; the experiments were tried with a long-boiler engine, and a glass water-gauge was fitted into the smoke-box and another into the fire-box. The degree of exhaustion in the smoke-box averaged three times as great as that in the fire-box, and this proportion was found to be nearly the same at all velocities; the greatest amount of exhaustion observed in the smoke-box supported a column of water 13 inches high. He thought that the whole resistance of the blast-pipe and the back pressure in the cylinder, did not amount to more than 15 per cent. of the power of the engine.

Mr. **Slate** remarked that assuming it to be 15 per cent., it followed that 10 per cent. of the whole power of the engine was absorbed by the friction of the air in passing through the tubes, as the exhaustion in the smoke-box was three times as great as in the fire-box; or one-third only of the pressure of the blast was effectively acting in the fire-box.

Mr. **McConnell** thought it was an important subject for investigation, to ascertain the actual power lost by the resistance of blast-pipes of different sizes, and under the different circumstances of size and number of tubes. In his own practice he had found that small tubes and many of them produced the best effect; the limit in reducing the size of the tubes was their stopping up with pieces of coke whilst working.

The **Chairman** said he thought there was some advantage in the form of boiler proposed by Mr. Ramsbottom, and that amongst the various modifications that had been proposed of the locomotive boiler there was not one that was so likely to be useful.

REGISTER OF NEW PATENTS.

CASTING PIPES.

David Yoolow Stewart, of Montrose, Scotland, ironmaster, for "*improvements in the manufacture of moulds and cores for casting iron and other substances.*"—Granted January 4; Enrolled July 4, 1849. [Reported in the *Patent Journal.*]

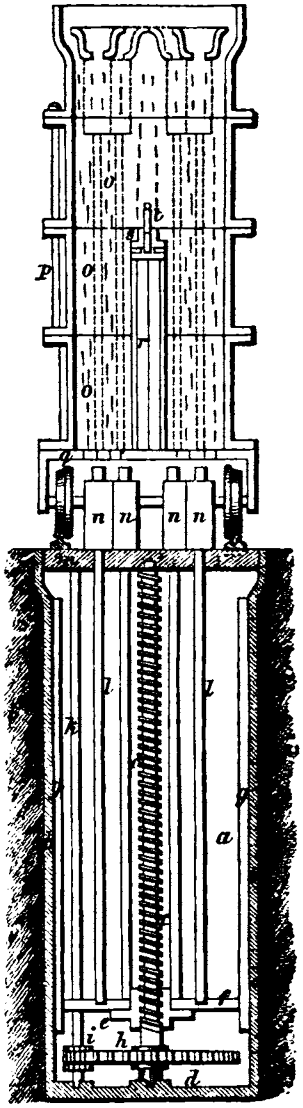
This invention has reference: First—To the formation of the moulds for casting pipes, or other similar articles, of a uniform, or nearly uniform, shape throughout.

Secondly—To the construction of moulds, and parts connected therewith, so that they may be readily moved into and out of the drying stoves.

Thirdly—To a mode of constructing cores; and also to the moving or starting cores (when of a large size) out of the castings.

In casting pipes, if of ordinary sizes, the patentee arranges to cast them in sets of six, in one flask or box, which is placed on end, as represented in the annexed engraving. *a*,*a*, is a pit, formed in the ground, with a metal lining *b*, *b*, to maintain the relative positions of the working parts. A screw *c*, is sustained in a vertical position in the centre of the pit, and fitted into a step *d*, at the bottom, so as to admit of a rotary motion. This screw *c*, is fitted with a nut *e*, which supports, and is fixed to, a plate *f*, sliding up and down on guides *g*, *g*, on the sides of the pit; this up-and-down motion being caused by the rotation of the screw *c*. To the bottom end of the screw, a spur-wheel *h*, is affixed, gearing with the pinion *i*, fixed on a shaft *k*, and worked by means of a wrench-handle from the top. The plate *f*, sustains six rods *l*, *l*, *l*, four only being seen in the engraving, that representation being a vertical section; these rods are arranged in a circle around the screw *c*, taking it as a centre, in which order they pass through, and are sustained by, the top plate *m*, through which they pass. The rods *l*, are surmounted by what he terms the patterns *n*, *n*, fitted to the rods *l*, so as to rest on a shoulder, and rise with the rods, and at the same time admit of being readily removed from the ends.

The flask or mould-box *o*, is constructed of four separate lengths, each in two halves, and hinged on the bolt *p*; this is mounted on a bed plate *q*, furnished with holes, corresponding in diameter with the patterns *n*, and so disposed as to come immediately over them; the box is so fitted as to travel on rails over, and be sustained in its position, so that the pattern, on being elevated by the rods *l*, will enter the holes in the bottom of the flask. When the height of the pattern pieces *n*, is such as to be nearly all within the flask (the lower piece being the only one on the bed plate), the workman then raises the sand in the flask, so as to surround the patterns, which, when nearly covered, are elevated still higher, by the same means, and an additional length of the flask or box applied to the top. When raising, the sand proceeds as before, till the top of the centre piece *r*, is covered, when a gate piece *s*, is placed on it, having six gates (one to each pipe), communicating with a centre channel, in which a gate pin *t*, is fitted, which is drawn up as the sand is filled into the box, so as to maintain a free gate up to the top of the mould, by which the metal is introduced; this pin *t*, being drawn up as the filling progresses. The patterns *n*, having attained the height represented by the dotted lines, moulds or passages will have been formed up the sand, corresponding in diameter with the exterior of the pattern; these being the moulds for the parallel part of the pipes. Faucet-pieces are then placed on the top of the rods *l*, and the sand moulded round them; the faucet-pieces and patterns are then removed, and a socket-piece placed on the rod *l*, having a socket both ways, one taking on to the rod, the other being presented upwards, for the reception of the cores, which are then lowered down into the mould by reversing the action of the screw *c*, when the moulds will be complete. Metal is poured in at the central gate, diverging when half-way down into the several moulds, as explained.



Although the pipes are here shown as cast in sets of six, this method will of course be equally applicable for other numbers, by adapting the several arrangements of the apparatus; or where the pipes are large, the moulds may be similarly constructed for one.

The second improvement is in the construction of boxes or flasks, and moulds, whereby they may be more readily handled than the ordinary mould boxes, which consists simply in fitting wheels to them, on which they may be wheeled about, instead of lifting them, as usual; and to facilitate the transport of such, he lays down rails suitable for the purpose, in and about the foundry, in such positions as required, and into the drying stoves.

The third improvement is in the construction of cores, which he forms of a hollow fluted cylinder, instead of wrapping wisps of straw round a rod, as usual. Round this cylinder he applies peat or vegetable substance, sufficient to cover the flutes; this having been dried, is drawn through a tube lined with sand, suitable for the core; this adheres, and forms a thin coating on the peat, which is then dried in the stove, when it will be fit for use, as an ordinary core.

The improvement in moving cores out of castings consists in effecting that object by the aid of hydraulic pressure. A press for this purpose differs only from the ordinary hydraulic press in having double sets of rods or pillars on each side of the ram, and having a portion of the centre of the head-piece removed, to allow the passage upwards of the core, when the ram is brought to bear on the lower end.

The patentee does not confine himself to the precise details, so long as the peculiar character of his invention be retained, and claims: First—The making several moulds at a time, or a single mould, by using patterns capable of being moved progressively into the mould-box.

Secondly—The mode of manufacturing and drying moulds, whereby they are moved on trucks into the stoves.

Thirdly—The mode of constructing cores; and also the modes of moving large core-bars out of castings.

WINDOW BACK ENCLOSURES.

John Tutton, of 20, South Audley-street, mechanist, for "*certain improvements in the construction and arrangement of certain parts of buildings.*"—Granted December 9, 1848; Enrolled June 9, 1849.

The improvements relate to constructing projecting windows of buildings, that safety and other closets may be more conveniently made under such windows; and it consists of using slate and cast-iron, as hereafter explained, when constructing such descriptions of windows.

Fig. 1.

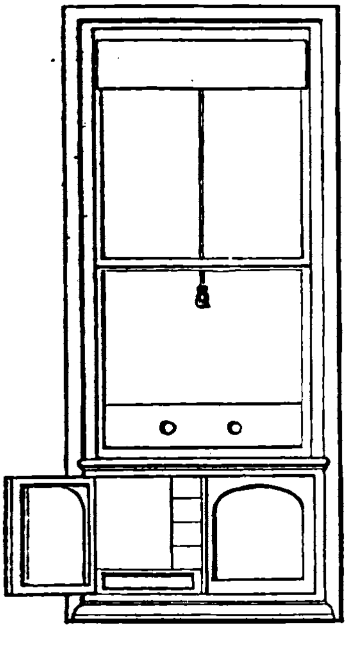


Fig. 2.

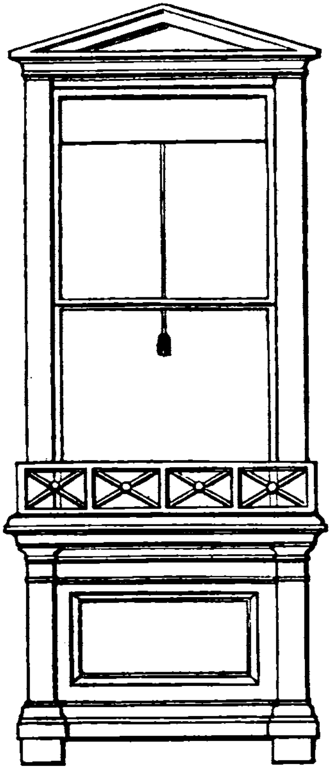


Fig. 1 shows an interior view of a projecting window, having under it a closet which, if of iron, may be fire-proof. The arrangement of the interior may be varied in respect to shelves and drawers, and such parts form no part of the invention.

Fig. 2 shows an external view of the projecting window shown at fig. 1. The architectural character given to the exterior may be varied to suit the character of the building, or the taste of the parties for whom the work is to be done.

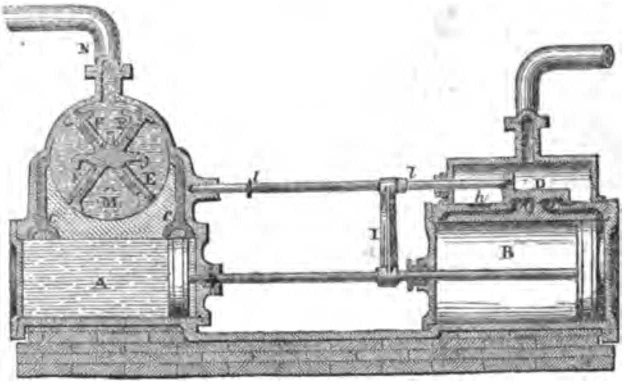
In constructing the projecting windows, in order that there should be as little projection as possible, for obtaining a given size or depth of closet the whole of the projecting parts are of slate, or in place of using slate, cast-iron may be used, which will give great strength, when comparatively thin material is employed; in either case the recess formed within by the projection may be fitted up as a safety or other closet by using fire-proof materials, such as slate or iron. In all cases the glazed sash-frame alone should be of wood or of metal, all the boxings or frames to receive the sashes being of cast-iron; or they may be of slate when metal sashes are used, and in place of using all slate or all iron, the use of these two materials may be combined in making a projecting window and a closet therein. In the drawings comparatively small projections beyond the exterior of the building are shown, and yet a closet of considerable dimensions may be obtained. The extent of projection of a window may however be varied to suit the circumstances of each particular case.

PUMPING ENGINES.

Edward Newton, of Chancery-lane, city of London, civil engineer, for "*improvements in engines and apparatus principally designed for pumping water.*"—Granted February 12; Enrolled August 11, 1849. [Reported in the *Patent Journal.*]

The improvements relate to the formation of the valves of pumping engines and pumps, whereby a more certain means may be obtained for working the valves of the engine; and also to improvements in the valves of pumps; the whole of which improvements are principally applicable to pumping water from mines, and other such situations where the speed of the engine is varied according to the quantity of water to be lifted. In pumping engines, the patentee observes, it is well understood that the movement of the slide-valve of the engine is dependent on the momentum of the moving parts, and in some cases the force of a spring is resorted to, in order to complete the movement valve, for the purpose of admitting the steam on the opposite side of the piston, both of which modes have hitherto been defective; in one case, from the fact that when the speed of the engine is slow, the momentum of the moving part is sometimes insufficient to complete the stroke of the valve, and allowing it to remain, so as to cover both ports, when, of a consequence, the engine stops,—and in case of the spring being used as an auxiliary, the force at one point varying so much from other points of its tension. Now, according to this invention, the patentee proposes to relieve the pump piston from the pressure of the water at that part of the stroke where the movement of the valve takes place, thereby allowing the engine piston to complete the stroke, and also the stroke of the valve, from the expansion of the steam already in the cylinder, or that steam which has produced the previous part of the stroke.

The first improvement in the pumps consists of a peculiar formation of the water passage of the pump, whereby the pressure of the water is in equilibrium on both sides of the pump piston, at the end of each stroke.



The wood engraving represents a vertical section of a horizontal pumping engine, and double-acting pump, constructed according to this invention, in which the steam-cylinder piston and the pump piston are attached to the same piston-rod; A, being the pump-barrel, and B, the steam-cylinder. C, C, are the water passages to the pump, which (it will be observed) are divided into two branches, opening into the pump-barrel, at a distance from each other rather greater than the thickness of the pump-bucket or piston; so that on the piston approaching either, or when it has nearly completed either stroke, it becomes suddenly relieved from the pressure of the water it is forcing, by the free communication formed by the double passage C, when the pump piston is in the position shown. The steam piston, thus relieved from its load, is free to be carried through the remainder of its stroke by the expansion of steam in the cylinder; its further admission having been cut off by the partial movement of the slide-valve D. The expansion of the steam thus completes the stroke of the piston, together with the complete movement of the valve D, and this at however slow a speed the engine may be working.

The second improvement in pumps consists of an arrangement of the valves, which are placed immediately above the pump, in a circular chamber or cylinder, in which a centre-piece is fixed, consisting of four radial partitions, with valve openings, on which are fitted the valves E, E, which are the induction, and F, F, the eduction valves, communicating with either end of the pump. These valves are hinged or pivotted on one side, while their movement is confined by suitable stops, which confine them to such a position as to insure their fall on the inclined valve faces or partitions, immediately on the cessation of the flow of water. The supply-pipe, or source from whence the water is drawn, is placed in connection with the passage M, the pipe N being the eduction passage, or that through which the water is transmitted.

The third part has reference to an improved valve, applicable to pumping engines of the construction represented in the engraving, by which the valve-rod may be worked directly from the piston-rod of the steam-engine. In the ordinary slide-valve, instead of working it directly from the piston-rod, it is necessary to employ the intervention of a lever, or some other contrivance by which the direction or motion may be reversed: as when it is required that steam should be admitted below the piston, the valve moves towards the top, in order to uncover the top, and *vice versa;* whereas by the construction of the valve D, its motion is in the same direction as that of the piston. This valve D, he denominates a "B valve," from the two hollows *g*, *g*, in the face; the office of one of these hollows being to pass steam to and from one end of the cylinder, and the other to the opposite end. It will be seen that in the face of the cylinder, besides the ordinary ports, there are two hollows *h*, *h*, which are alternately partially covered, and wholly uncovered at each stroke of the valve, the hollow g^1, as shown in the engraving, partially covering the hollow h^1, and at the same time the steam passage to the bottom of the cylinder; and the hollow *g*, at the same time covering the steam passage and the eduction port for the escape of the steam from the top of the cylinder; the position of the valve being the result of the down stroke of the piston. On the piston arriving at the other end of the cylinder, the arm, or tappet on the piston-rod, will come in contact with the collar *l*, when the position of the valve will be reversed, and steam opened into the top of the cylinder.

With reference to the equilibrium passages in the pump, he mentions several other modes by which it may be effected, such as a number of grooves in the pump-barrel, of the length required, or by connecting the two ends of the pump by a pipe, in which a valve is opened at the proper time to effect that object; but he prefers the method shown in the engraving, and in conclusion remarks that he does not confine himself to the precise detail, so long as the peculiar character of the invention be retained, as the same object may be effected by the other arrangements contemplated; but that what he claims as new is, removing or reducing the resistance on the pump pistons at the proper time of each stroke, in order to allow the momentum of the moving parts of the expansion of the steam already within the cylinder, to accelerate the motion of the parts as explained, so as to throw the slide-valve across the ports with certainty, whether at high or low speeds; and this he claims, in either of the arrangements mentioned, or any other substantially the same, by which this acceleration of speed of the piston at the end of the stroke may be produced.

Secondly—He claims the arrangements of valves in which the seats radiate from one common centre substantially, as herein described.

On the Preservation of Water, by M. Perinet.—M. Perinet, ex-Professor of the Hôpital Militaire d'Instruction, has succeeded in preserving water in a sweet state, by placing 1½ kilogramme of black oxide of manganese in each cask of water containing 250 litres. He has kept this water for seven years in the same barrels, and exposed them to various temperatures; at the end of that time he found it as limpid, free from smell, and of as good a quality, as at the beginning of the experiment. The above is equal to 6½ lb. to a butt of 108 gallons.

THE EXPOSITION OF 1849 AT PARIS.

The constant struggle in which our manufacturers are engaged with their foreign rivals, makes it of great importance they should be well acquainted with the steps taken by these latter. It is not enough that we seem to be doing well here; we must be quite safe that we are doing better than others. The mere fact that we have a large market in a foreign country for our cottons, our iron, or our machinery, is an inducement to the manufacturers of that and other countries to wrest the market from us. Knowing, therefore, the interest that attaches to the progress of foreign industry, we felt it our duty to attend the Exposition lately open at Paris; and it seems a fitting time that the whole subject of these expositions or shows should be gone into, as they daily attract more attention.

The Exposition is one of those measures, having their beginning in the first great French revolution, which were taken to promote the welfare of the people,—and which down to our time, notwithstanding the hostility of kings and the apathy of governments, continue to keep alive the great principles that the end of society is not to make the happiness of the few, but of the many. The English have been the great apostles of these truths, and have given the best exemplifications of them; but it so happens, that for many institutions, and the Exposition is one of them, nothing has been done here. It was a great thought, amid the din of war and the suffering of a fearful revolution, to give new life to trade by drawing together the products of manufactures,—strengthening public hopes by showing what resources France possessed,—awakening the skill of the man of learning and ability by showing what she still wanted—wherein she was behindhand; where the field needed no further tilling—where it was waste and could yield a good crop. The first experiment was a short one. It took place in 1798, now fifty years ago, and a building was raised at Paris called the Temple of Industry, in which, for three days, the infant Exposition was opened. At that time there were only 110 contributors.

From that time, under the influence of the great patron of French trade, Napoleon, in that as in everything the friend of his country, the Exposition was frequently held,—though it has been said the honours shown to the manufacturers and engineers in 1806, drew down the jealousy of the military party. The great war caused it to languish, and it was not until 1819 that this institution, suspicious to the Bourbons for its birth in the days of revolutionary freedom, was allowed to revive. From that time, an Exposition has been held every four or five years. It is called the National Exposition of the Productions of Agricultural and Manufacturing Industry, but agriculture holds only a subordinate place.

This great show is commonly held in a building set up for the time in one of the great open places in Paris. The first was in the Champ de Mars; those of 1801, 1802, 1819, 1823, and 1827, in the palace of the Louvre; that of 1806 on the Esplanade of the Invalides; the one of 1834 on the Place de la Concorde; of 1839, 1844, and 1849, in the Champs-Elysées. The length of the show was at first three days; afterwards, six and seven; in 1806, twenty-four days; in 1819, thirty-five; in 1823, fifty; and since then, sixty days.

The following will show the progress made:—

Year of Show.	Exhibitors.	Rewards.
1798	110	23
1801	229	80
1802	540	254
1806	1,422	610
1819	1,662	869
1823	1,642	1,091
1827	1,695	1,254
1834	2,447	1,785
1839	3,281	2,305
1844	3,960	3,255
1849	4,532	——

The rewards are medals of gold, silver, and bronze, an honourable mention, and a favourable citation. To the name of each exhibitor is appended, in the official catalogue, a list of the rewards gained at the Expositions. Thus, Derosne and Cail, the great machinists, are named as having gold medals in 1827, 1834, 1839, and 1844, showing how long have been their exertions. Japy, brothers, hardware manufacturers, are named as having gold medals in 1806, 1823, 1827, 1834, 1839, and 1844.

Besides these medals and certificates, the cross of the legion of honour is always given to some of the most meritorious exhibitors. Napoleon took a great interest in the Exposition. Louis Philippe, however great a tyrant, certainly a friend to the arts of peace, spared no pains in promoting the three great Expositions of his reign. In 1844, he spent a long time each Monday in the show, talking with the manufacturers, and the leading men among them were likewise made welcome at the palace. The influence of a man of enlightenment could not have been otherwise than favourable; and it is very likely, as said, that Louis Philippe often gave good practical suggestions to the manufacturers with whom he talked. They, too, had the opportunity of showing the legislative evils under which they laboured, and of impressing a powerful protector of industrial interests, as they are understood in France—that is to say, of industrial monopoly. Louis Napoleon, in whom the love of patronage is strong, likewise spends his Mondays at the Exposition.

The admission is wholly free, all but Thursdays, when there is a charge of one franc; but that is given to charities. Thus the great feeling is kept up, that this is an institution for the benefit of all, and that all have an interest in the national industry and national welfare.

For the Exposition of 1849, a grant of 24,000*l.* was made to the Minister of Agriculture and Trade. In each department or shire of France, a committee was named by the Prefect to settle the claims of exhibitors. This committee, or jury, as it is likewise named, was on this occasion specially authorised to point out, in a written report, "the services rendered to agriculture or industry by masters, foremen, or workmen." From the head town of each department the objects exhibited were carried, at the cost of the government, to Paris, and were so sent back. A "central jury" was named by the Minister to judge to whom rewards should be given. Their report was sent to the Minister, and by him to the President of the Commonwealth, by whom the rewards were bestowed.

On the Central Jury we find the following names:—Arago, Blanqui, Michel Chevalier, Charles Dupin, Dumas, Mathieu, Payen, Wolowski, and other men of science; Leon Feuchere and Fontaine, architects, and Firmin Didot. About half the members are men of science. As so many leading manufacturers are exhibitors, of course they are thereby excluded from the Central Jury.

The department of the Seine, in which Paris is situated, naturally sends by far the greater proportion. Of 4,352 exhibitors, 2,856 are from that department. From the Orne, 222; the Lower Seine (Rouen), 117; the North (Lille and the cotton districts), 119; and the Rhone (Lyon), 100. None others come near these numbers. Most of the departments send very few articles. The difficulties of carriage are a great hindrance in France, which would not be felt in England; indeed, no part of this island, or the neighbouring one, would be without its representative at an exposition.

That this institution has a favourable effect on French industry, no one who sees it can doubt. It makes the manufacturers fully aware, so far as France is concerned, of what they can do. Some can see in what they are behindhand, and why; and to all there is the motive of exertion. Public fame is awarded to those who do well; nor does fame end with a medal or a sheet of paper,—but the well-deserving manufacturer, becoming better known, has an immediate reward in the demand for his productions. Many new articles of manufacture have thus been prominently brought forward, and obtained a publicity which would otherwise have been long in coming. Many clever mechanics have found their interests advanced by having the opportunity of showing their inventions before the eyes of the manufacturers and capitalists of all France. Indeed, the very encouragement of genius, which we here sigh for, is there found, and honour and wealth become more surely the lot of the meritorious.

If France, notwithstanding such an institution, does not go beyond us, and if we, with the want of it, are still flourishing, it does not arise from this one circumstance. The inborn energy of Englishmen, exerted during hundreds of years, has created an enterprising and independent people, whom bad government has not been able to depress. The want of true freedom in France has created a people, listless—whom no public reward can fully encourage, because vicious legislation fetters and trammels them at every step. In England, a bad government does not do its duty in encouraging and upholding merit: in France, a bad government goes beyond the proper sphere of government by interfering with the personal action of individuals. In both cases the error is great and threatening—here it is an error of omission, there of commission. The fruits are different, because an Englishman is still free to work for himself, and because a Frenchman is trammelled by a vicious police, which deprives him of energy of action and independence of character. Thus these characteristics so common in England are rare in France.

We shall now transcribe a few notes as to the career of some of the exhibitors; not taking those who have begun as capitalists, but rather those who have devoted themselves to mechanics.

M. Gustave Hallet, machinist, at Paris, left in 1835, the School of the Industrial Arts at Paris, in which he had studied; and having been employed as a clerk and assistant in factories, set up in 1840 on his own account, as a mechanical engineer and millwright. He now exhibits, for the first time, a high-pressure engine, of 3-horse power, with some ingenious modifications.

M. Farcot was a pupil of M. Achille Collas, and was afterwards brought up with Jecker, brothers, manufacturers of marine instruments. He was afterwards in M. Perrier's engineering works, at Chaillot, with Mr. Edwards, the elder, but being discharged, was employed by M. Albony, a locksmith. Thence he became the first workman of M. Christian, at that time Director of the Conservatoire des Arts et Métiers. By him, Farcot was employed in the establishment of machine works in the Hospice des Quinze Vingts, at Paris, and at Argenteuil, and constructed a number of machines for the colonies. In 1823, he left M. Christian, and with his own savings and his wife's money set up a factory as a millwright. Besides other machinery, he constructed, in 1827, a great bakery. At each Exposition from 1834, he has been an exhibitor, and from a yearly manufacture of engines of 36-horse power, he has reached a yearly supply of 240-horse power.

In 1813, there was no dyery at Roubaix. M. Descat-Crouzet set up one on a small scale for cotton yarn and piece goods, and by 1815 he had gained some reputation in the department of the North. His eldest son, Theodore, a lad of fifteen, powerfully helped him; he was successively workman, foreman, and clerk, and afterwards became head of the house, in which his brothers were partners. In 1825, English goods were driving French goods out of the market, as our manufacturers had discovered new processes. It was important to learn them, and M. Theodore Descat effected this, to the great satisfaction of the manufacturers of the department; and by successive experiments and journeys, by money and by skill, he has kept up his fame. In 1832, he set up a large dye-work at the bridge of Brœncy. On him the progress and prosperity of the town of Roubaix has depended, and the Departmental Jury express themselves in the strongest terms of gratitude towards him. His dye-works have steam-engines of 80-horse power, and all the necessary machinery; and a large village has sprung up around. He employs 850 workmen, and his transactions are 80,000*l.* yearly.

M. Tesse Petit was foreman of a cotton-spinning factory at Paris, the head of which gained a prize at the Exposition of 1819. In 1820, he set up a small factory of 1,296 spindles. In 1834, he gained a silver medal. He had then only 90 work-people. In 1839, he set up a steam-engine. He has now 160 work-people in the factory, and 80 out of doors, and 15,800 spindles.

These examples will show how men get on in France, and the danger in which we are from such rivals. An account of some of the French establishments will still further illustrate the state of French industry.

Messrs. Charles Derosne and Cail are great engineers. They employ altogether 2,600 men, and turn out locomotives and railway plant and sugar machinery for France and the colonies, besides steam-engines, mill-work, and coining apparatus. They ship to Java, Brazil, Mexico, Surinam, Egypt, Spain, Cuba, Bourbon, Guadaloupe, Martinique, Russia, and Austria. They have made 160 locomotives. The firm have establishments at Paris, Grenelle, Denain in the North, Brussels, Amsterdam, and Guadaloupe. The motive power is 45-horse power at Paris, 15 at Grenelle, 60 at Denain, and 15 at Brussels. Among the plant is, at Paris and Grenelle, 107 forges, 278 lathes, planing, and boring machines, and three foundry furnaces; at Denain, 114 forges, 45 lathes, &c.; at Brussels, 42 forges, 36 lathes, &c. Charles Derosne, the founder of the firm, died in 1846, in consequence of his repeated visits to the West Indies.

Messrs. Petin and Gaudet, of Rive de Gier, set up their factory in 1839, and were the first in France to use the steam-hammer for forging. At that time, wrought-iron boiler plates for marine engines were only to be had in England, and the price was very high. Paddle-wheel shafts cost 6*l.* per cwt., and now they are delivered at 2*l.*, and the firm supply most of the leading houses of France.

The factory at Graffenstaden, on the Lower Rhine, belongs to a *societé anonyme*, and was set up in 1838. It has 82 lathes, 60 forges, 3 foundry furnaces, and employs, when at full work, 700 or 800 men, using 1,100 tons of metal, and 1,600 tons of coal annually. It turns out machine tools, tenders, wagons, railway wheels, &c.

The *Societé Anonyme des Forges d'Audincourt* has 5 charcoal iron-smelting furnaces, 2 foundries, and 20 refining hearths. It uses yearly 50,000 cubic yards of charcoal, and turns out 8,000 tons of iron in a good year. Japy, brothers are the directors.

The Metallurgic Society of Vierzon is another company; has engines of 300-horse power, 9 high furnaces, 11 puddling hearths, 12 balling wires, 30 refinery fires, 1 reverberating oven, 1 steam-hammer 4,000 lb. weight, and 5 rolling presses.

The cotton-mills of Messrs. Seillière, at Sénones, in the Vosges, were set up in 1804, and then employed 8,500 spindles. They have now several establishments, and employ 516 people in the spinning department, 550 in the power-loom department, 86 in the bleachery, altogether 1,667. They use as moving power, 6 water-wheels of 142-horse power, 3 steam-engines, 1 turbine of 50-horse power, and 1 of 30-horse power. They have 26,500 spindles, and 660 looms, and work up yearly 650,000 lb. of cotton into yarn. This factory does not seem to have had the success anticipated, as for a long time it suffered from want of power, the water-power being at first only 50-horse power; but they have now greater resources. The spinner, who in 1830 earned only 1 franc a-day, now earns from 2 to 2½ frances per day.

The firm of Nicholas Schlumberger, at Guebwiller, in the High Rhine, is that of one of the great cotton lords of France. The mill was founded in 1810. The firm spin cotton, linen, hemp, combed wool, and silk waste, and have likewise a factory for making spinning machinery. They have above 2,000 work-people, with 55,000 spindles, and work up 800,000 lb. of cotton yearly into yarn, and 550 tons of metal, besides 1,000 tons of coal.

The firm of Mahieu-Delangre have cotton-mills at Armentières, in the North, and employ 1,342 work-people.

The firm of Scrive, brothers, of Lille, spin and weave flax. They employ 550 people. M. Scrive Labbé introduced the flax-weaving machinery into France.

Messrs. Cohin and Co, at Rallepot-lès-Frévent, have a flax-mill with 600 work-people, and 10,330 spindles.

M. Lemaitre-Demeestere has a flax-mill at Halluin, in the North, and employs 600 or 700 people.

The firm of Messrs Bertéche, Chesnon, and Co. dates from 1806, and has establishments at Sedan and Paris, for cloths, cassimeres, &c. They turn over above 300,000*l.* yearly, and ship to the United States, Peru, Chili, Brazil, Mexico, Spain, Belgium, Russia, and even England.

These will give some idea of the large French establishments of various kinds, and although we may pride ourselves on having larger ones, we cannot help seeing we have powerful rivals.

We were very much pleased with the show. It does the greatest credit to the manufacturers of France, and gives the most gratifying proofs of their progress. It may be most usefully studied by Englishmen. In every article of taste the French are beyond us, though we are making way upon them; and it is likely that if we had a show ourselves, a higher class of productions would be brought forward, and would receive greater encouragement. The metal manufacturers exhibit many creditable works—not models, but working locomotives, stationary engines, and tool machines. We do not consider the French go beyond us, or come up to us, but they show an earnest rivalry, and are certainly getting ahead. Even Englishmen are at first struck by this truly great show; but a careful examination modifies the first opinion of exclusive excellence, and affords the strongest ground for believing that a London Exposition would far surpass that at Paris.

To the establishment of a show of English productions our attention was long since turned; and we are the more convinced of its necessity, and of the propriety of taking some immediate step. We have, however, no faith in the scheme put forward by the Society of Arts, because we think that society is wholly unable to carry it out, and an abortive attempt would have the most mischievous results. We consider that an Exposition should originate with the manufacturers, and be managed by them.

An Exposition, in all its attributions, is well calculated to encourage industry. The reports of the shire-committees on the state of trade, and of those who have done the most service to trade and agriculture, would have very good results. In France, most establishments exhibiting state how many men they employ, the extent of their works, and the value of their produce. These are not things that can be kept secret in England; the statistics of each iron-work or cotton-mill are accessible to rivals, though they are not well known by the public. The opportunity that is presented of ascertaining the comparative condition of each branch of industry is invaluable, and many would be greatly stimulated were their existence or capabilities fully known.

In France, a classified catalogue shows the number of exhibitors in each department, and some of them we will enumerate. There are 22 exhibitors of steel, 84 of iron, 518 of machines, 152 of apparatus for heating, distilling, and drying, 120 of watchmaking, 133 of husbandry implements, 138 of what are called instruments of precision, and 123 of tools. Other exhibitors to be noticed are, 6 of slates, 11 of bitumen, 2 of anthracite, 13 of geographical articles, 73 of colours and varnishes, 3 of razor strops, 20 of daguerreotyping, 7 of ink, 5 of goffering, 3 of gutta percha, 15 of waterproofing, 183 of musical instruments, 12 of letters in relief, 23 of marbles, 15 of mosaics and incrustations, 114 of paper-works, 10 of pasteboard-works, 15 of paper-hanging, 33 of stays, 35 of perfumery, 18 of wooden shoes. These will show the varied character of the exhibition, and what a *specialité* there is for some articles looked upon as inconsiderable.

(To be continued.)

THE PUBLIC WORKS OF ENGLAND.

No. IV.—Docks.

Necessitas mater artuim. These most useful establishments were, in many instances, the last adopted in the most important commercial towns. The reason is that the most important towns were established in favoured situations where the absolute necessity for docks was the latest felt. Dry docks, for the mere purpose of constructing vessels, are, of course, of very ancient date, and are to be found everywhere; but wet docks, for the purpose of giving vessels when arrived at their destination a safe receptacle and easy means of loading and unloading, are of singularly recent date. The Mediterranean, in its tideless waters, stood in comparatively little need of such convenience. Thus when Venice, Genoa, Leghorn, Marseilles, were totally without docks, some of the towns on the Baltic, of much less commercial importance, possessed docks of excellent construction. On the same principle in our own country, London was anticipated by many second-rate seaports. Liverpool, at a time when it bore a very low rank amongst our commercial towns, first established the dock system in Great Britain. In those days no one could ever have dreamt of the North American trade. Liverpool owed nothing to its near position. The advantage of its proximity to America was an after-accident. The energy probably of a few private individuals, instituted a scheme which totally altered the commercial balance of the empire. To some accidents of private conduct is due in like manner the arrangement and position of most of our great emporiums, for whatever celebrated—whether for art, industry, commerce, or education.

The shifting of the sands in the Mersey, however, and other disadvantages of the harbour, rendered docks more necessary at Liverpool than in most other places. The first Act for this purpose in Liverpool was obtained in 1708. The management was invested in the Corporation for a term of 21 years. That body gave 4 acres of land, and were authorised to borrow 6000*l.* The old dock was thus constructed, covering an area of somewhat more than 3½ acres. In 1717 the term was extended by 16 years, and the Corporation empowered to borrow an additional 4000*l.* In 1737 a new Act gave a further prolongation of the term, an additional dock permitted to be constructed, and a new power given of borrowing 6000*l.* By 1761 another dock was wanted, and 25,000*l.* more was permitted to be borrowed. In 1784 two more docks were granted, and the power of borrowing 70,000*l.* In 1799 two more docks and a further loan of 120,000*l.* were authorised. The Corporation contributed the necessary ground. The aggregate sums thus authorised amount to 231,000*l.* for seven docks. The dock dues, which in 1724 amounted to 810*l.* 11*s.* 6*d.*, reached above 10,000*l.* in 1790, and above 100,000*l.* in 1818. The number of vessels, which in 1760 was 1245, reached 10,000 in 1824.

The area covered by these docks varies, from the first, or "old" dock, which, as we have stated, occupies 3½ acres to the Queen's Dock, which covers about 11 acres. Besides the docks, there are six basins, covering from 2 to 4 acres each. The construction of most of the docks, especially that called the Prince's Dock, is of the most solid description. The offices are splendid, cast-iron sheds are built round it, and a spacious parade runs along one side.

More recently the Brunswick and Birkenhead Docks have been built. Of the latter the fortunes are not yet developed; the vicissitudes of this undertaking have hitherto been considerable. They are designed upon the most magnificent scale, and may probably have to wait some years until the inevitable expansion of British commerce under an increasing population, and the blessings of free trade, may call into use the vast area and superb appliances which they offer to the merchant and the shipmaster.

The next in order of time were the Hull Old Docks, which were commenced in 1774, on the site of the old fortifications. The area of dock, quay, &c., is above 30 acres; that of the dock itself, 10 acres. Rennie, the engineer, had many difficulties to encounter in the loose nature of the soil. The first dredging machine ever employed in England was constructed by him for the use of these docks. This was one of the most profitable undertakings of the kind in the hands of shareholders, the docks at Liverpool, like those at Bristol, being the property of the Corporation. The original number of shares was 120; that number has since been increased to nearly 200. In 1806, previous to the increase, the dividend was no less than

72*l.* 15*s.* 10*d.* per share, but it sensibly diminished afterwards. Hull New Docks were built in 1807. The area is about 7½ acres.

Up to the beginning of the present century, the city of London had no docks at all. In fact, several interests were in the way—the proprietors of the various wharfs above and below the bridge were against any scheme of dock building, and various projects for the improvement both of the legal quays and the sufferance wharfs were proposed in opposition. The legal quays were, however, only 1464 feet long altogether, and occupied precisely the same positions that they did at the time of the great fire of London, while the imports from the port had, from the year 1700 to 1792, increased from 4,785,538*l.* to 12,072,674*l.*, and the exports from 5,387,787*l.* to 14,742,516*l.*

In the year 1793, a plan was first projected of making wet docks at Wapping, the Isle of Dogs, or Rotherhithe, the preference being given in the first instance to Wapping, on account of its proximity to the city. This first plan contains the germ of almost all that has been carried out since. In 1794, a general meeting of merchants took place, when a committee was appointed to examine the matter, and a report was drawn up, recommending the construction of docks at Wapping. In conseqence, a well-known engineer, Mr. Daniel Alexander, who had been previously employed about the river, was directed to make a survey, and to prepare plans and estimates for constructing the proposed Wapping docks, with a cut and canal leading to them along the site of the present East and West India Docks. The plans and estimates were prepared accordingly and laid before another general meeting of merchants on December 22, 1795, when a subscription of 800,000*l.* was filled in a few hours, for the purpose of carrying the plan into execution. In fact, projects of this kind were at this time eagerly listened to. It was the great year for canal schemes. A petition was presented to the House of Commons, who appointed a select committee "to inquire into the best mode of providing sufficient accommodation for the increased trade and shipping of the port of London." In this committee a variety of objections were raised, and plans proposed for constructing docks in all sorts of places. It took two or three years to overcome these difficulties, and the final petition to the House was not presented till December, 1798. A few days afterwards a petition was presented by the Corporation with similar objects, and with the additional plan of cutting a navigable canal from Blackwall to Limehouse, and constructing wet docks in the Isle of Dogs, for the West India Shipping. The West India merchants had, however, apart from the Corporation, already projected a competing plan to that of the last proposition. The Corporation and the companies united at last, and all difficulties were overcome. The Act for the West India Docks was passed in 1779—that for the London Docks in the next year—and the Act for the East India Docks in 1803. All these projects arose out of the original scheme for the London Docks, which scheme was carried out simultaneously in all its fulness, though under the management of three separate companies, and appearing as three distinct undertakings.

The London Docks were constructed under Rennie's superintendence. The Act allowed seven years for its completion; it was opened in five, but was not completely finished for some time afterwards. A capital of 300,000*l.* was authorised, five per cent. interest guaranteed, and ten per cent. fixed as a maximum. Proprietors of 500*l.* to 1000*l.* have one note; of 1000*l.* to 5000*l.*, two votes; of 5000*l.* to 10,000*l.*, three votes, and proprietors of more than 10,000*l.* have four votes, which is the maximum. The dock-rates were fixed by the Act at per ton:—For vessels trading between the ports of Great Britain (including the Scottish isles) 1*s.* For traders to Ireland, the Channel islands, France, from Ushant to Dunkirk, Flanders, Germany, and Denmark, to Elsineur, 1*s.* 3*d.* North of Elsineur and the Baltic, 1*s.* 6*d.* South of Europe to Cape St. Vincent, Africa, America, South Seas, 2*s.* Eastern Asia, 2*s.* 6*d.* All vessels arriving with more than 20 pipes of wine or brandy are obliged to enter the docks. Six weeks are allowed for unlading, beyond which a charge of ¼*d.* per ton is made for the first two weeks, and ½*d.* per ton afterwards. All vessels, except those devoted to the East and West India trades, are allowed to enter the docks, without distinction of nation. Wine, spirits, and tobacco, form the principal cargoes delivered at the docks. Ranges of warehouses have been erected for the reception of these articles—those for tobacco are of very fine construction. The superficies occupied by the warehouses in general amounts to 120,000 square yards. The dock itself is 420 yards long, 276 broad, and 29 feet deep. It occupies a surface of 25 acres, and the basin 2½ acres. The whole premises, including warehouses and quays, contain a superficies of 110 acres. It is estimated to hold about 230 ships of 300 tons. The tobacco warehouse, underneath which are wine cellars, covers five acres—the greatest extent of any one roof in the world, unless we except the Great Pyramid.

The West India Docks, the most magnificent in the world, were begun in July 1800, and opened for the reception of vessels in September 1802, in the short space of 27 months. Mr. William Jessop was the engineer. The prosperity of these docks in former days was prodigious. The original capital was 500,000*l.*, afterwards raised to 1,200,000*l.* The revenues of the company in 1809 amounted to 330,623*l.*, and in 1813 they reached their climax, amounting to 449,421*l.* Since that time the depreciation of the West India trade has caused a sad decline in this magnificent income. Up to 1818, the company, besides paying the maximum dividend of 10 per cent., had accumulated 800,000*l.* as a reserve fund, but they were obliged to devote a part of this sum to dividend very soon afterwards. The annual expenses alone of the establishment amounted in 1819, to 151,644*l.*, of which above 50,000*l.* went to workmen, above 40,000*l.* to building and improvements, and 13,320*l.* to taxes, an enormous impost. The cooperage materials are set down at 16,766*l.* in addition. The management of the company is in the hands of 21 directors, eight of whom must belong to the City Corporation. Four directors go out in each year, except the fifth, when five go out of office. Only shareholders holding above 500*l.* are entitled to vote. The nature of West Indian produce has rendered necessary the construction of the sheds and warehouses on the most careful principle. The pillars of the whole, and the framework of the roof of some of the sheds, are of cast iron, most ingeniously constructed. The great difficulty is to guard against contraction or dilatation by cold or heat. To remedy this, the iron beams which run from one pillar to another, are not actually in contact, and a longitudinal play is thus allowed to the structure, which prevents any mischief from the alteration of temperature. The pavement is partly of iron and partly of granite, and the mechanical contrivances are of the most excellent kind. The docks are in two divisions, the export and the import. The import dock is 2600 feet long, and 500 feet broad, and estimated to hold 204 vessels of 300 tons each. The export dock is of the same length, and 400 feet broad; it holds 195 vessels. There have been deposited in the sheds and warehouses at the same time 148,563 casks of sugar, 70,875 barrels and 433,648 bags of coffee, 35,158 pipes of rum and Madeira, 14,021 logs of mahogany, and 21,350 tons of logwood. The reader may conceive the economy of room necessary for the reception of such a mass.

The City Canal enables vessels to enter the docks without making the circuit of the Isle of Dogs, but in most instances the captains save the charge and go round the bend. The canal serves as a receptacle for ships laid up in ordinary; its long range of a mile presents a magnificent spectacle of masts and shipping, when viewed from the river. The depth of water in the docks at high tide is 24 feet. The area of the import dock is above 80 acres; that of the export about 25 acres. The docks, basins, and locks, altogether, include an area of 68 acres, and the total superficies, if we include quays and warehouses, amounts to 140 acres. The 68 acres of excavation form a work in its way unrivalled by any in existence.

The East India Docks were not commenced until 1805, though their Act passed in 1803. The first ship entered them in August, 1806, 17 months after their commencement. Their capital, originally 200,000*l.*, was subsequently doubled. The number of directors is 13, who must each hold 20 shares in the stock of the company, and four of them must be directors of the East India Company. This forms almost the only connection which the East India Company has with the docks. The possession of five shares gives a right of voting. The immense value of East Indian produce, and of the cargoes of the vessels engaged in the trade, causes a different arrangement in these docks from either the London or West Indian. The docks, in the first place, are much smaller; as fewer vessels are engaged in the oriental commerce, and as they are much longer on the voyage, they will be in dock a proportionately shorter time to the period they spend at sea. Then, the value of the property prevents its being allowed to remain on the spot. The warehouses are four miles off, and the cargoes are immediately delivered to the merchants. The company subscribed 10,000*l.* to the Commercial-road, which was originally constructed as a thoroughfare from the docks to the city. There is, likewise, much greater restriction in the admission of visitors to these docks than to any of the others. Business commences later in the day, and the doors are punctually closed at three in the winter, and four in the summer months. The depth of the East India Docks is greater than that of the rest, on account of the size of the vessels in the trade, which draw more water than any merchant vessels. The depth accordingly, is never less than 23 feet, or, as measured from the surface of the quays, is 27 feet. The superficies of the export dock is 10 acres, of the import dock 19 acres, which, with 3 acres for the basin, makes a total surface of 32 acres. The carriages used to convey the merchandise from the docks are of a peculiar construction. They look something like a gipsy caravan; the door is behind, and secured, besides its lock, by bars of iron. Long before the construction of the East India Docks, an old dock, called Perry's Dock, stood on the site; it was a private affair, but of great use to merchants. Greenland Dock, on the other side, was likewise an old private dock.

It was estimated that, before the construction of the great docks just described, the loss by robberies alone exceeded the hundredth part of the whole importation of wines, tea, indigo, cocoa, &c.; the fiftieth of the sugar, and the fortieth of the rum. The value of the loss during the years 1799, 1800, and 1801, was estimated to amount to 1,214,500*l.* The estimate of the saving to the present increased commerce of the country would be quite enormous.—*Daily News.*

Irish Bogs.—A letter in the *Times*, from Mr. H. J. Baylee, county Clare, states that "bog" land can be reclaimed, and brought into bearing at a cost of 7*l.* an acre; some which he had himself reclaimed yielded for the first crop 10*l.* an acre, the second for potatoes 40*l.* per acre (although, in ordinary years, only 20*l.*), the third 6*l.*, and it appears there is now growing on the bog a crop of potatoes worth 20*l.* per acre—thus, for an outlay of 7*l.*, all expended in labour, a return of ten times the amount has been made in the short space of four years. This instance should afford sufficient encouragement to the landholder and capitalist, as well as to the government, to adopt the system so successfully carried out, and which must be so conducive to the benefit of the sister country.

ZINC-WHITE A SUBSTITUTE FOR WHITE-LEAD.

It has been proved that zinc-white may be employed, with great advantage, as a substitute for white-lead, for painting and other purposes for which that substance is ordinarily employed; as the former substance is free from the disadvantages possessed by the latter, which is not only liable to turn black by the action of the air, but also produces the painters' cholic, and other disorders, which are often fatal. Zinc-white is, moreover, found to be unchangeable; this fact has been proved, beyond dispute, by numerous well-verified experiments; but the principal obstacle to its employment has been the difficulty of working with that material. This arises mainly from the fact, that workmen, who are accustomed to a certain routine practice, are at fault when a new substance is set before them; and, after attempting to use it according to the method with which they are acquainted, and not finding it succeed, they immediately condemn it as useless. Although persuaded of the beneficial results which would accrue from the use of zinc-white, the masters will not take the trouble to look into the matter themselves, but rely upon their workmen, and thus the public are persuaded that the application is impracticable. Now, it is the object of the present paper to obviate this difficulty, by pointing out the method of employing zinc-white with success and economy.

The first thing to be done is, to procure oil as nearly white as possible; this is essential if a bright colour be required, for, as the zinc-white possesses less body than white-lead, coloured oil imparts a colour to it which tarnishes its brightness; if, however, a yellow colour be required, there is no occasion to be so particular about the whiteness of the oil. The most suitable oil, and which is generally sufficiently white, is the oil of the black poppy, which may be procured from Flanders and Alsace, where it is in common use;—in default of obtaining this, any other siccative oil, provided it be white, will answer the purpose, although it may, perhaps, smell a little stronger.

The zinc-white is to be ground, while dry, into powder, with a mullar; it must then be scraped, with a painter's knife, into a heap, in the middle of which a hollow is to be made, to receive a small quantity of oil; the whole is then to be mixed with a knife, so as to bring it to the consistency of very thick mortar or paste, and rather dry than otherwise,—as this substance becomes more liquid the more it is ground. This paste is then placed on a separate palette, from which a small quantity is taken and put under the mullar, and triturated; and, as the colour escapes, it is scraped up with the knife, and placed in heaps on a clear space on the stone, where it is again ground,—the mullar being carefully placed in the centre of the heaps: when, by this means, the colour is spread over the whole surface of the stone, three or four turns from one end to the other will finish the grinding; the whole must then be scraped off with a knife. This operation, which appears, at first sight, tedious and troublesome, soon becomes easy of performance,—as zinc-white has a fine and easily-separated grain, which, consequently, requires but little grinding. Care must be taken that the colour is of sufficient consistence to be laid on a flat surface without showing through; and, consequently, if it be too liquid, it will be necessary to add a sufficient quantity of powder to give it the required consistency, and again grind it; it is then to be put in a clean vessel containing clear water. In this state it may be mixed with any of the ordinary colours, and will be found to make up with any of the colours usually combined with white-lead, producing a fresher tint than when the latter substance is used.

The natural colour of zinc-white is a milk-white, less bright than that of white-lead of the best quality, which inclines to blue, but much superior to that of common white-lead or ceruse; and, therefore, zinc-white may be said to be the medium quality between "kremnitz" and the common white-lead or ceruse generally employed for painting the interior of apartments. Zinc-white may therefore be considered as an efficient substitute for white-lead, without possessing any of its disadvantages.

Paints having zinc-white as their base, do not dry so quickly as lead colours, but they will set more quickly than ochre: the difference in time, as compared with white-lead, is about 2 to 5; and, if it be ground up with oil which is rather old, and not very oleaginous, it will dry as quickly as white-lead.* When mixed with substances that do not dry easily, it will only be necessary to add, as a siccative, a little white copperas (sulphate of zinc); care being taken not to use the oil prepared with lead, usually employed by painters, as it would not only turn the white yellow, but would impart to it the deleterious qualities sought to be avoided by its use; if, however, it is found necessary to use this oil for black or other colours which will not dry, it must be used with caution.

When large surfaces are to be painted, the brushes used must be very soft and not too close, in order that the colour may be laid equally; and, if the first coat be properly laid on, the laying of the second will be unattended with difficulty.

Experience has shown, that about 2½ ounces of zinc-white are sufficient to cover a square yard; while from 4½ to 5 ounces of white-lead, of second quality, are required for this purpose; at the same time, supposing it to be more expensive, this is amply compensated by the certainty that it will not prove injurious, either to those employed in painting, or persons inhabiting apartments painted with it.—*Translated for Newton's London Journal.*

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* By the addition of siccative oil, colours, made with zinc-white, will dry as quickly as ceruse.

HARDENING LIMESTONES.

On the Formation of Hydraulic Limestones, Cements, and other Minerals, in the Moist Way. By Professor KUHLMANN.

The author had some time ago observed that all limestones contain small quantities of alkalies; and he has recently found that, in hydraulic limestones in particular, a very considerable amount of potash occurs.—From this he concluded that the silicate of potash must exercise an essential influence upon the production of cements; and he succeeded in producing artificially hydraulic limestone in the moist way, by mixing lime with silica or alumina dissolved in water containing some potash. When powdered chalk is employed for this purpose, the pasty mass obtained gradually hardens in the air, and attains equal hardness with the very best hydraulic cements. If, on the other hand, chalk in pieces or porous limestone is dipped into a solution of silicate of potash, they acquire, after several days' exposure to the air, such a degree of hardness at the surface that they scratch limestone; they admit of being polished, but it is only with porous stones that the hardening penetrates through the entire mass. This property may be usefully employed in the manufacture of ornaments, as, by judicious treatment, the surface experiences no alteration. The silification may even be employed for obtaining lithographic stones from chalk.

Gypsum is likewise hardened in the same manner, and its decomposition by alkaline silicates takes place far more rapidly and more completely. Crystallised gypsum is only superficially acted upon by it; but when ground and mixed with silicate of potash, it acquires a hard and shining surface. If, too, concentrated solutions are employed, the decomposition is too rapid, and the surface exfoliates after several days' exposure to the air. Oxide of manganese and potash may be employed with the same effect as the silicate of potash. The author ascertained, by experiments, that lime has the property of precipitating metallic oxides dissolved in alkalies; as, for instance, oxide of copper from its solution in ammonia. He observes, on this subject, that in general, every insoluble salt in contact with a saline solution, the acid of which forms with the base of the insoluble salt a still more insoluble combination, produces a decomposition of the salt in solution, which, however, in most cases, is incomplete. Thus white lead precipitates a considerable quantity of chromate of lead from a cold solution of chromate of potash; silicate of potash and chromate of lime yield some silicate of lime, &c.

The author is inclined to suppose that the crystallised silicic acid in the limestone rocks, as also flints, agates, &c., owe their origin to this cause; that they have consequently been formed by the decomposition of the silicate of potash by carbonic acid. In fact, he found, in examining these minerals, that, after ignition and pulverization, they communicated a decidedly alkaline reaction to water. In these siliceous deposits, the two following causes have been principally active:—

1. Decomposition of the earthy carbonates by alkaline silicates, producing earthy silicates, which are decomposed under certain circumstances by water containing carbonic acid, and part with the earths.

2. Direct deposition of silicic acid by decomposition by carbonic acid of the alkaline silicate held in solution in water.

The author finds a confirmation of his view in the circumstance that, besides the minerals previously mentioned, manganese, dolomite, talc, asbestos, emerald, corundum, sulphuret of antimony, &c., contain small quantities of alkalies.—*Ann. de Chim. et de Phys.*

NOTES OF THE MONTH.

Patent Decorative Glass, or Vitrified Lace-Pattern Glass.—The company state that the process and effect produced are perfectly novel, and perfect representations of net or muslin curtains with embroidered borders, correct in every detail, and every description of lace pattern, can be undertaken. The material used for the matt or ground-work is different to that usually employed for the same purpose—is more even in surface, will retain its colour, and cannot in any way be affected by exposure to the atmosphere, and has a semi-transparent appearance, not found in work of a similar character. They consider that for internal decorations, the patent glass possesses a decided advantage over every other description of white ornamented glass, has the same appearance from both sides, does not require the aid of a light behind to show the design; and the ornament stands out in strong relief when viewed by lamp-light. The material can be had as low as 1*s.* 4*d.* per 16 oz.

Cleansing Buildings.—The dingy appearance of buildings in the metropolis is far from creditable, but the expense of cleaning is a great obstacle to improvement. The supposed necessity of scaffolding entails the greater part of the outlay. Lately, Wren's church of St. Michael's, Bassishaw, has been cleansed by Mr. Oldis, builder, of Basinghall-street, at a cost of 30*l.* only, including colouring inside and out from the tower to the ground, and painting doors, &c. Had scaffolding been set up, the cost would have been double; whereas, the cleansing was effected by a running stage worked by a derrick on the roof, with a fall and tackle. It is much to be desired that Bunnett and Corpe's iron shutters were more used, so as to allow the fronts of buildings to be washed down with fire-engines, as the Bank of England is. Part of Mercers' Hall front has just been cleansed by washing. We consider that a good business might be done in cleansing buildings on reasonable terms, as an exclusive employment.

Britannia Bridge.—At the meeting of the Chester and Holyhead Railway Company, held on the 9th ult., Mr. Robert Stephenson made the following report:—"The masonry of this contract is completed as far as practicable, prior to the floating of the tubes; awaiting that operation, the progress of the remainder will depend upon the lifting. In this latter proceeding there has been some delay, owing to an unsoundness in one of the large castings of the new hydraulic press in the Anglesea Tower, which occasioned so much leakage, as threatened at one time to render a new casting necessary, which would have delayed for several weeks the process of lifting the tube, which has been, as you are aware, floated into its position for being raised. I have, however, the satisfaction of reporting that the leakage has been successfully stopped, and that the operation of lifting is progressing, and might by this time have been completed; but I have deemed it prudent to lift by short stages only, and to build up step by step underneath with brickwork, in order effectually to guard against the serious consequences which might arise from any failure or derangement of the hydraulic presses, whilst the tube was suspended from them. Such an accident I believe to be very improbable; but, after the fracture that took place in one of the cross-heads during the lifting of the Conway tubes (which was fortunately discovered in time to prevent a very serious disaster), I do not feel that I should be justified in omitting in the case of the Britannia tube (where a mishap would, in all probability, interfere permanently with the navigation of the Straits) any one expedient which caution can suggest. With these feelings, therefore, I have, with your sanction, resolved to follow the course alluded to, notwithstanding it will protract the time of lifting in each tube a fortnight or three weeks beyond the period originally contemplated. The arrangements for floating the next tube (which, with that already being lifted, will enable us to complete one line of rails across the straits) are in a very forward state, and will certainly be ready by the 24th inst., with a view of taking advantage of the spring tides of the 7th and 10th of September, if it should be deemed expedient to do so. Upon this point I am hardly able to decide positively at this moment, for if any delay should take place from some unforeseen contingency, it may be advisable not to float the next tube until the following spring tides. No great loss of time would ultimately arise out of this postponement, as the interval would be occupied in removing the presses from their present positions into those for lifting the second tube; and some advantage would be gained by lessening the time during which the principal channel for navigation would be interfered with. On the other hand, I think it very desirable not to allow the season to advance further than absolutely necessary before the next floating takes place. This latter consideration appears to me so important that we shall not fail to avail ourselves of the spring tides from the 7th to the 10th of September, if consistent with the further consideration of the circumstances I have mentioned as affecting the question. The present arrangements will, I believe, admit of one line of railway being completed in the course of November. This conclusion is arrived at from the results of our recent experience, and cannot far mislead; but I am bound to add, that the operations are so dependent upon casualties which man cannot control, that the most careful calculations as to time may not be exactly verified. I do not, however, see any reasonable grounds for doubting that one line will be finished throughout by the abovementioned date, or, at the latest, before the end of the year."

Accident at the Britannia Bridge.—The raising of the monster tube of this stupendous bridge to its final resting place is delayed for a month or six weeks, in consequence of the lower part of the cylinder of the huge hydraulic press on the Anglesea side bursting, on the 17th ult., with a tremendous explosion, and in its descent on to the tube, a height of about 84 feet, fell with a terrific crash. The press was at work at the time, and had raised the tube about 3 feet during the lift this day; and had it not been for the urgent and very precautionary means adopted, by packing and bricking under with cement as the tube was being raised, the most dreadful consequences were inevitable. One of the workmen was precipitated from a rope ladder running from the top of the tube to the recess in which the hydraulic machine was fixed; he was struck by the huge mass of iron in its descent, and now lies in a dreadfully crushed state. This most disastrous affair is to be attributed entirely to a defective casting of the cylinder, and the raising of the tube will, consequently, be delayed some time until the completion and fixing of the new one in its place. The tube is now raised about 21 feet above the water.

High Level Bridge at Newcastle.—The high level bridge over the Tyne at Newcastle was opened for the passage of trains on the 22nd ult., the morning mail train south being the first that passed. There is only one line of the permanent rails laid, but the other is in a forward state. The carriage-way is also just approaching completion, and in a few months it is expected the entire structure will be made available for public use. The general character of both mason and metal work of this magnificent structure is of the most solid and substantial kind. The masonwork was let by contract to Messrs. Rush and Lawton, the firm having been extensive contractors on various lines where the works had required strength and solidity in the masonwork, despatch in the execution, and a careful superintendence. These requisites have not been neglected with regard to this noble structure. The contract for the metal and iron work was let to Messrs. Hawks, Crawshay, and Co., in which they were assisted by the firms of Messrs. Losh, Wilson, and Bell, and J. Abbott and Co. The bridge consists of six arches, each having a span of 125 feet, with two curved approaches of about 69 feet in length, formed of cast-iron pillars and bearers, from the design of Mr. R. Stephenson. Messrs. Losh and Co. executed the castings for the approaches, and Messrs. Abbott and Co. the arches. The stipulated price was about 120,000*l.* The arches are circular and made of cast-iron, the whole weight of which is above 6,000 tons. The railway is carried over the backs of the arches in the usual manner; and below this is formed, by suspension, a carriage and foot road for the convenience of vehicles and foot passengers. This portion of the bridge, however, will not be completed in less than another month, the workmen being busily engaged in laying down the wood pavement.

Pesth Suspension Bridge.—The *Mining Journal* observes: "This splendid bridge is generally supposed to have been completely demolished during the recent events of the war operations between the Hungarians and Austrians; but, up to the present time, we are glad to learn, from a correspondent on the spot, no serious damage has been done to the structure. In the first retreat the Austrian army was obliged to make from Pesth, the general gave orders for the destruction of the bridge, and 60 cwt. of powder were placed on it, 30 cwt. on each side, or under the chains, with the view of breaking them. Both charges were fired at the same time; the person who superintended the arrangements and fired the charges, was literally dashed in pieces. The effect it produced on the bridge was the breaking down of the road, which consists of transverse cast-iron bearers, to a considerable extent. The vibration of the chains was very great, and continued for some length of time; but after the retreat of the Austrians the bridge was again repaired. The Hungarians, however, were obliged again to retreat over the bridge, when Dembinski gave orders for its destruction. Mr. Clark, at Pesth, went to Dembinski, and remonstrated with him, and told him that it would be nothing to his credit, as a general, to destroy so fine a structure. The general told Mr. Clark that his orders were peremptory, but after a great deal of negociation, he consented that some of the bearers should be taken down, and put into boats, and taken down to the Island of Schntt, the boats to be scuttled, and sunk in deep water; this was done. Then came the Russian and Austrian armies, when the bearers were taken up, and the bridge again repaired."

Lighthouse Lamps and Reflectors.—A very interesting experimental trial of the powers of several lighthouse reflectors took place on the evening of Friday the 17th ult., at Woolwich, under the direction of the Trinity House, and, we believe, at the request of the Board of Admiralty. The lamps and reflectors tried were those in ordinary use by the Trinity House, and two others on plans of the invention of Mr. A. Gordon. The Trinity House lights, manufactured by Messrs. Wilkins, of Long Acre, are used in nearly all the lighthouses of the kingdom; the reflector is parabolic in form, and the one tried was 22 inches in diameter, and 9 inches in depth; the lamp of the Argand construction, at 3¼ focal distance. One of Mr. Gordon's apparatus consisted of a reflector of the hyperbola form, 22 inches in depth, and 19 in diameter, with Argand lamp at 1⅛ focal distance; and the other of Mr. Gordon's lights has, in addition, four annular glass refractors. The lamps were lighted at half-past eight, on the upper story of the Royal Marine Barracks, and the power of the lights directed to the village of Rainham, in Essex, a distance of about 6½ miles, at which place, the gentlemen to whom was confided the task of reporting on the efficiency of the respective apparatus, were assembled. It appeared to be the almost unanimous opinion of the witnesses of the experiments that the Trinity House light was the best on the whole: for although Mr. Gordon's *lens* apparatus was certainly equal to the other when seen in a direct line, it was inferior when tried at an angle of 7 degrees of divergence from the line of observation; and that, without the lens, was not equal in any point of view to the ordinary reflectors. The cost, also, we are informed, would be in favour of the parabolic reflector.

Lighthouse, Cape Pine, Newfoundland.—There was lately exhibited at the premises of Messrs. De Ville, and Co., 367 Strand, the lantern and lighting apparatus for the lighthouse about to be constructed at Cape Pine, in Newfoundland. The dense fogs and sudden changes of temperature to which that coast is liable, make it a matter of great importance, not only that such a work should be erected, but that it should be of the most efficient character. Accordingly, the present apparatus has been prepared by the authority of the Admiralty, under the direction of Mr. Alexander Gordon, whose talent in this respect has already been thoroughly established by the lighthouses erected by him at Jamaica, Bermuda, Point de Galle, Ceylon, and elsewhere. In the present lanterns, Mr. Gordon has introduced an important alteration—viz., that of making the reflector more concave, securing thereby a more powerful light. The tower is to be of cast-iron, and, with everything connected with it, has been constructed in this country. Although the order for the work was not given till the 23rd of April last, the whole will be exhibited, 320 feet above the sea, on the headland of Cape Pine, during the autumn. This despatch is the more extraordinary, considering the difficulty of access to the site of the lighthouse, there being neither road nor harbour, and the surrounding district being uninhabited except by a few wreckers. Mr. Gordon has united with the revolving light of the tower a new and ingeniously constructed screaming apparatus, the invention of, and patented by Mr. George Wells, to act as a fog signal, instead of by guns, bells, and gongs, which have hitherto been used for that purpose, but the sound of which too nearly resembles that of the waves on a stormy coast to render them really serviceable.

The Northern Artesian Well, near Southampton, has now been bored to 353 feet in depth. The progress has been impeded by a stone 22 inches thick, and the supply of water has decreased through decay of the rods.

The Pacific Steam-Navigation Company.—A magnificent iron steam-ship the 'Bolivia,' has been launched from Mr. Napier's building yards at Govan. She has been built for the Pacific Steam-Navigation Company, to ply between Valparaiso and Panama. She is 200 feet in length, and 27 feet beam, and measures 773 tons burden. She is on the paddle wheel principle, and will be propelled by side-lever engines of 300-horse power. There are some peculiarities in the construction worth mentioning. There is a full poop 60 feet long; between the paddle-boxes there is a hurricane-deck, and in front a top-gallant forecastle. These three decks are 7 ft. 6 in. above the main-deck, and are connected together by gangways. Ample promenading room is thus afforded on the main-deck, sheltered from storms or oppressive heats.

Steam Screw Apparatus.—The General Screw Steam Shipping Company's new ship, the 'Bosphorus,' fitted with engines by Messrs. Maudslay and Field, lately made a trial of her speed. The result was considered as the most satisfactory that has ever yet been known under similar circumstances. The following are the particulars:—The dimensions of the ship are—Length, 175 feet: breadth 25 feet; measuring in tons, 531 feet; horse power, 80; diameter of cylinder, 36 inches; stroke, 24 inches; diameter of screw, 10 ft. 6 in.; pitch, 18 ft. 6 in.; mean revolutions, 62·2; length of engine-room, 30 feet, which includes a space for the stowage of 150 tons of coals; draught of water on trial, forward, 6 ft. 8 in., aft 9 ft. 6 in., the screw propeller being 14 inches out of the water. The trials of the measured knot were—

First Knot	5	min.	10	sec.,	equal to	10·286
Second ditto	6	„	21	„	„	9·448
Third ditto	6	„	4	„	„	9·890
Fourth ditto	6	„	9	„	„	9·756
Fifth ditto	6	„	54	„	„	8·695

giving a mean speed of ship, in knots, 9·679; speed of screw, 11·348; slip in knots, 1·669; or 14·7 per cent. The 'Bosphorus' left Blackwall about 1 p.m., and proceeded in capital style down the river, the wind at the time blowing hard from the south-west.

English-built War-Steamers for the Austrian Government.—It is stated that some time ago, the Austrian government ordered the building of three large and powerful steam men-of-war at Bristol. The contract for the structure of these vessels was taken by Messrs. Patteson and Co., ship-builders of that port, who immediately proceeded to the execution of their engagement. The greatest despatch was used in the construction of the first steamer, which was launched a few days ago; her equipment for sea is now progressing rapidly. The two other vessels, which are of large tonnage and power, are building in the yard of the contractors, near the Princes-street bridge.

Self-Heating Shot for War Purposes.—"We saw, the other day," says the 'Glasgow Chronicle,' "in the establishment of Mr. Field, tin-plate worker, Argyll-street, a peculiar and apparently most valuable mode of obtaining red-hot shot for large guns. It is the invention of Mr. Scoulier, the foreman in Mr. Field's workshop, and consists in the filling the hollow shot with a highly-combustible powder, the composition of which we are not yet at liberty to make public. Two or three fuse-holes are made in the shot, so that, when fired from the piece, ignition takes place, and the shot is made red-hot before it arrives at its destination. In the trial we saw, the shot, which was about 2¼ inches diameter, was simply laid on the ground, and the composition was ignited by a light applied to the fuse-hole. Violent combustion immediately ensued—liquid fire appeared to stream from its three fuse-holes, and the material became quite red-hot in a few seconds. The inventor states that, when fired from a gun, a red heat will be attained in less than 20 seconds from its leaving its mouth. The composition will burn under water. It is easily made, and there is little doubt as to its efficiency for war purposes, in place of the present expensive and troublesome system of heating, the shot being put into a gun in a cold state, as with ordinary solid balls.

Liquid Glue.—Messrs. Neuber and Watkins have invented an improved liquid glue, which has the advantage of being stronger than the ordinary glue, and is always ready. It will unite almost every description of material, whether it be wood, iron, or plaster.

Improved Method of Tempering Edge Tools.—The 'Scientific American' gives the following process for heating axes or other similar articles:—"A heating furnace is constructed, in the form of a vertical cylinder, the exterior made of sheet-iron, lined with fire brick, 4 ft. 8 in. diameter, or of such outside diameter as to give it an inside one of 4 feet and 3 feet high. In the interior of this cylinder, several fire chambers are formed—usually four. The inner wall of each fire chamber is 18 inches long, 4 inches from front to back, and about 4 inches in depth—forming, in the whole, a circle of 3 ft. 4 in. diameter. Under each there are grate-bars, and air is supplied through a pipe connected with a blowing apparatus. A circular table of cast-iron, 3 ft. 4 in. diameter, is made to revolve slowly on the level with the upper part of the said chamber. This chamber is sustained on a central shaft, which passes down through the furnace, and has its bearing in a step below it; a pulley keyed on to it serves to communicate rotatory motion to the table. When the axes or other articles are to be heated, they are placed upon the table, with their bits or steeled parts projecting so far over its edge as to bring them directly over the centre of the fire, and the table is kept slowly revolving during the whole time of heating. When duly heated, they are ready for the process of hardening. The hardening bath consists of a circular vat of salt water; within the tub or vat, a little above the surface of the liquid, is a wheel, mounted horizontally with a number of hooks around the periphery, upon which the axes or other articles are suspended. The height of the hooks from the surface of the liquid is such as to allow the steeled part only to be immersed. As soon as the hardening is effected, the articles are removed from the hooks, and cooled by dipping in cold water. With the best cast steel, a temperature of 510° Fahr. has been found to produce a good result, in hardening in about 45 minutes."

Evaporation.—The *Bombay Times* of the 25th of April, contains a report of the monthly meeting of the Geographical Society of Bombay. The secretary, Dr. G. Buist, made an interesting communication on a method adopted by him for ascertaining the heat of, and evaporation from, the soil. The objects and details of the experiment are stated to be as follows:—"As the evaporation from a shallow dish of water exposed to the sun, and liable to be raised to a temperature of 100° or 120°, gives no idea whatever of the amount of evaporation from the surface of the sea, large pools, or lakes, which vary but little in temperature, he was anxious to determine the amount of evaporation from the surface of wet earth compared with that from the surface of a considerable mass of water. With this view, two zinc cylinders were prepared, 3 feet in length and 4 inches in diameter, and secured by a strong brass ring at the top and bottom, carefully turned. These contained fifteen pounds, or a gallon and a half of water each, temperature 82°, or nineteen pounds of the loose red earth to be found associated with trap rock. When filled with earth well shaken down they were able to take in six and a half pounds of water to overflowing. Each was provided with a glass tube ½-inch bore, connected with the bottom of the cylinder, and running parallel with it to the top: this was intended to show how high the water stood inside. The tubes were provided with scales divided into inches and tenths from top to bottom. On filling one of them with earth, and then adding water till it flowed over, that in the tube of course decreased rapidly by evaporation—but, strange to tell, after continuing to descend from noon till daybreak, it commenced immediately to rise again till 11 a.m., remaining motionless till 1 p.m., when it began to sink, and so continued descending till about an hour after sunrise, when it commenced immediately to rise, and so continued till the same hour as during the preceding day. This had gone on regularly for four days:—each day it sank from 2 to 3 inches, and only rose half as much; the fluctuation was in all respects most perfectly regular and symmetrical."—The importance of an inquiry of this kind extended over several years and wide districts is great; and the simplicity of this arrangement appears to recommend it to the attention of all who are in any way interested in solving the problems that connect themselves with meteorological phenomena."

Painting without Smell.—A bottle of sweet oil of turpentine has been sent to us for our inspection. It appears to possess the merits, when used with white lead, of being free from smell; and at the same time, the colour, when mixed with it, is improved in appearance.

Stucco Colouring and Whitewash.—The following recipe is used for preparing the celebrated stucco whitewash, used in the United States on the east end of the President's house, at Washington. Take half-a bushel of good unslacked lime, slack it with boiling water, covering it during the process to keep in the steam. Strain the liquor through a fine sieve or strainer, and add to it a peck of clean salt, previously dissolved in warm water, three pounds of good rice, ground to a thin paste, and stirred while boiling hot; half-a-pound of powdered Spanish whiting, and a pound of clean glue, which has been previously dissolved by first soaking it well, and then hanging it over a slow fire in a small kettle, within a large one filled with water. Add five gallons of hot water to the whole mixture; stir it well, and let it stand a few days, covered from dirt. It should be put on quite hot; for this purpose it can be kept in a kettle on a portable furnace. It is said that about one pint of this mixture will cover a square yard upon the outside of a house, if properly applied. Brushes more or less small may be used, according to the neatness of the job required. It retains its brilliancy for many years. There is nothing of the kind that will compare with it, either for inside or outside walls. Any required tinge can be given to the preparation, by the addition of colouring matter.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM JULY 24, TO AUGUST 23, 1849.

Six Months allowed for Enrolment, unless otherwise expressed.

George Fellowes Harrington, of Plymouth, dentist, for improvements in the manufacture of artificial teeth, and the beds and palates for teeth.—Sealed August 1.

Florentin Joseph De Cavaillon, of Paris, chemist, for certain improvements in obtaining carburetted hydrogen gas, and in applying the products therefrom to various useful purposes—August 1.

Jerome Andre Dries, of Manchester, machinist, for certain improvements in the manufacture of wearing apparel, and in the machinery or apparatus connected therewith.—August 1.

Thomas Potts, of Birmingham, Warwick, manufacturer, for improvements in apparatus used with curtains, blinds, maps, and plans.—August 1.

Benjamin Thompson, of Newcastle-upon-Tyne civil engineer, for improvements in the manufacture of iron.—August 1.

William Greves, of Battle-bridge, saw-mill proprietor, for improvements in the manufacture of boxes for matches, and other purposes.—August 1.

Julian Edward Disbrowe Rodgers, of High-street, Pimlico, Middlesex, professor of chemistry, for improvements in the manufacture of white lead.—August 1.

David Harcourt, of Birmingham, for improvements in vices, and in the manufacture of hinges; and also in apparatus for dressing and finishing articles made of metal.—Aug. 1.

Adam Yule, of Dundee, master mariner, and John Chanter, of Lloyds, gentleman, for improvements in the preparation of materials for coating ships and other vessels.—August 1.

Richard Kemsley Day, of Stratford, Essex, hydrofuse manufacturer, for improvements in the manufacture of emery paper, emery cloth, and other scouring fabrics.—August 1.

John Shaw, of Glossop, musical instrument maker, for certain improvements in air-guns.—August 1.

Augustus Roelm, of Paris, gentleman, for improvements in making roads and ways; and in covering the floors of court-yards, buildings and other similar places.—August 1.

James Murdoch, of Staples'-inn, mechanical draughtsman, for certain improvements in converting sea-water into fresh, and in ventilating ships and other vessels; applicable also to the evaporation of liquids, and to the concentration and crystallisation of syrups and saline solutions. (A communication.)—August 1.

John Parkinson, of Bury, Lancaster, brass founder, for improvements in machinery or apparatus for measuring and registering the flow of liquids.—August 1.

Benjamin Aingworth, of Birmingham, button-maker, for improvements in ornamenting iron and other metals, for use in the manufacture of gun-barrels, and all other articles to which the same ornamented metals may be applied.—August 1.

David Clovis Knab, of Leicester-place, civil engineer, for an improved apparatus for distilling fatty and oily matters.—August 1.

William Thomas, of Cheapside, merchant, and John Marsh, foreman to the said William Thomas, for improvements in the manufacture of looped fabrics, stays, and other parts of dress; also in apparatus for measuring.—August 9.

Arthur Howe Holdsworth, of the Beacon, Dartmouth, esquire, for improvements in the construction of marine boilers, and funnels of steamboats and vessels.—August 9.

William Furness, of Lawton-street, Liverpool, builder, for improvements in machinery for cutting, planeing, moulding, dovetailing, boring, mortising, tongueing, grooving, and sawing wood; also for sharpening and grinding tools, or surfaces; and also in welding steel to cast iron.—August 9.

John Knowlys, of Heysham Tower, near Lancaster, esquire, for improvements in the application and combination of mineral and vegetable products; also in obtaining products from mineral and vegetable substances, and in the generation and application of heat.—August 9.

Alfred Vincent Newton, of Chancery lane, mechanical draughtsman, for improvements in derricks for raising heavy bodies. (A communication.)—August 9.

John Ruthven, of Edinburgh, civil engineer, for improvements in propelling and navigating ships, vessels, or boats, by steam and other powers. (A communication.)—August 10.

Arthur Dunn, of Worcester, soap maker, for improvements in making soap.—August 16.

Frederick William Bodmer, of Paris, civil engineer, for certain improvements in machinery or apparatus for letter-press printing.—August 16.

Richard Archibald Brooman, of Fleet-street, London, for improvements in machinery, apparatus, and processes for extracting, depurating, forming, drying, and evaporating substances.—August 16.

Jonathan Blake, of Mount Pleasant, Eaton, Norwich, surgeon, for certain improvements in lamps.—August 16.

James Young, of Manchester, manufacturing chemist, for improvements in the treatment of certain ores and other matters containing metals, and in obtaining products therefrom.—August 16.

Louis Lemaitre, late of Paris, in the Republic of France, but now of the Hotel de l'Univers, Blackfriars, engineer, for improvements in the manufacture of ferules, for fixing the tubes of locomotive and other boilers.—August 16.

Charles Cowper, of Southampton-buildings, Middlesex, for improvements in machinery for raising and lowering weights and persons in mines; and in the arrangement and construction of steam-engines employed to put in motion such machinery, parts of which improvements are applicable to steam-engines generally. (A communication.)—August 23.

Frederick Chamier, of Warwick-street, Middlesex, commander in the Royal Navy, for improvements in the manufacture of ships' blocks. (A communication.)—August 23.

William Edward Newton, of London, civil engineer, for certain improvements in steam boilers. (A communication.)—August 23.

Alfred Vincent Newton, of London, mechanical draughtsman, for improvements in manufacturing and refining sugar. (A communication.)—August 23.

CANDIDUS'S NOTE-BOOK,

FASCICULUS XCVIII.

> " I must have liberty
> Withal, as large a charter as the winds,
> To blow on whom I please."

I. Much mischief has been done by attempting—futile as such attempt in itself is—to lay down express rules for almost everything in architectural design. Were mere rules all-sufficient, the art would be converted into mere handicraft, and there would be no occasion for architects at all, but only for builders and their operatives. There has been by far too much of what, though it may at first sight look very sagacious and profound in the speculations or the reasonings of architectural writers, is very little better than arrant quackery in point of practice, or mere verbose vapouring in point of doctrine. He who trusts implicitly to rules, or who adheres to them merely because he knows not how or when they may be deviated from not only excusably but successfully, can never be more than second-rate in Art, let the particular art to which he applies himself be what it may. But the idol set up for our worship at the present day is Precedent; and to that architects bow down and surrender up, if not always voluntarily yet at the bidding of their task-masters, all energy of mind and all inventive power,—rendering themselves little better than mere automata which are moved by the clockwork of precedent and rules. Vain is it to look for originality and imagination so long as they continue to be *tabooed* and prohibited, if not formally and expressly yet virtually, by a superstitious reverence for Precedent.

II. At a banquet lately given at the Mansion-House, some one—I will not say who—observed that an architect ought to possess universal talent in his art, he being one day called upon to design a palace, and perhaps the next to erect a hovel! We all know that after-dinner speechifying is sure to produce a good deal of twaddle and nonsense, but my Lord Mayor's wine must have been unusually potent to produce such an effusion as that. Now, it is fairly to be presumed that those who build hovels are never applied to when a palace or palatial edifice is required: indeed, it may be questioned whether an architect is ever employed at all when no more than a hovel is wanted. Whether it would not have been more satisfactory to those who pay for palaces—at any rate for *royal* ones—had the architects engaged been building hovels instead, is another matter.—With regard to the sapient speech here commented upon, it would be just as sensible to say that a poet must be equally prepared to produce an epic or an epigram, just as the one or the other may be demanded of him,—to produce, one day, lofty Miltonic strains, and on another an advertisement in rhyme for the Moses of the Minories. Surely, too, there are different walks in architecture as well as in all other arts, in any one of which he who follows that one in particular may excel, although he might fail in others; for it is not every one who, like Sir Robert Smirke, is equally great in all subjects alike, be they Post-Offices or British Museums——but I will leave my readers to guess what it might not be exactly becoming to say of so great an architect, and moreover a living one, although I presume now quite defunct—professionally. And at that I weep not, but leave those to weep who can, and who have tears at command—perhaps a thumb-phial would contain them all.

III. It has been well said by Ruskin, that the young architect should learn to think in shadow,—to which I add: and to think in *perspective* also, and should study how to bring in piquant effects arising out of it. Instead of which, study of that kind seems to be quite neglected—or rather never thought of. I do not say that architects are ignorant of perspective;—most of them, it may be presumed, are fully capable of making perspective drawings from their own designs; yet that is a very different matter from consulting and providing for ultimate perspective appearance while making the designs themselves. If there be any happy effect of the kind, it comes of its own accord, unsought and unsolicited. No wonder, therefore, that there is generally so much tameness and insipidity in what, when looked at as mere "elevations" upon paper, and with regard to their details and mere *pattern-work*, may have promised well enough, yet afterwards fall very far short of such promise. I would advise the young architect to think first of all of his general composition—secure character and effect there; and then, and not till then, begin to think of *dressing* it by working it up in detail;—whereas now, detail, and that alone, so as to answer to some foregone if not bygone style, appears to be chiefly thought of. Here, to the seniors in the profession I would say: my good Sirs, put on your spectacles; but to the juniors: *open your eyes*, and avail yourselves, while you can and as far as you can, of the blessing of unimpaired vision—vision which is or ought to be unobstructed, ought not to be blindfolded by routinier methods, which tend to exclude all freshness of ideas, and to prevent all diligent and well-considered study of the actual subject.

IV. At the time of the competition for the Army and Navy Clubhouse, it was remarked in one publication that the opportunities afforded by buildings of that class for introducing piquant effects and combinations of plan, and ingeniously varied forms of rooms, were not turned to account. Nor is it to be denied that such is the case; for among those in all our clubhouses there is not one circular, octagon, or hexagonal apartment to be found, much less one which exhibits any of the countless variations which may be obtained by those forms partially in combination with others. However spacious and lofty the rooms may be, they betray, in point of architectural contrivance and design, only the most quotidian, not to say humdrum, ideas. A couple of columns *in antis* at the ends of a long room, with perhaps some pilasters on its sides, are made the *ne plus ultra* of their architecture; and even that is merely borrowed from the standard Orders, instead of being made to display some well-devised difference of treatment between orders so applied and those employed externally. As to mere decoration and costly furniture,—as to gilding and painting, window draperies, mirrors, chandeliers, and candelabra, there may be enough, and perhaps a great deal to spare also; yet, such paraphernalia, *alias toggery*, may, provided people choose to pay for it, be bestowed on any large room—even a mere barn. "What do you think of these hangings?" was a question once put to one who replied: "Before you hung this room you should have hanged your architect."—Professional men, that is architects, are apt to turn up their noses at decorators and upholsterers, somewhat ungraciously and ungratefully too, since, as matters now go, it is they who clothe and cover the nakedness of an architect's ideas for his interior. Were it not for such allies to architects, we should get nothing more than four bare walls for each room,—quite enough in ordinary houses, but infinitely too little in palatial mansions and palatial clubhouses.

V. It was but yesterday that I heard the entrance doors of the British Museum compared to those of a gin-palace, with no other difference than that of being *magnified*,—a very different matter, by-the-bye, from being made magnificent; and in like manner, I should say, that as far as interior architecture is concerned, many of our clubhouses are no better than amplified and magnified taverns. So far from showing anything like contrivance, or even ordinary attention to the requirements of mere convenience, some of them manifest the most unpardonable carelessness of plan. There is, for instance, the "Athenæum," nearly one-half of whose Pall-Mall front is, on the ground-floor, devoted to that most unsavoury of goddesses, Cloacina—in plain English, is given up to water-closets! The "Union" is both Smirkish and sulky within and without; the "Arthur" is most wretchedly planned; and the "Army and Navy" will be humdrum in the extreme. From a published plan of it may be seen, that instead of corresponding in its width with the loggia, the vestibule takes in only the door and the window on one side of it; the other window serving to light what, though only a closet, 7 feet by 10, and which we at first supposed to be intended for the porter, is dignified by the pompous name of the Reception-room! Yet, although there is only a door and window on that side of the vestibule by which we enter, the opposite one is divided into three arches, in such manner that the door is in a line with one of the piers! Beyond those three openings is the Inner Hall, in which is the staircase, placed not at its further end so as to be seen directly in front on entering, but turned *sideways*, whereby the first flight not only cuts up the space, but leaves no more than barely room to pass by it. On the opposite side is the door leading into the Coffee-room; but which, instead of directly facing the first flight of the staircase, is put just a little on one side, so as to be also out of the axis or centre of that wall. Nor can that offensive architectural blunder be a mere error in the drawing, because in the Coffee-room itself that door comes in a line with one of the chimney-pieces on the opposite side of tha room. Taken altogether, the plan is excessively poor; but such exceedingly gross blundering as that just pointed out would be unpardonable even in a Pecksniff.

THE BRITISH MUSEUM.

Whether the British Museum be altogether so defective in point of accommodation as Mr. Fergusson represents it, or not, certain it is, that any further increase of accommodation—and it is already beginning to be required—is rendered impracticable, in consequence of so much space that might have been rendered available being now so disposed of that it cannot be built upon at all. It is somewhat extraordinary that the great advantage, both architecturally and otherwise, that might have been derived from bringing the principal portico and general line of front nearly up to the street, so as to be in advance of the main body of the edifice, which being completely shut out from view, might then have been wholly, as it is now partially, of brick,—it is extraordinary, we say, that it should not have struck if not Sir Robert Smirke himself, at least some one or other among those to whom he submitted his designs.

It was not too late even when the present façade was about to be commenced, to adopt such plan, for it would not at all have interfered with the general plan as now executed, although it would greatly have enlarged and otherwise improved it; and galleries and rooms which are now complained of as being imperfectly lighted owing to there being colonnades before them, would have been relieved from such obstructions. Unluckily, however, it was then deemed advisable by many-headed wisdom not to comply with the demand for the model of the intended façade being exhibited to the public; although, however impertinent the demand itself was, the refusal was infinitely more ungracious, if nothing worse. The Trustees were sulky—were determined to stave off criticism as long as they possibly could, and by such manœuvring have now got a very sulky-looking though would-be-classical structure, which criticism treats very unceremoniously, and not without reason.

Some time ago, an idea was shown in this *Journal*—not very satisfactorily, indeed—for imparting greater variety and dignity to the colonnaded façade, by making the central octastyle of the Corinthian order, and carrying it up higher than the rest. Yet, as it happens, it is perhaps better that Smirke's design was adhered to, unless alteration had been extended a great deal further. To make anything consistently grand and of uniformly classical character with the dwelling-houses which he has planted out as wings—and in which the donkey-ears of Cockneyism stick out from the lion's hide of Hellenic Ionicism, at once ludicrously and lamentably,—would have been impossible. If the present façade be not a wretchedly bad composition, it can be only because it is no composition at all, but a mere jumbling together of architectural incoherences, and some of them of an exceedingly prosy and prosaic kind. It will, perhaps, be said, that its poetry is to come, for we are told that the pediment is to be filled-in with sculpture, and will have statues placed upon it as acroteria. And when that shall have been done, all the rest will look poorer and more insipid than it does now, and the general composition—so to call it—will show of more patchwork character than ever. Hardly will a sculptured pediment serve to reconcile us better than at present to the architectural sluttishness of letting a brick carcase and sundry little excrescences that are anything but decorative or dignified, come into sight along with the façade. In all the views which have been published of the Museum, those offensive eyesores have of course been kept out of sight; and not they alone, but also what ought to have been—and what perhaps, the architect himself takes, or rather took to be, sufficiently worthy features in the *ensemble*—viz., the official residences, which even considered in themselves are so exceedingly *jejune* in point of design, that should, as is by no means unlikely, the opposite houses be in course of time rebuilt with any aim at architectural display, those wings will look more insignificant than ever.

Let it not be thought that we merely abuse, and that perhaps somewhat spitefully, the façade of the British Museum: condemn it we certainly do, and most decidedly too, but not without pointing out its serious and now irremediable defects and shortcomings, which, most unluckily, is all that can now be done, and which ought to be done, in order to prevent another fine opportunity—though one equally fine is not likely to present itself for a long time to come—from being thrown away in a similar manner. And even the Museum will, all unsatisfactory as it is, be instructive, if we profit by the errors and mistakes there committed.

Mr. Fergusson has said: "I never found fault without satisfying myself that I could do better;" and we proceed also to justify our heavy censure of the façade of the Museum by submitting to our readers an idea of our own, which we surrender up to *their* criticism.—The general line of the façade should have been brought up to the street—that is, within a few feet of the foot pavement, or as far as the extreme wings now are; and have been made to form a nearly continuous range of building, 570 feet in extent, composed of two wings running east and west, and leaving a space of about 200 feet wide between them, where the centre of the composition would have retired about 50 feet backwarder, and would have presented a magnificent Corinthian octastyle connected with the wings by curved screen colonnades of the Ionic order, which would have been that of the wings, exhibited in two tetrastyle porticoes directly facing each other, consequently at right angles to the principal one, whereby the three pediments so disposed would have combined and contrasted with each other in an equally novel and picturesque manner, and would have produced a happy play of perspective. We would have given 50 feet* to the height of the Corinthian columns, and made that also the entire height of the secondary, or Ionic order; so that the diameter of the columns in both orders would have been alike—viz., 5 feet; and the intercolumns also equal throughout. Some—we might say many—perhaps, will object to the associating two distinct orders together in the same composition; yet, those who can tolerate an Ionic and Corinthian order combined together by the latter being placed *over* the former instead of by the side of it, or who do not feel scandalised by the licentiousness of the Greeks, who made no scruple of placing Ionic columns behind Doric ones, cannot possibly with any consistency object to the marrying together two different orders; or if they require a positive precedent for it, they may find one—such as it is, in the Ecole de Medicine at Paris, where a Corinthian and Ionic order—such as they are—are intermingled with each other, yet by no means very happily, although that piece of architecture is one of considerable reputation—the Ionic columns being continued within the prostyle, notwithstanding that they are not much above half the diameter of the Corinthian ones which come immediately before them. Besides which, not only is the prostyle itself so exceedingly shallow, that it is scarcely entitled to be called one, but both character and effect are greatly injured, if not destroyed, by the addition of an upper story whose cornice is in continuation of that of the larger order, and whose windows, disproportionably large in themselves, rise considerably higher than the architrave of the Corinthian entablature, in consequence of which, the hexastyle beneath the pediment has the look of being depressed; whereas, had that upper story been a low attic one, carried up only to the level of the tops of the capitals of the larger order, the latter would have acquired that nobleness and energy of expression which, though aimed at for it, have been missed.

Should the immediately preceding remarks be thought both an ill-timed digression and valueless in themselves, we leave them to be set down as impertinent without pleading for their excusation; and proceed further to explain our very visionary scheme, *alias* dream of what might have been.

The treatment here suggested would, we conceive, have secured for the central octastyle of the Museum an unusual degree, not only of positive loftiness, but of relative loftiness also. The whole would have been upon a dignified scale, the columns of the lesser or Ionic order being 40 feet high, which, though about 5 feet lower than those of the present façade, would have been of the same diameter—somewhat less lanky of course, yet, as to height, rather above than at all below the average. Into many and various particulars of detail and decoration we are unable to enter, because they would be scarcely understood unless exhibited in a drawing, therefore must leave it to be judged whether, independently of the great advantage gained by leaving space behind the wings† for additional buildings, should they be required,—such a general arrangement, presenting a decided architectural focus, with both richness of columniation, and diversity of it, and with three porticoes grouped together in the manner described, would not have been decidedly superior to what we have now got. Whatever may be alleged against it, it must be allowed that it would be stamped by consistency of design, by largeness of man-

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* Such dimensions may be appreciated by comparison with the following:—

Inigo Jones' Corinthian portico at Old St. Paul's	45	feet.
Portico of the Assize Courts, Liverpool	45	"
Portico of the Royal Exchange	45	"
Portico of the British Museum	45	"

The columns of our Ionic order would have been 5 feet less than those of the present building; yet for those of a secondary order that height would be no inconsiderable one.

† By the portico being advanced, a spacious entrance hall would be obtained between that and the main body of the Museum; and beyond that,—provided the works had not been at the time too far advanced to admit of such alteration being made—the principal staircase might have been placed, and the space now occupied by the staircase would have formed an additional gallery lighted from its north side. It may be further observed that our side colonnades would have formed a communication between the three porticoes, whereas those of the present façade are in the predicament of "passages that lead to nothing."

ner, and by grandiosity carried on throughout. The composition itself also would be strikingly novel,—at least, we know of no similar one among all the numerous buildings or designs with which we are acquainted.

To look now to ourselves, it will probably be said that our idea, containing as it does a central portico, with columns 50 feet high,—or about three more than those of the Pantheon at Rome,—is, to say nothing of the panels of reliefs for the wings, somewhat extravagant. In our opinion, far greater extravagance, with nothing at all adequate to show for it, has now been committed. In the first place, an inner court, which might just as well have been, like the body of the edifice, entirely of plain brick-work, has been faced with stone, to the extent altogether of upwards of 1,100 feet; and there also are hidden no fewer than 16 engaged columns and 12 antæ, which, with the columns and pilasters of the façade, and the pilasters between the windows of the *houses* or external wings, make altogether no fewer than *one hundred and twenty-six* columns, antæ, and pilasters; whereas our design would require no more than *forty-four*. Again, as to length of ashlar wall, there is now altogether, the inner court included, about 2,400 feet, and in ours not more than 1,000, or thereabouts. Still, taking into account the greater degree of richness and finish bestowed upon it, we do not suppose that there would have been any saving at all as to mere cost, but we may safely assert that there would have been infinitely more to show for the money; which is infinitely more than can be said of the present structure, for, considering what the occasion demanded and the opportunity afforded, it is upon the whole the most prosaic and soulless production of modern times, with the single exception, perhaps, of that minikin mass of *mesquinerie* hight Buckingham Palace. O, England! put not thy confidence in princes—at least, not in matters of taste; and beware of trusting in future to the sapience and the taste of Trustees.

C.

DISCHARGE OF WATER FROM RESERVOIR

The Theory of the Contraction of the Movement of Water flowing from Apertures in thin Plates, in a Reservoir in which the Surface of the Water is maintained at a constant altitude. By J. BAYER, Lieutenant. (Translated for this *Journal* from Crelle's '*Journal für die Baukunst.*' Band 25.)

(*Continued from page* 264.)

When H = 0, the upper edge of these orifices is on the surface of the water, and

$$h. \qquad Q = k'\sqrt{(4gl)}\,.\,\tfrac{2}{3}\,l^2.$$

Expand in the equation (d) the power $(H + b)^{\frac{3}{2}}$ in a series, and we have

$$\tfrac{2}{3}\left\{(H+b)^{\frac{3}{2}} - H^{\frac{3}{2}}\right\} = b\left(H^{\frac{1}{2}} + \frac{b}{4H^{\frac{1}{2}}} - \frac{b^2}{24H^{\frac{3}{2}}} + \frac{b^3}{64H^{\frac{5}{2}}}\ldots\ldots\right)$$

$$= b\left(\sqrt{(H+\tfrac{1}{2}b)} - \frac{b^2}{96H^{\frac{3}{2}}} + \frac{b^3}{128H^{\frac{5}{2}}}\ldots\ldots\right)$$

Neglecting the other terms, we have approximately—

$$i. \qquad Q = k'bl\sqrt{(4g)}\;\sqrt{(H + \tfrac{1}{2}b)}.$$

This is the formula commonly adopted: it gives, however, the quantity of discharge generally too large, and is applicable only when the values of b and H are so related that the neglected terms disappear; in practice, however, this occurs when the value of H is not very small.

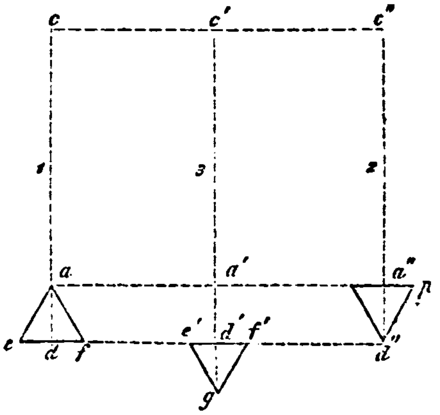
When in equation (b) $m = 0$, the orifice is a triangle (fig. 1), of which the height $b = ad$, and the base $l = ef$; and in this case we have for the quantity of discharge

$$k \qquad Q = k'\sqrt{(4g)}\,.\,\tfrac{2}{3}\,l\left\{(H+b)^{\frac{3}{2}} + \tfrac{2}{5}\,.\,\frac{H^{\frac{5}{2}} - (H+b)^{\frac{5}{2}}}{b}\right\}$$

When H = 0, the vertex of the triangle is in the surface of the water, and

$$l. \qquad Q = k'\sqrt{(4gb)}\,\tfrac{2}{3}\,.\,\tfrac{3}{5}\,bl.$$

From equations (l and e), it follows that the quantity of discharge through a triangle is ⅗ as large as that through a rectangle which has a base and altitude equal to those of the triangle, when the vertex of the triangle and the upper side of the rectangle are in the surface of the water.



If in equation (b) $l = 0$, the orifice will also be a triangle, but in an inverted position (fig. 2). The altitude is the same, b, which here $= a''d''$, and the base $m = op$. The quantity of discharge is

$$m. \qquad Q = k'\sqrt{(4g)}\,.\,\tfrac{2}{3}\,m\left\{\frac{2}{5}\,.\,\frac{(H+b)^{\frac{5}{2}} - H^{\frac{5}{2}}}{b} - H^{\frac{3}{2}}\right\}.$$

When H = 0, the base m is in the surface of the water, and we have

$$n. \qquad Q = k'\sqrt{(4gb)}\,.\,\tfrac{2}{3}\,.\,\tfrac{2}{5}\,mb.$$

Compare this expression with equation (l) on the hypothesis that $m = l$, and it follows that the quantities of discharge through both triangles are to one another as 3 to 2.

Make in figs. 1 and 2, $ef = op$, or $l = m$, and add the equations (k) and (m): then for the quantities of discharge through a parallelogram of which the height $= b$, and the base $= m$, we have

$$o. \qquad Q = k'\sqrt{(4g)}\,.\,\tfrac{2}{3}\,m\left\{(H+b)^{\frac{3}{2}} - H^{\frac{3}{2}}\right\}.$$

Compare equations (d and o): it follows that the quantities of discharge through a rectangle is equal to that through a parallelogram of equal area and base.

Increase in equation (m) the altitude of pressure H by b; so that instead of H, the value H + b is substituted. Then for the quantity of discharge through an orifice as $e'f'g$ (fig. 3),—

$$p. \qquad Q = k'\sqrt{(4g)}\,\tfrac{2}{3}\,m\left\{\frac{2}{5b}\left[(H+2b)^{\frac{5}{2}} - (H+b)^{\frac{5}{2}}\right] - (H+b)^{\frac{3}{2}}\right\}$$

Add now the equation (k) to equation (p), and put $l = m$: it will be thus found that for the quantity of discharge through a parallelogram in which one diagonal is vertical and $= 2b = d$, and the other diagonal horizontal and equal m,

$$q. \qquad Q = k'\sqrt{(4g)}\,\tfrac{8}{15}\,\frac{m}{d}\left\{(H+d)^{\frac{5}{2}} - 2(H+\tfrac{1}{2}d)^{\frac{5}{2}} + H^{\frac{5}{2}}\right\}.$$

In this equation if $d = m$, the orifice is a square, in which one diagonal equal m is vertical, and we have for the quantity of discharge,

$$r. \qquad Q = k'\sqrt{(4g)}\,\tfrac{8}{15}\left\{(H+m)^{\frac{5}{2}} - 2(H+\tfrac{1}{2}m)^{\frac{5}{2}} + H^{\frac{5}{2}}\right\}.$$

When here H = 0, the summit of the square orifice is in the surface of the water, and the quantity of discharge is

$$s. \qquad Q = k'\sqrt{(4gm)}\,\tfrac{2}{15}\,m^2\left\{4 - \sqrt{2}\right\}.$$

If the side of the square equal l, $m^2 = 2l^2$.

Put this value of l in the foregoing equation, and we have for the quantity of discharge from the sides of the square when the diagonal is vertical,

$$t. \qquad Q = k'\sqrt{(4gl)}\,.\,l^2\,.\,\tfrac{4}{15}\,\sqrt[4]{2}\left\{4 - \sqrt{2}\right\}.$$

From equations (g and r), (h and t), the proportion of the quantities of discharge through the same square is found, when in one case the side, in the other case the diagonal, is vertical or horizontal.

If the altitudes of pressure be measured from the surface of the water to the under edges of the orifices, we have only to put

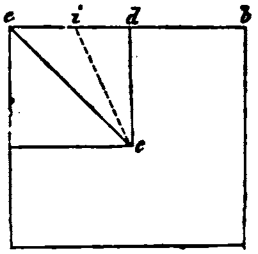
$H + b$ or $H + l$ or $H + m = H$. The equation (r), for example, gives in this case—

$$Q = k'\sqrt{(4g)}\,\tfrac{8}{15}\left\{H'^{\frac{5}{2}} - 2(H' - \tfrac{1}{2}m)^{\frac{5}{2}} + (H' - m)^{\frac{5}{2}}\right\}.$$

12.

Co-efficient of Contraction of Square Orifices.

In order to estimate the quantity of discharge from a square orifice, the value of co-efficient k' must still be found. As the magnitude of the contraction by § 7 is dependent on the magnitude of the diagonal or central width of the orifice, the co-efficient for different forms of the orifice must vary in proportion to these widths or secant lines. The co-efficient for a square orifice must, therefore, be considerably different from that for a circular orifice; it may however be estimated as soon as the mean value of all the secant lines of a square is known.



First, then, the co-efficients for a square and a circular orifice under otherwise similar circumstances, must be in the inverse proportion of their contracting forces. Now these forces, by § 7, are proportional to the radii or secant-lines, and conseqently are as the radius of the circle to the mean secant of the square. By the mean secant is here meant the mean value of all the secants, as *ci*, which can lie between *cd* and *ce*.

In order to find these values, the method in § 2 for estimating y' will be adopted.

Let $di = x$, $ic = y$, $cd = \tfrac{1}{2}l = \tfrac{1}{2}eb$; then

$$y = \sqrt{\left\{(\tfrac{1}{2}l)^2 + x^2\right\}}; \quad \text{and,} \int y\,dx = \int dx\sqrt{\left\{(\tfrac{1}{2}l)^2 + x^2\right\}}$$

$$= \tfrac{1}{2}x\sqrt{\left\{(\tfrac{1}{2}l)^2 + x^2\right\}} + \tfrac{1}{2}(\tfrac{1}{2}l)^2\log\left[x + \sqrt{\left\{(\tfrac{1}{2}l)^2 + x^2\right\}}\right].$$

Take this integral between the limits $x = 0$ and $x = \tfrac{1}{2}l$; then,

$$\int_0^{\frac{1}{2}l} y\,dx = (\tfrac{1}{2}l)^2\left\{\tfrac{1}{2}\sqrt{2} + \tfrac{1}{2}\log(1 + \sqrt{2})\right\}.$$

Divide now by $\int dx = \tfrac{1}{2}l$, and we find for the mean secant,

$$a. \qquad y' = \tfrac{1}{4}l\left\{\sqrt{2} + \log(1 + \sqrt{2})\right\}.$$

The square, however, of which the side $= l$ has an area equal to that of the circle of which the radius $= r$; whence $r^2\pi = l^2$, and $l = r\sqrt{\pi}$. Substitute this value in the above expression, and we find

$$b. \qquad y' = \tfrac{1}{4}r\sqrt{\pi}\left\{\sqrt{2} + \log(1 + \sqrt{2})\right\}.$$

Call now the contracting force in the circular orifice f_0, and in the square orifice f_q; then, $f_0 : f_q = r : y'$; and

$$c. \qquad \frac{f_0}{f_q} = \frac{r}{y'} = \frac{4}{\sqrt{\pi}\{\sqrt{2} + \log(1 + \sqrt{2})\}}.$$

We have seen in § 10, respecting circular orifices, that the co-efficient of contraction, by adopting the true velocities, is constant for all altitudes of pressure and $= (\tfrac{1}{4}\pi)^2$. By comparison of square orifices with circular this, however, is no longer the case, while the velocities in both orifices at the same depth below the surface are neither equal nor for different altitudes related by a constant proportion. Hence it follows that the relation of these co-efficients to one another, depends not merely on the contracting forces but also on the velocities. As these velocities, however, for different positions of the orifices give results differing from one another, the comparison ultimately consists in finding points which with respect to the velocities are to one another in constant relation. When such points are found, the velocities which take place at them will serve for a nearer computation of the co-efficient. Of all points which can here come into consideration, those may be considered most proper in which the pressures sustained by the water towards the orifice are in equilibrium, or the centres of pressure.

The next step is to determine the relation of the co-efficients of square and circular orifices to their velocities. Let the expression $Q = kFV$ be taken, in which the quantity Q is the product of the co-efficient k, the area of the orifice F, and the velocity V: then, when Q remains invariable, the product kV must be constant; and k must increase in the same proportion in which V decreases, and conversely. Hence it follows that the co-efficients are in inverse proportion to the velocities; they are also in inverse proportion to the contracting forces. Put, therefore, V_0 and V_q for the velocities at the points of comparison or centres of pressure, and k, k', the co-efficients of contraction of circular and square orifices: then $k : k' = f_qV_q : f_0V_0$; and therefore for the co-efficients of square orifices,

$$d. \qquad k' = \frac{kf_0V_0}{f_qV_q};$$

Designate, for circular and square orifices, the distance of the centre of pressure below the surface of the water by H_0 and H_q; the altitudes at the upper edges of the orifices by h_0 and h_q; the radius of the circle by r; and the side of the square by l. Then we know that

$$H_0 = h_0 + r + \frac{r^2}{4(h_0 + r)}; \qquad H_q = h_q + \tfrac{1}{2}l + \frac{l^2}{12(h_q + \frac{1}{2}l)}.$$

Until now nothing is determined respecting the relative positions of the orifices; they must however be assumed so that the mutual relation of the velocities to one another may not be neglected. This object will be attained when the under edges are at the same depth, and then it follows that

$$h_0 + 2r = h_q + l; \quad \text{or,} \ h_0 + 2r - l = h_q.$$

Substituting this value in the above expression for H_q,

$$H_q = h_0 + 2r - \tfrac{1}{2}l + \frac{l^2}{12(h_0 + 2r - \frac{1}{2}l)}.$$

When both orifices are of equal magnitude, $r^2\pi = l^2$, or $r = \dfrac{l}{\sqrt{\pi}}$. Substitute this value of r, and put $h_0 = ml$, we find

$$e. \qquad H_0 = \left[m + \frac{1}{\sqrt{\pi}} + \left\{4\pi\cdot\left(m + \frac{1}{\sqrt{\pi}}\right)\right\}^{-1}\right]l.$$

$$f. \qquad H_q = \left[m + \frac{2}{\sqrt{\pi}} - \tfrac{1}{2} + \left\{12\cdot\left(m + \frac{2}{\sqrt{\pi}} - \tfrac{1}{2}\right)\right\}^{-1}\right]l.$$

When V_0 and V_q designate the velocities at the centres of pressure, $\dfrac{V_0}{V_q} = \dfrac{H_0}{H_q}$; and as $k = (\tfrac{1}{4}\pi)^2$, we have by equation (c),

$$\frac{kf_0}{f_q} = \frac{kr}{y'} = \frac{4(\frac{1}{4}\pi)^2}{\sqrt{\pi}\{2 + \log(1 + \sqrt{2})\}} = 0{\cdot}6064.$$

Substitute this value in equation (d), and we find for the general expression for the co-efficients for square orifices,

$$g. \quad k' = {\cdot}6064\left\{m + {\cdot}564190 + \frac{1}{4\pi(m + {\cdot}564190)}\right\}^{\frac{1}{2}}\left\{m + {\cdot}628379 + \frac{1}{12(m + {\cdot}628379)}\right\}^{-\frac{1}{2}}.$$

For $m = 0$, the altitude of pressure $= 0$, and we find $k' = {\cdot}5836$. For $m =$ a very large value, the expressions in the brackets are together nearly equal to unity, and $k' = {\cdot}6064$. For $m = 1000$, the altitude of pressure $H = 1000\,l$, and $k' = {\cdot}60638$. In the following table the co-efficients for square orifices for different values of m, from 0 to 1000 are collected.

Table I.

Values of m.	Co-efficient k'.	Values of m.	Co-efficient k'.	Values of m.	Co-efficient k'.	Values of m.	Co-efficient k'.
·1	·5836	1·4	·5968	10	·6046	30	·6058
·2	·5849	1·6	·5977	11	·6047	40	·6059
·3	·5862	1·8	·5984	12	·6048	50	·6060
·4	·5877	2·0	·5990	13	·6049	60	·6061
·5	·5890	2·5	·6001	14	·6050	70	·6061
·6	·5903	3	·6010	15	·6051	80	·6062
·7	·5913	4	·6022	16	·6052	90	·6062
·8	·5923	5	·6029	17	·6053	100	·6062
·9	·5932	6	·6034	18	·6053	200	·6063
1·0	·5939	7	·6038	19	·6034	300	·6063
1·1	·5946	8	·6041	20	·6055	500	·6064
1·2	·5959	9	·6044	25	·6056	1000	·6064

The sinking of the level (§ 10) vertically above the orifice of the reservoir is observable for values of $m = \dfrac{H}{l} = 5$, and has considerable influence only when m is less than 5. We will therefore call those altitudes of pressure for which m is greater than 5, for which also the sinking of the level may be neglected without sensible error, *greater altitudes;* and those for which m is less than 5, for which the sinking must be taken into consideration, *less altitudes*.

The estimate of the quantity of discharge for greater altitudes may be effected in the following manner:—When H signifies the altitude of pressure above the upper edge of the orifice, and l the sides of the square, seek first for $m = \frac{H}{l}$. For this value of m, find in Table I. the corresponding value of the co-efficient k', and then the quantity of discharge may be estimated by equations (g) or (i) §. 11. For practical purposes equation (i) suffices; and the altitude will be the whole perpendicular distance measured above the orifice, and designated by H″.

When $H'' = 1{\cdot}2148$; $l = {\cdot}2$ meter; $\frac{H''}{l} = m = {\cdot}6034$; and by equation ($i$),

$$\begin{aligned}
\log \surd(H'' + \tfrac{1}{2}l) &= {\cdot}05943 \\
\log l^2 &= {\cdot}60206-2 \\
\log \surd(4g) &= {\cdot}64633 \\
\log k' &= {\cdot}78061-1 \\
\hline
\log Q &= {\cdot}08843-1
\end{aligned}$$

or $Q = {\cdot}12258$ cubic meter, or 122·580 liter. The experimental result (Tab. III. No. 4) gives 122·659 liter.

Table II.

Comparison of the Co-efficients for Greater Altitudes, with experiments with Quadrilateral Orifices.

Name of Experimenter.	Side of the Orifice l.	Altitude H.	Ratio m.	Co-efficient found by experiment k'.
Poncelet	0·2 metr.	1·1250	5·625	·6024
"	"	1·2150	6·075	·6040
"	"	1·3323	6·661	·6030
"	"	1·3720	6 860	·6028
Michelotti	2 Par. Zoll.	6 F. 9″ 10‴·1 Par.	40·915	·6033
"	"	21 8 10·7	130·442	·6056
"	"	6 8 11·2	80·933	·6086
"	"	11 9 8·0	141·666	·6061
"	"	21 9 8 8	261·733	·6047

Compare the co-efficients here found by experiment by means of the ratio m with those computed in Table I., and it will be found that the greatest error does not exceed ½ per cent.

(To be continued.)

REVIEWS.

An Algebra of Ratios, founded on simple and general Definitions; with a Theory of Exponents extended to Incommensurable Ratios, and the Propositions of the Fifth Book of Euclid easily and symbolically deduced. By HENRY B. BROWNING, Architect, Stamford. Cambridge: Macmillan, 1849; 8vo. pp. xiv+133.

In the olden time many of our great architects were also profound geometers:—yet, not many of *our* architects, but many of the continental ones. Indeed, with the solitary exception of the builder of St. Paul's, we look in vain for anything approaching to even moderate acquaintance with the *principles* of geometry amongst English architects. The "rule-of-thumb" is the universal guide; and mere taste is considered infinitely more valuable than any amount of science. Far be it, however, from us to undervalue taste: though much that is obtruded on the public as the very æsthetic of architectural taste, is only the wild arabesque of a prurient imagination. We give honour where honour is due for all developed conceptions that are worthy of the name of "tasteful:" but we shall continue, as our pages will prove we have hitherto done, to censure with the utmost freedom those uncultivated vagrancies of fancy that are so often obtruded upon us as the emanations of superior genius.

Though many architects have been able geometers, their attention has been for the most part (indeed almost wholly) confined to those forms of it that had a more or less direct bearing on architectural problems—that is, to "Descriptive Geometry," or to the statical conditions which were essential to the safety of a structure. Few of them wandered into the regions of pure abstraction —into the philosophy upon which geometrical evidence is based. To do this bespeaks a still higher order of *logical* intellect than has been evinced in the cases of De l'Orme, Jousse, Derande, Landau, Frezier, or even by the great Buonarotti, or the universal Da Vinci. Desargues, indeed, is the only marked exception—one of the most marked exceptions *even in mathematical history*. He, from whom Pascal acknowledged that he learnt almost all he knew, whom one of the most original writers of the age has called "the Monge of his century," and whose researches have in some important matters anticipated discoveries of our own age,—such a man is an honour to the profession, independently of any professional works he executed in his native city of Lyons.

We confess that to find an architect publishing a work on such an abstract subject as that of Euclid's fifth book, notwithstanding the single precedent of Desargues, came upon us by surprise; and from what we happen to know of the geometrical character of English architectural writers and professors, it was not without some misgivings that we opened it—fearing to encounter a heap of crude conundrums, that would confer little honour on the class to which Mr. Browning belongs. A slight glance, however, over its pages, with a pause here and there, sufficed not only to remove our apprehensions, but to convince us that it deserved a more deliberate and systematic examination. Such an examination we have made; and though we take exception to an important step of his investigation, and remit the subject back to his consideration, we yet form an exceedingly high opinion of the skill and address of several detailed parts of his subsequent investigations. Let him remove this one objection (fatal to his whole system as it *at present* stands), and we shall gladly acknowledge that he has conferred a great boon on mathematical science. As it is, he has made a step in advance: but till his foundations are better laid, he has but an insecure footing.

As a great deal of misapprehension on the subject of proportion exists, even in "high places," we have thought it desirable, for the sake of clearing away a little of this, to enter into some account of the real character and difficulties of the subject, at greater length than we usually devote to a review.

We have little doubt that the geometry of a succeeding and not distant age will wear a different face from its present one; and no one branch of it will be more changed in its physiognomy than the doctrine of proportion. The *géométrie récente* of the French is finding its way even into the higher class of *our* elementary books: but any reference to this would be foreign to our present purpose. We only purpose to point out what are the difficulties, and the present degree of success attained in dealing with them, that attach to the one specific subject—that of Ratio.

All men of even common observation without pretension to science, have a rude notion of proportion: but it is rude indeed with the greater part of them, if we accept their language as an index of their conceptions. We hear them talk of the "proportion between two" things, or of "one thing to another;" or one thing being "so many more times as large" as another. These are really neither more or less than illiterate vulgarisms of phraseology; whilst at the same time they point to an imperfectly expressed conception of what constitutes *ratio*. Let them be slightly modified, and we get Euclid's definition (*lib.* v. *def.* 4) of ratio—viz. "Ratio is the relation of one magnitude to another of the same kind, with respect to quantuplicity"—that is, *how often* (how many times, parts of a time, or times and parts of a time) one magnitude contains another of the same kind. This, we say, is the rude idea; and were all magnitudes *commensurable* (that is, such that every two of the same species had any finite common measure, however small) it would be adequate to all the purposes of geometrical science:—as, for instance, did one magnitude contain the other 10, $25\frac{8}{10}$, $100\frac{81}{102}$, *etc.* times (as these have the common measure 1, $\frac{1}{10}$, $\frac{1}{102}$, *etc.*), the entire doctrine of proportion could be established with respect to such magnitudes with simplicity and facility, as will be shown presently. When, however, we come (to take a familiar instance) to compare the side of a square with its diagonal, the latter is $\surd 2$ times the former—that is, $1 + \frac{412136 \ldots\ldots \textit{figures ad infinitum}}{10^{\textit{infinity}}}$ times the former. Now, view $10^{\textit{inf.}}$ how we will, $\frac{1}{10^{\textit{inf.}}}$ cannot be a *finite* number; and hence all the reasonings which involve an expression of the relation in *finite terms*, must be nugatory in respect to such a ratio as that of the side of a square to its diagonal. This method, though the earliest and most obvious, is clearly an insufficient one on which to build a *universal system* of such relations. It nevertheless *suggests an idea*—and that is much.

The algebraist views the expression *ratio* as a fraction,[1] and to him, therefore, it has a certain degree of intelligibility, though it must of necessity be somewhat confused and very incomplete. He seldom cares, however, for this: his machine is in gear, and he can grind out results at his own pleasure—though his intellect have as little to do with the process as the heart of a Tartar has with the prayers and charms which he puts into his little windmill, to perform alike his devotions and his physical cure.

The geometer takes a different course. A ratio, like a fraction, in itself and alone, is a mere conception of the mind, and, taken *alone*, without the least use. His object is not to find or express the relation of one magnitude to another, but to *determine the laws* by which several magnitudes, having a specified set of relations, are connected together in respect to some other set of relations. To effect this, as far as proportion is concerned in the task, he compares the ratio of two magnitudes with the ratio of two others; and the expression of the sameness of these ratios it is which *he* calls "*proportion*." Under this aspect, proportion becomes intelligible. Still this assumption furnishes no criterion which determines whether four magnitudes, *given by any other conditions*,[2] are proportionals or not; and we seem to have made little way—though, indeed, the step was a wide one.

In comparing any ratios capable of numerical expression in finite terms (that is, commensurable quantities), it would readily be discovered "such equi-multiples of the first and third and such equi-multiples of the second and fourth" could be taken, that the multiple so taken of the first *should be* equal to that of the second, and that the multiple of the third *would be* then equal to that of the fourth. The result is obtained by cross-multiples. It would naturally occur to inquire what would take place between the multiples of the third and fourth if the multiple of the first should be taken so as to be greater or to be less than that of the second: and the third and fourth having in these cases universally the same relation as to greater, equal, less, this relation was proved to be a *property of proportionals*, as long as they were commensurable.

"But are these properties confined to commensurable proportionals alone?" would be a natural question. The primary one, respecting the equality of the multiples, it would be clear at once could never be more than approximately fulfilled by finite cross-multipliers:[3] but during that approximation, however closely pushed, the other two criteria were invariably fulfilled—as, for instance, in the case of the sides and diagonals of two squares. It would also be seen and readily proved that in all commensurable magnitudes, those other two criteria being made the hypothesis (or the definition of proportionality), the principal condition of "equal-equal" could be shown to follow as a consequence;—so that, in reality, those two conditions ("greater-greater," "less-less") were adequate to form a defining criterion of proportional magnitudes, as long as they were commensurable. The "equal-equal" criterion was a consequence of commensurability only; and the other two being capable of existence independently of commensurability, were not of necessity bound by that peculiar relation.

Euclid, then, had good reason for choosing the "complicated" criterion of proportion which constitutes his fifth definition, and of non-proportionality which forms his seventh. The tests of greater and less, completely and without other aid defined the proportionality of commensurables; and they were equally applicable and definitive when the magnitudes were incommensurable, where the "equal-equal" test could not be applied, but, indeed, where it was not at all required. This definition, then, being alike applicable to commensurable and to incommensurable magnitudes, is fully justified in principle, and contains all the qualities of a philosophically constructed definition. The only objection urged against it is its "*complexity*": but there is to be urged against all others which essentially differ from it—their *incompleteness*, *ambiguity*, or *inapplicability*.

Those who are accustomed to look into Simson's "notes" on his edition of Euclid, will see how often he has made changes in the text; and, in fact, of all editions, as Peyrard has remarked, this is the farthest removed from the whole of the existing texts, or of printed books from those texts. We can hardly, therefore, refer to Simson to ascertain the views of Euclid upon disputed points, and especially upon points of great delicacy of thinking. Simson's labours on this book are indeed exceedingly valuable; and he himself in one of his notes expresses that to be his own opinion. His very expanded expression of the fifth definition, however, has more of the verbosity of the lawyer than of the neat discrimination of the philosophical geometer. Williamson translates the Greek literally as follows:—

> "Magnitudes are said to be in the same ratio; the first to the second, and the third to the fourth; when the equi-multiples of the first and third, according to any multiplication, are at the same time less, or at the same time equal, or at the same time greater, than each of the equi-multiples of the second and fourth, compared with one another."

If, therefore, the texts of Euclid could be depended on (which they certainly cannot) as genuine and uncorrupted, we should think that Euclid had committed a grave oversight by introducing as a part of a general definition a circumstance that was only accidental and confined to a limited class of cases—the introduction of the "equal-equal" test as an essential one. The two are universal and sufficient: the other is accidental and casual—incapable of being generally made to exist,—and even when so made in any particular case, adding no force to the proof.[4]

This we hold to be a question of paramount importance in the doctrine of proportion; and more especially as it has done much towards not only creating confused views of proportion, but given rise to numberless visionary books and the loss of much valuable time both of writers and readers. Men of mediocre minds do not select such topics as this for their crude speculations; and it is unfortunate that able men should be led the dance of years after an *ignis fatuus*.[5] There has indeed been a race of persons who have "reformed" proportion,—so also has there been who manufactured "geometry without axioms,"—and another still, who "squared the circle" and "trisected an angle." It is not, however, of these cognate races that we speak: but of men of truly philosophic minds, who have been led by the admission as genuine of a phrase occurring in a probably corrupted text, or by an accidentally superfluous phrase of Euclid himself, to establish the necessary co-existence of the three tests instead of two.

That one great obstacle to the reception of Euclid's method of proportion arises from the cumbrous language in which it is delivered, there can be no doubt. The tautology in the expression of the conditions of the text, and enunciation of the conclusions deduced by them, is so wearisome to the eye and ear, as to operate like an opium-pill or the "passes" of the mesmerist—to produce a catalepsy of mind, if not a physical catalepsy. The Greeks, however, had nothing that could be called "pure arithmetic" (their nearest approach to it being the doctrine of numbers as delivered in Euclid's 7th, 8th, 9th, and partly the 10th books), and of course their language respecting its most elementary truths is necessarily imperfect. This is one cause, indeed the chief one, of the *form* of the fifth book. For instance (to use the language of De Morgan), "V. 1, 2, 3, 5, 6. These are simple propositions of concrete arithmetic covered in language which makes them unintelligible to modern ears. The first, for instance, states no more than that

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[1] Not *ratios only*. It has, after the fancy of Françæis, Ampère, and Dufourcy, become a fashion at Cambridge to consider an *angle as a ratio*. and a ratio as a fraction. One could almost think that the merry Frenchmen meant to "hoax the pilfering Johnians," by giving them a bait that would render them ridiculous to all men and through all time.

[2] When four magnitudes are given by actual exhibition, without any specified connection or dependence, of course it is only by a series of experiments upon the multiples that we can bring the definition to bear upon the proof of proportionality or disproportionality. But in geometrical inquiries are they ever so given?—There is always given *a relation amongst them*; and *subject to this relation* it is that they are to be proved to be proportional or not.

Such a remark would be almost too trivial to make, were it not that we have observed it to escape the notice of students so often as to create great vagueness in their minds of the objects and conditions of proportionality. "How am I to assure myself that the four lines drawn here are proportionals? Must I make experiments with the multiples till I am satisfied? And how, indeed, can I be satisfied absolutely and logically, from a limited number of experiments, such as I can make, that the conditions will be universally fulfilled?"—Questions such as these from intelligent students show that this note is not superfluous. We have many a time heard them asked—and in no captious spirit.

[3] The approximation may be made by narrowing the limit of difference between the equimultiples to any given finite extent. The problem is, manifestly—"Two magnitudes of the same kind being given to find multiples of them that shall differ by a magnitude less than any given magnitude." The process would be that given by Euclid for finding the common measure of two magnitudes in *book* ix. *prop.* 7, till we obtained a remainder less than the given magnitude. These operations are arithmetically represented by a continued fraction, which, reduced to a common fraction, has its numerator and denominator for the required multipliers.

[4] It is very probable that Euclid gave (supposing he gave it at all) the "equal-equal" test as an incidentally occurring *variation of form* of the test depending on the other two conditions; and which, in the cases where it might occur, would of itself be sufficient. We cannot, however, bring ourselves to think that *he* gave it as a part and parcel of the fundamental definition. We do not need the testimony of Simson to the corruption of Euclid by "unskilful commentators;" for almost every page contains internal evidence of the 'Elements' not being in their original condition. The present looks like a scholium or corollary concentrated into the text. Poor Theon! he has much to answer for.

[5] We may instance here a circumstance that has been often, and indeed generally, misapprehended—viz. the Props. 7, 8, 9, 10, of Euclid's fifth book. It is very natural to say that "if ratio be the relation between two magnitudes with respect to *quantity*, then equal magnitudes have the same relation *as to quantity* to any third magnitude of the same species, *and hence the same ratio*." All this is very true, and so are corresponding objections to the other three: but it was incumbent on Euclid to show that this result also flowed as a consequence *from his definition*. These propositions formed a practical test of the correspondence of his system with our common notions, where they could be brought into comparison. Extreme cases are the severest tests of every system. Euclid's bears it rigorously.

ten acres and *ten* roods make *ten* times as much as one acre and one rood."—We want more of arithmetical and lingual reform in the fifth book of Euclid, than reform (or reconstruction, or novelty) of argument. The essence of Euclid's reasoning is pure.

In all the editions of Euclid, the magnitudes are represented by *lines*—never by any other species of figure, as angles, circles, polygons, polyhedra, cones, or spheres. Yet the reasoning itself, as well as the language in which it is couched, is perfectly general—is applicable to all classes of magnitudes (as numbers, time, or force), as well as to geometrical entities. A confined view of the application of proportion is thus *suggested;* and as no warning is given, the suggestion too often takes the place of a positive and enforced limitation of the doctrine to linear magnitudes. That this is no imaginary case is plain from this—that many able and accomplished mathematicians, who were no mean thinkers neither, have *assumed* this limitation in their variations of Euclid's proofs. For instance, in the demonstration of v. 18, it has been proposed over and over again by Euclid's commentators, even down to the present day, to interchange the second and third magnitudes as the preliminary to an abridged proof! If, then, the masters in geometry can thus deliberately enunciate such a limitation, we cannot wonder that the inexperienced student should be led to form it from the suggestions of the figures. Of course the cure is obvious: make, in all cases where the hypothesis does not imply all being of the same species, the third and fourth magnitudes of different species from the first and second. Let, for instance, the first pair be lines, and the second angles—the first be angles and the second rectangles, circles, polyhedra, or cones. The only condition that is *essential* is that the two members of each pair shall be of the *same species*—no matter what that species be. It is not even necessary that the members of either pair shall be of the *same form;* for it is not form but magnitude which is the relation under discussion.

This last remark is an answer to objections which have been made to the use of any other figures but lines; namely, that as far as we know at this stage of our learning, we cannot make multiples of any other figures *of the same form* (or, at least, of *all* other figures), so as to fulfil the conditions. Does Euclid prescribe sameness of form as a condition amongst the equi-multiples? or even that the multiple shall constitute one figure (in the ordinary sense of the word figure) similar to that of which it is the multiple? Every child knows that the twenty equal bits of clay which he has rolled up into "marbles," if made into a single one, would be twenty times as large as one of the small (a sub-multiple) marbles; and this child would admit, the terms being made intelligible to him, that the twenty small marbles formed as truly a multiple of one of them as the large ball into which they were all combined did. It is left as a discovery to be made by fastidious geometers, that the reverse is the case!—or at least to found an objection to salutary changes upon such an assumption!

We have spoken of proportion mainly in reference to geometry; but neither the fundamental idea nor the laws of proportion are peculiar to magnitude, properly so called—though doubtless originally suggested by them. It is even rendered familiar to early boyhood in its extension, by the questions which we solve in arithmetic, under the heads of the "rule-of-three, direct and inverse," the "rule-of-five," *etc.* We have, indeed, brought [rudely and imperfectly laid down, it is true, but still brought] under our notice four terms, which are generally in pairs, of different species, even as to *form;*[6] as money and the goods the money will purchase: and always different in respect to concrete signification; as principal and interest, length and breadth, *etc.* We have, therefore, much elementary training to introduce the conception of sameness of ratio, where the pairs of magnitudes or entities of any kind are of different species, the first pair from the second. Yet, withal this, writers enforce the total forgetfulness or abstraction of all concrete considerations when we come to general inquiries concerning proportion; and teach us to view it in reference to numbers or the symbols of number only, and to consider the ratio as only a numerical fraction arising from the division of the first term by the second or the second by the first. This carries the research back to its first rude and imperfect conception: but the difficulties of that conception are got over by considering all functions of all numbers, whether expressible in finite terms or not, as numbers—thus including (not very logically, indeed, but with a logic that suits and satisfies most algebraists) the incommensurables as well as commensurables.[7] Proportion is then expressed as an equation between two such ratios; and all the properties of proportionals are then obtained by ordinary algebraic transformation. We do not say that such a process is altogether inconclusive with respect to *proportional numbers:* but we do say that the "off-hand way" in which it is usually developed, is so far wanting in precision and completeness, as to render the logic of it very difficult to discover. It is *short* enough; and the facts are visibly tabulated—which, to too many minds, are the great desiderata of mathematical learning. The indolence of mankind will always render "short cuts" in science matters of high estimation; and we fear, too, that the system of Collegiate and University examination, involving so much "book-work," and enforcing so much "writing out," has a tendency to perpetuate this stenographic system of developing science. Nevertheless, we feel confident of this—that an algebraic system of proportion, complete in all its parts and written out intelligibly, would be but a little less expanded treatise than one founded on the the most general views and carried out to the same extent. Nay, more,—we think it would be extremely difficult to devise a course of reasoning upon algebraic ratio which can be considered perfectly legitimate, which does not involve principles that are far more general than those of simple algebra—indeed, the most general principles of ratio. This is tantamount to saying (and we mean it to be) that all demonstrations of proportion which confine the idea of ratio to arithmetic in its most generalised forms, is little less than a mathematical farce;—either on the one hand giving us mere legerdemain under the title of demonstration,—or, on the other, representing the principles which are common to all ratio as peculiar to mere arithmetic.

The structure of Euclid's 'Elements' (including the books omitted by Simson), leads us to the conclusion, that the illustrious Greek had in view to include arithmetic and geometry in his demonstrations—the abstract and concrete. In truth, the idea of *force*, as we view it, does not appear to have ever been mooted as a conceivable application of the exact methods of research in the School of Plato; and *time* is no otherwise an element of the applied mathematics, even now, than in connection with force. Contrary, indeed, to modern practice, the Greeks treated number in subordination to, and by means of, geometry; instead of treating geometry as subordinate to, and by means of, number, as in the modern fashion. His reasoning, too, reaches both views; and as he did not conceive any other entities could come under the shelter of exact science, he strained after no greater generalization either of idea or language. He saw arithmetic (the properties of numbers) only as a subordinate branch of geometry—or at least as entirely dependent upon geometry for all its evidence; and he gave, therefore, to his doctrine of ratio a form which renders this dependence obvious and (as he thought) real. We can not here, however, enter into the instructive inquiry which the circumstance just quoted suggests: we may perhaps find an opportunity hereafter.

Many writers have attempted to give the fifth book of Euclid in general terms and symbols, unrestricted by the references to figures:[8] but, in general, both their language and their professed intention have bespoken their treating it as a branch of geometry only. Of all these writers, Playfair is perhaps the most successful; and did we know less of its details than we happen to do, we should feel great confidence in this editor's quick logical perceptions having prevented him from making any change that would vitiate the reasoning. Yet (our readers must believe us, unlikely as the statement may appear), we have heard not only good geometrical investigators and teachers of mathematics of high repute

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[6] It is strange what an influence early-formed habits have upon us through life,—a manifestation of which is almost universal in respect to "stating a rule-of-three sum." We were *taught*, after the celebrated *Francis* Walkinghame, to make the first and third terms of the same kind, in accordance with the venerable precepts traditionally descended from the early Italian merchants, and as religiously adhered to by our "school-arithmetic" manufacturers as though it were "a saving article of their faith." No elementary author, we believe, before Bonnycastle, ventured to depart from this mode of statement; and, as far as we know, his heresy has been almost left to die with him. We must confess that for ourselves, even after the fifth decade of our life has been completed, we have sometimes detected ourselves unconsciously returning to the old worship, and gravely performing the old rites in solving a question in the "rule-of-three!"

[7] It may be worth the reader's while to demonstrate, after Euclid's manner, the truth of such a proportion as this:—

$$2 : \surd 2 :: \surd 8 : 2,$$

or indeed any other involving radicals or transcendentals. It equally applies to all forms. But let him keep in mind that only *integer* numbers are admissable as multipliers. Whether *functions of numbers* can ever be rendered available as multipliers, and the legitimacy of the process rendered unassailable, we offer no opinion: it has not yet been done at all events.

[8] The assumption of a *letter of the alphabet* to designate any magnitude or quantity, has been considered by many persons to constitute the research dependant on that assumption an algebraical process. They would not say that the process was algebraical (even though it may be) *if* the whole were written out in "English-Dictionary words." The mode of writing has no more to do with the question than Tenterden steeple with Goodwin Sands. The fact is, the magnitude or quantity is labelled with that letter as a condition for more brief impression,—it becomes the *name* of the quantity, not a numerical representation of its *value*. In algebra it is solely the *name of a number, not of a concrete quantity.* Even in those very imaginative places, a government office or a merchant's counting-house, he must be a dull fellow who supposed that "Form A" or "Ledger B" designated the number of figures, words, or letters in the one, or the actual amount of the "Cr. balance," in the other. Yet the cases are analogous.

call this very book of Playfair's edition, *an algebraical treatise!* The confusion of idea we so frequently meet with amongst mathematicians of no mean fame, with respect to the relations or analogies of arithmetic and geometry, is most extraordinary. Who that really understood the *grounds* of his science, could for one moment confound an abbreviated mode of writing (which is all the essential change made by Playfair of Simson's edition of the fifth book) with the abstractions of arithmetic?

It will be generally conceded that nothing could come from the pen of Professor De Morgan which did not bear the impress of profound and independent thinking. He is no imitator. We may differ from him: but we can never fail to admire the earnest spirit in which he writes, nor to wonder at the extraordinary resources of his intellect. Of course, then, when (a dozen years ago) he published his tract on the 'Connection of Number and Magnitude,' we were prepared to expect that the doctrine of ratio would be placed in a new and more philosophical light than before. The great object of the work, however, turned out to be—an attempt to bring intelligent pupils into a position to philosophise on this subject for themselves. In this the author has been eminently successful; and his illustrations are admirably adapted to prevent the student from resting with those vague and misty notions, with which too many even of matured geometers are so supinely satisfied.

Mr. De Morgan starts with "an extension of the arithmetical notion of ratio, to magnitudes in general and especially to space-magnitudes." Perhaps, *au fond*, his view is not different from that which we have taken some pains in the earlier part of this review to enforce; although we view the arithmetical idea as a mere *suggestion* of the general one, whilst Mr. De Morgan considers the general one as an *extension* of the arithmetical one. The difference may, possibly, be only verbal; but we think we see something more in it. Our views, as well as his, are now before the reader—whether they wholly agree or partially differ, we shall not here further stop to inquire, for it is time to say a word or two respecting Mr. Browning's work itself.

Mr. Browning "takes the bull by the horns," and at once starts with the consideration of "concrete quantities."[9] The theorems respecting the limits of variable concrete quantities are both neat in form, and we think, with the author, that they are new in manner. These are brought in for ulterior purposes.

We have quoted Euclid's fifth definition literally translated from the Greek: we now give Mr. Browning's. "The ratio of A to B is a relation of magnitude, which is determined by comparison of A with the several fractions of B in regard to equality, excess, or defect: so that C has to D the same ratio which A has to B, when C is equal to, or greater than, or less than any fraction of D, according as A is equal to, greater than, or less than the same fraction of B." (p. 11.) The neatness of the Euclidean definition is here replaced by a too close imitation of the manner of Simson's version. Setting this aside, the marked difference between it and Euclid's is,—that the first and third terms are here compared respectively with *fractions* of the second and fourth; whereas, Euclid compares *equi-multiples* of the first and third with *equi-multiples* of the second and fourth. This difference is not an essential one, except it shall prove that an essentially different mode of subsequent demonstration can be built upon it.

Mr. Browning *assumes as an axiom* that when three terms of a proportion are fixed upon, a fourth *exists*. There is nothing in the details or the spirit of the ancient geometry analogous to this assumption. Euclid never assumes the existence of anything which he does not first show how to actually find; and most (though not all) modern geometers of any authority have followed his example in this respect. Still, we will not quarrel with the assumption, though we could wish the author had been able to dispense with it.

If the proportional quantities be commensurable, Mr. Browning's fractions will amongst their varieties express the ratio of any quantity whatever to its fellow. The test "equal-equal" amongst Euclid's equi-multiples are there formed by the multiplication of the terms by the denominator of the fraction. So far, then, we run nearly parallel with Euclid's argument, however different our routes may seem to be. Nothing lost and nothing gained, then, by the change, thus far.

There is one point of view under which exception will be taken by many to Mr. Browning's definition:—that the cases are very few in which *we can exhibit the arbitrary fractions* of any one of the quantities concerned; either in the same form as the original, which we hold to be a superfluous condition,—or in any form whatever, which is a more weighty consideration. We only indicate it here—not discuss it.

If algebra be considered, as many writers of the present day consider it, the "act of combining symbols according to given laws," there will be as many algebras as there can be formed laws of combination—that is, innumerable ones. Mr. Browning says of such algebras, that each "should have Rules limited by its Definitions; and that an extension of the Definitions is the only license for an extension of the Rules." Considering the "Definitions" to signify the laws of combination, and the "Rules" to signify the resulting formulæ, we quite concur in his statement. We must guard ourselves, however, by saying that the *interpretation* of those resulting formulæ, and of everything obtained by means of them, must also be consistent with the ideas upon which the laws of operation were founded. We can introduce into the interpretation nothing different from, nor even more special than, what we introduced amongst the original conditions. Nothing can be explicitly got out of an equation that was not implicitly put into it. The extrication is all that we can do.

This is a view which, obvious though it be, is often forgotten in the course of a general system of reasoning. We so often find assumptions which are not contained in the "definitions" in such reasonings, that we habitually look out for them; and though, by some modification or other, some of these may be removed or otherwise deduced, yet it very often happens that the whole force of the reasoning *as reasoning* is rendered nugatory. It appears to us that Mr. Browning has a little to do in the way of amendment here,—though we cannot suggest *how it is to be done.*

His definition of proportion (p. 11) is tantamount to this: that if

$$A = \frac{y}{z} . B, \quad \text{then } C = \frac{y}{z} . D;$$

$$A > \frac{y}{z} . B, \quad \text{then } C > \frac{y}{z} . D;$$

$$A \angle \frac{y}{z} . B, \quad \text{then } C \angle \frac{y}{z} . D;$$

for all values of y and z expressible in finite terms. In this if y and z be not numerical symbols, we apprehend that the term "fraction" will be deemed inappropriate; and not only so, but that the definition itself is without distinct meaning. We have viewed them, then, as "numerical symbols." On the next page, however, they are for the present deprived of their arithmetical character, and are directed to be understood as "symbols of ratio" only. This seems to us to invalidate the definition itself; and we apprehend that, to render this consistent, a new definition of ratio which does not involve *any numerical considerations whatever*, ought to be given. We remit this to Mr. Browning's consideration.

Again, what idea can we form of adding, substracting, multiplying, and dividing *ratios*, when the ratio itself is deprived of all defined meaning? Symbols of number they are not allowed to be,—and symbols of magnitude (or of any kind of quantity) it would be preposterous to suppose Mr. Browning meant them to be. This however is the pivot upon which Mr. Browning's escape from the difficulty of incommensurables entirely turns. How it happened that the very terms "factor" and "quotient" occurring in his investigations respecting his symbols of ratio, did not enforce upon his mind that he was really conducting an *arithmetical inquiry*, he himself, by looking back at the history of his own mind during the research, will be best able to tell. Such lapses are, however, to be expected in all attempts at logical generalization founded on mere generalizations or changes of definition. Definition is a two-edged sword; and few persons in wielding it escape a cut or two from the back-edge.

Till this fundamental difficulty is removed it would be useless to pursue the mere consequences. It is sufficient to say generally that the work itself manifests great ingenuity and much real skill in dealing with very abstract and difficult topics. There are many instances of consummate address in dealing with the details of his reasoning; and we think that when a more intelligible basis is laid for the superstructure, the greater part of his materials will be found to be of a long-enduring character. It is by these that we were led in an earlier page to say that Mr. Browning has "made a step in advance;" and with the caution we have given, we strongly recommend his book to the careful reading of all who take interest in this recondite inquiry.

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[9] We wish the term "quantity," or something analogous, were by common consent adopted instead of "magnitude." The "magnitude of a force" is indeed a common but an awkward expression; and it has led to much quibbling and inconsecutive reasoning in the elements of mechanical science. But the "magnitude of a period of duration" involves an absurdity too gross even for the "magnates" of scientific license in language and demonstration. Yet we want the phrase "magnitude of the time," in order to perfect generality, if we must be compelled to use the term magnitude in these researches. Even Mr. Browning is not uniformly consistent on this point.

PNEUMATIC LIFT.

Fig. 1.

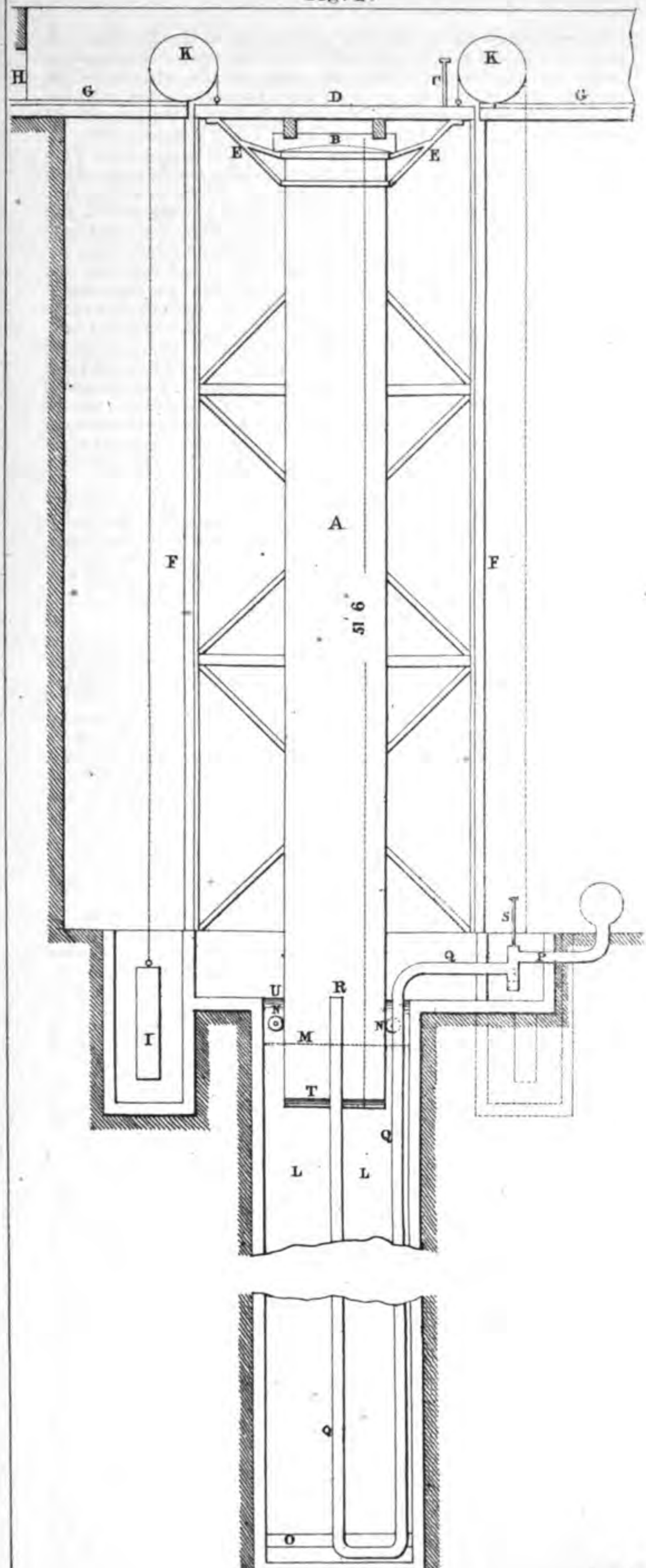
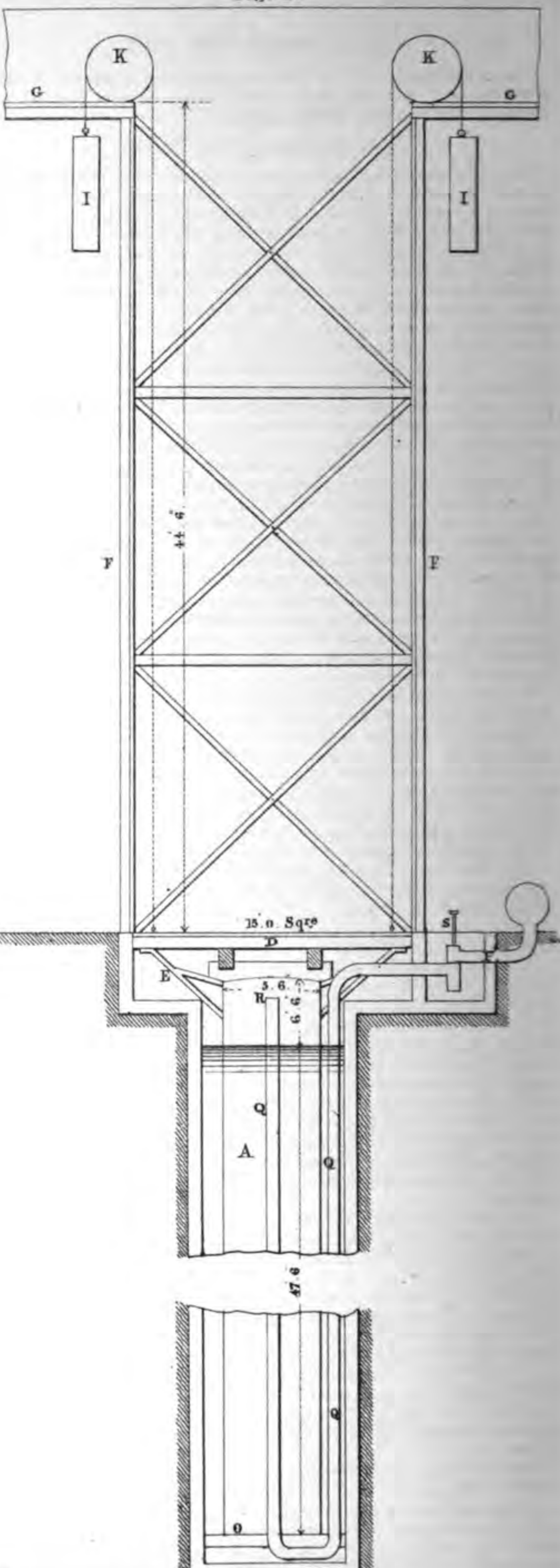


Fig. 2.



SCALE.

ON A PNEUMATIC LIFT.

On a Pneumatic Lift. By Mr. Benjamin Gibbons, of Shut-End House, near Dudley.—(Paper read at the Institution of Mechanical Engineers, Birmingham.)

(*With Engravings, Plate* XVIII.)

The Pneumatic Lift described in the present paper is employed to raise the ore, coal, and limestone for charging four smelting furnaces at Corbyn's Hall New Furnaces, near Dudley. In some districts the levels of the ground admit of the furnaces being charged by wheeling the materials on a level platform from higher ground to the top of the furnaces, but in general these have to be raised by machinery to the level of the top of the furnaces, the height raised being about 40 to 50 feet. The usual plan of raising the materials is by an inclined plane, which rises from the ground to the top of the furnaces at an angle of about 30°; there are two lines of railway upon it, and a travelling platform on each line, drawn up by a steam-engine by means of a chain passing over a pulley at the top of the inclined plane. The two platforms balance one another, one of them descending while the other ascends, and the top of each platform is made horizontal and works level with the ground at the bottom and with the stage at the top of the furnaces, so that the barrows of materials are readily wheeled on and off the platforms; several barrows are carried by each platform. A rack is fixed on the inclined plane along the centre of each line of railway, and a catch is fixed on the moving platform which falls into the teeth of the rack in ascending, for the purpose of stopping the platform and preventing an accident in the case of the chain breaking; but the use of this catch is found to be inconvenient in practice, and is generally omitted. There is a difficulty in stopping the platform at the required level, and the inclined plane is objectionable from the space which it occupies and the expense of its construction.

Where the inclined plane cannot be employed, the power of the steam-engine is not employed directly to draw up the materials vertically by a chain, because of the difficulty in working it conveniently and safely, to stop the platform at the correct level for wheeling the barrows on and off, and prevent the risk of serious accident by the chain breaking, particularly in the night work. At some iron works an endless chain is used for this purpose, with a series of buckets fixed upon it, which are filled with the materials at the bottom, and empty themselves into the furnace by turning over at the top. This lift is not suitable for supplying more than one furnace; and when there are more than one furnace it is most advantageous to employ a lift that will take up the materials in the barrows, ready for wheeling at the top to the different furnaces.

Another plan for lifting vertically is by means of a water-balance; the platform on which the barrows of materials are raised is suspended by a chain passing over a pulley at the top, and a bucket is attached to the other end of the chain; the platform in descending draws up the empty bucket, and when the platform is loaded the bucket is filled with water until it overbalances the loaded platform and draws it up. There is an important objection to this plan, that the bucket descends with an accelerated velocity, and a friction break has to be used to check the velocity to prevent a violent concussion on stopping its momentum at the end of the descent; this causes a risk of accident from breakage of the chains, and the friction break is also liable to derangement and extensive repairs.

At the Level Iron Works near Dudley an instance occurred where a vertical lift had to be introduced in consequence of the furnaces being raised 16 feet in height; there were two furnaces, originally 34 feet high and raised to 50 feet, and at the original height the materials were wheeled on the level to the top of the furnaces. When the height of the furnaces was increased, the materials were required to be raised 16 feet, and a vertical lift was necessary in consequence of the situation being so much confined by a canal as to prevent the adoption of an inclined plane. For this purpose the author of the present paper constructed a pneumatic lift, worked by the pressure of the air from the blowing-engine that supplied the blast for the furnaces. This lift was designed with the object of avoiding the objections to the plans of vertical lifting previously in use, and obtaining a safer and more economical application of power.

This Pneumatic Lift consisted of a heavy cast-iron cylinder, 4 ft. 4 in. diameter inside, closed at the top, and inverted in a well filled with water, in which it was free to slide up and down like a gasometer; this cylinder was suspended from the top by a chain fastened to the circumference of a pulley which was fixed on a horizontal shaft above the level of the top of the furnaces. A pipe from the air-main was carried down the well and turned up inside the cylinder, rising above the surface of the water, and when the blast was let into the cylinder through this pipe the cylinder was raised in the water by the pressure of the compressed air against the top; this pressure was about 2 lb. per square inch. A platform for raising the barrows of materials was suspended by a chain from another pulley on the same shaft as the former pulley, and the platform was guided in its ascent by vertical framing. The cylinder was heavy enough to draw up the platform with the load upon it by descending into the water when the blast was withdrawn; and the empty platform was lowered by admitting the blast into the cylinder and thus raising it. The cylinder was lowered again by opening a valve which let out the compressed air, and its velocity of descent was regulated by opening this valve more or less. The velocity of the platform both in rising and falling was completely under command, by regulating the opening of the valves for admitting or letting out the compressed air, and the velocity was gradually checked towards the end of each stroke with certainty and ease, so as always to stop the platform without concussion. The height to which the cylinder was raised was only 5 feet, and the two pulleys were made of different diameters so as to raise the platform 16 feet; the load raised upon the platform was about half-a-ton.

This pneumatic lift has now been in constant work for thirty-nine years, and has worked quite satisfactorily during the whole time; it has not required any repairs except renewal of the chains and repair of the rubbing parts. An accident happened once by the chain breaking whilst lifting, and the platform fell about five feet, causing a shock to the man going up with it, but no injury was done to the machinery.

An improvement on this pneumatic lift was made by the author of the present paper, in constructing a lift on a considerably larger scale at the Corbyn's Hall New Furnaces; this is shown in the accompanying engraving, and was constructed at the time of building the furnaces. The height to which the materials have to be raised is 44 ft. 6 in., and the present plan was designed to prevent the risk of an accident occurring through the breaking of a chain. There are four furnaces supplied by this lift, which is fixed between two of them, and the four furnaces are connected on the same level by the staging at the top, on which the barrows of materials are wheeled from the platform of the lift.

In this lift the platform for raising the barrows of materials is fixed on the top of the air-cylinder, and it is raised by the pressure of the blast, the action being the reverse of the former plan. In Plate XVIII. the lift is shown at the highest position in fig. 1, and at the lowest position in fig. 2. A, is the air-cylinder, which is 5 ft. 6 in. diameter, and 51 ft. 6 in. long, constructed of riveted wrought-iron plates averaging $\frac{1}{4}$-in. thick, the plates being $\frac{5}{16}$-in. thick in the lower part and $\frac{3}{16}$-in. in the upper part; the cylinder is closed at the top and open at the bottom, and has a throttle-valve B, 8 inches diameter, in the centre of the top, which is opened by pressing down the foot lever C, fixed upon the platform.

D, is the platform on which the materials are raised; it consists of planking carried on timber bearers, which rests upon the edge of the cylinder top, and upon four wrought-iron brackets E, E, carried out diagonally from the cylinder to steady the platform, and fixed to two hoops passing round the cylinder.

F, F, are four timber guides placed at the corners of the platform, and connected at top to the level stage G, G, upon which the barrows of materials are wheeled to the mouth of the furnace H. These guides are faced with angle-iron on the inner edge, and a corresponding angle-iron is fixed in a notch at each corner of the platform D, to slide easily up the guides; the height that the platform rises is 44 ft. 6 in.

Four cast-iron balance-weights I, I, are suspended outside the guides F, F, by chains which pass over the pulleys K, K, in the top framing, and are attached to the four corners of the platform D. These four balance-weights weigh about 6½ tons, and the air-cylinder and platform together weigh about 7 tons; leaving an unbalanced weight of about ½-ton to bring down the air-cylinder and empty the platform.

The air-cylinder A, descends into a well L, L, which is filled with water to the level M; and it is guided by four rollers N, N, 6 inches long and 7 inches diameter, each of which works against a strip of bar-iron riveted on the cylinder, 4 inches wide and the whole length of the cylinder. At the bottom of the well a foundation of timber O, is fixed, to form a stop for the cylinder in descending, and the cylinder rests upon the timber when at the lowest position by a ring of angle-iron riveted round the bottom edge. The cylinder is stopped on rising to the top by a wood block fixed on each of the four guide-posts F, F, which stop the platform at the level of the top stage G, G.

P, is a cast-iron pipe 7 inches inside diameter, which conveys the compressed air from the air-main, and the pipe Q, of the same size, carries it into the cylinder, passing down to the bottom of the well between the cylinder and the side of the well, and rising up the centre of the cylinder; the end of the pipe at R, is open and stands above the level of the water.

The valve S, regulates the admission of the compressed air into the cylinder when the platform is raised, and also lets out the air from the cylinder when it is lowered. This valve consists of a plug or deep piston, sliding in a vertical bored cylinder of the same diameter as the air-pipe, which is closed at the top and open at the bottom. When the plug is in the lowest position, as shown in fig. 1, it closes the bottom of the cylinder, and the communication is opened between the pipes P and Q, and the compressed air passes into the air-cylinder A, and raises it, with the platform D, by the pressure of the air upon the top of the cylinder and upon the surface of the water; the pressure of the compressed air is 2⅓ lb. per square inch, and the water is depressed inside the cylinder to T, and raised to U outside the cylinder, making a difference of level of 5 ft. 4 in. When the platform is required to be lowered, the plug-valve S, is drawn up to the top, as shown in fig. 2, closing the pipe P, that admitted the compressed air, and leaving the pipe Q, open to the external air to discharge the compressed air from the cylinder A; this discharge is accelerated by opening the escape-valve B, at the top of the air-cylinder by means of the foot-lever C.

The total pressure of the compressed air against the top of the air-cylinder is 3½ tons; and deducting the unbalanced weight of the cylinder and platform (½-ton), this gives an available lifting power of 3 tons. The load of materials raised varies according to the working of the furnaces, and the average load of materials raised each time is 1½ tons, exclusive of the barrows and men, or about 2 tons gross weight. The lift is raised 16 times per hour during 20 hours in each day of 24 hours, or once in 3⅓ minutes; and the total weight of materials raised each day is about 500 tons. The time of raising the platform from opening the inlet valve to reaching the top is from 50 to 70 seconds, according to the load in regular work; and the time of lowering the platform is from 30 to 50 seconds, according to the degree of opening of the escape valve on the top of the air cylinder; the empty platform can be raised in 45 seconds, and lowered in 25 seconds, with the present size of apertures.

In raising the platform the inlet-valve is kept full open until the platform arrives at 14 inches distance from the top, when it catches a lever which gradually draws up the plug of the inlet-valve, so far as nearly to close the pipe leading to the air-cylinder; this checks the moving power and causes the velocity of the platform to be so much retarded by the time it arrives at the top, that the platform stops dead against the wood blocks without any concussion being felt. The platform is held firmly up to these stops by the pressure of the air as long as may be required, without any recoil, and without requiring any catches to hold the platform, as it cannot descend in the least unless the air is allowed to escape from the cylinder, and the supply from the air-pipe keeps it full in the case of any leakage taking place. When the platform is raised empty, a wood block turning on a pivot is slipped by the foot under the lever that closes the inlet-valve, so as to begin closing the valve sooner; this is adjusted according to the velocity of the ascent of the platform, and regulates the lifting power so as to prevent any concussion on stopping at the top of the ascent.

When the platform arrives at the top, the men who go up with the barrows wheel them off to discharge the materials into the several furnaces; and as soon as the empty barrows are brought back, the platform is lowered by drawing up the plug of the inlet-valve to the top, which shuts off entirely the supply of compressed air, and opens the exit below the plug for the air in the cylinder to escape. This is done by the men on the platform at the top by means of a rod from the valve carried up the framing; and the escape-valve on the top of the cylinder is then opened, and kept open till the platform is near the bottom, when it is closed, and the velocity of the platform is so much checked before stopping, that scarcely any concussion is felt at stopping; it can easily be stopped without any concussion.

The velocity of the platform is also gradually checked in descending by the gradual immersion of the cylinder in the water, which reduces the unbalanced weight of the cylinder. The total loss of weight of the cylinder when at its greatest immersion in the water is ½-ton, which reduces the effective unbalanced weight of the cylinder and platform from ½-ton to nothing; but the weight of the four chains, amounting to ⅛-ton, is added to the balance-weights at the beginning of the descent, and is transferred to the platform at the end of the descent, and the result is that the moving power causing the descent of the platform is reduced ¼-ton during the descent, being about ⅜-ton at starting and ⅛-ton at stopping; this moving power can be altered as required, by altering the balance-weights.

This lift was originally constructed to work only two furnaces, and the air pipe was only 5 inches inside diameter, and the time of raising the platform was usually 140 seconds; when the other two furnaces were added it became necessary to add a second air pipe of the same size, for the purpose of working the lift twice as fast; one pipe only is shown in the accompanying drawing, equal in area to the two actually employed. When the lift was constructed it was found that the well could not be made sufficiently water-tight, on account of a slight disturbance in the strata from the getting of the neighbouring mine, and an outer cylinder of similar construction to the air-cylinder, was consequently sunk into the well; this outer cylinder having a close bottom, and holds the water in which the air-cylinder works, like the tank of a gasometer.

The quantity of air blown into the cylinder each time of raising it is 1,128 cubic feet, and the total quantity per day of 24 hours is 360,960 cubic feet, or about 12 tons weight of air; the total quantity of air blown by the blast engines is 16,185 cubic feet per minute, and 23,306,400 cubic feet, or about 780 tons weight of air per day of 24 hours. The proportion of the total blast that is used by the lift is therefore as 12 tons to 780 tons, or $\frac{1}{65}$ of the whole, and consequent $\frac{1}{65}$ part of the total power of the blowing engines is employed in working the lift; there are two blowing engines employed The pressure of the blast is 2¾ lb. per square inch, and the total engine power is consequently 165-horse power; and the air consumed by the lift being $\frac{1}{65}$ of the total blast, it follows that $\frac{1}{65}$ of 165, or 2½-horse power, is the power that is actually employed in working the lift; this power being a constant power acting during the whole day instead of acting merely at the times when the lift is rising. The actual power required to elevate the lift, with the average gross load of 2 tons on the platform, or 2¼ tons total weight, including the average unbalanced weight of the cylinder and platform, raised 44 ft. 6 in. in 70 seconds, is 6-horse power; the greatest power employed being 3½ tons raised that height in 70 seconds, which amounts to 9-horse power, and the least is ¼-ton raised in 45 seconds, amounting to 1-horse power. Thus it appears that the work of 6-horse power occurring at intervals, is performed by a power of 2½-horse power constantly acting.

The total consumption of coal-slack by the blowing engines is about 13 tons per day of 24 hours, consequently the expense of working the lift is $\frac{1}{65}$ part of this, or 4 cwt. of coal-slack per day, costing about *5d.* per day; and as this lift raises 500 tons of materials per day, it follows that 100 tons are raised 44 ft. 6 in. high for *1d.*, or 4,450 tons are raised 1 foot high for *1d.* The quantity of air required to fill the cylinder of the lift is 1,128 cubic feet, and the total contents of the blowing cylinders for one double stroke is 1,056 cubic feet; consequently, an increase in the rate of the engines of one stroke per minute is sufficient to raise the lift in 70 seconds, without diminishing the supply of air for the blast of the furnaces.

These two circumstances cause an important economy in working this pneumatic lift; a small power constantly acting is sufficient to do the work, and the sudden application of this power concentrated into a short time causes but a small increase in the rate of the engine. The total cost of this lift was about *500l.*; and the cost of an inclined plane lift, including the engine for working it, would be about double that amount.

This pneumatic lift has been in constant work for the last nine years, and no accident or stoppage has occurred with it, except that the chain of one of the balance-weights broke once; the platform stopped with a very trifling fall, and was held in its position by the pressure of the air; no damage was caused, and the lift was got to work again within an hour's time. The only repairs that have been required since it commenced working, are the renewal of the chains of the balance-weights and repair of the pulley-bearings: the set of chains can be taken off and replaced whilst the lift is standing during the dinner hour, without causing any delay to the work. This is an important advantage, as it is essential to ensure a continued supply of materials to the furnaces, and to avoid any risk of stoppage for repair of the lifting machinery.

The platform in this pneumatic lift cannot fall quicker than the time in which the whole body of air can escape, amounting to

1,128 cubic feet; and the greatest leakage that can arise from an injury of the cylinder cannot let it down so rapidly as to cause any damage. The load is supported by an air cushion during the whole time of its ascent, instead of depending on chains or racks, which prevents any risk of its falling. The complete control over the motion of the platform that is given by the air-valve which regulates the entrance and exit of the air, gives the means of checking, stopping, or reversing the motion at any part of the stroke; and it prevents any concussion at the ends of the stroke, although the lift has a quick action, and is stopped dead at each end of the stroke at the exact level required. The friction of the lift is very small, as the cylinder works through a water joint; and in consequence of the low pressure at which it is worked the loss at any leak is very small, and the strain upon the joints is much diminished.

This pneumatic lift is of course applied most economically and conveniently in the case of blast-furnaces, where the compressed air can be obtained very economically and without additional machinery; but it is probable that its application may be extended advantageously to several other cases, such as raising railway wagons, or even railway trains, discharging vessels at quays, and various other purposes, and it possesses several advantages which make it deserving of consideration. The low pressure at which it is worked causes great simplicity and economy in the construction and working, the loss at leaks being reduced, and the joints easier kept in order; and the friction is very small as the cylinder works through a water-joint. Where the lift is not required to be always working, but only to be worked at intervals, a further economy could probably be effected by employing a reservoir for the compressed-air, to accumulate power during the time that the lift is not required to work, and thus reduce the size of engine requisite for the work; a large capacity of reservoir could be constructed at a moderate expense, on account of the low pressure upon it. It may be mentioned that at the Corbyn's Hall New Furnaces the reservoir of compressed-air contains 5,000 cubic feet, at the pressure of the blast 2⅓ lb. per square inch, and consists of four wrought-iron cylinders from 6 to 8 feet diameter, constructed of riveted plates from $\frac{1}{8}$ to $\frac{3}{16}$-inch thick; and the cost would be about 3*l.* per 100 cubic feet for air reservoirs of this construction.

Remarks made at the Meeting after the reading of the foregoing Paper.

Mr. Buckle observed that he had frequently seen this lift at the works of Mr. Gibbons, and could bear testimony to its smooth and exact working and its uniform motion. He was of opinion it might be usefully applied to a variety of purposes, as it was undoubtedly the best description of lift that he was acquainted with for its present purpose.

Mr. Beyer said it appeared to him to be a very simple and efficient mode of raising the materials.

Mr. Cochrane observed that a similar lift was employed at his iron works, for which he had been indebted to Mr. Gibbons; it had proved entirely satisfactory, and there had never been any accident with it.

Mr. Gibbons remarked that his object in bringing the lift before the Institution, was to render it more generally useful; for in his opinion it might be advantageously applied to a great variety of purposes, more especially at railway stations and in the docks. It would be a great convenience for raising and lowering trucks, and for loading or discharging vessels; as the platform could be quickly raised or lowered to any exact level, and could be stopped at any point at pleasure without concussion, and held quite firm in the position without any danger of falling, as long as might be required.

Mr. Slate thought it was applicable to lifting railway wagons; and considered that a small blowing engine might be advantageously employed for the purpose, working at a much quicker rate than usual, even 700 feet per minute, like the pistons of locomotive engines; the leakage of the piston would then be of much less consequence.

M. Cowper suggested that steam might be available for the purpose of raising the lift where there was not a blowing engine at work; for although there would be a loss of steam by condensation on the surface of the water, that loss would be very small compared to the whole quantity of steam employed, as the surface of the water would become quickly heated by the steam, but the heat would only extend very slowly downwards in the water.

Mr. Gibbons remarked that he considered there would be a difficulty in applying steam, from the difficulty of keeping the joints steam-tight.

M. McConnell referred to the use of hydraulic cranes which had been introduced at some railway stations and other places; and observed that it appeared to involve the question of the relative cost and advantage of air and water as the means for communicating the power.

Mr. Gibbons observed that the pistons necessarily used in hydraulic cranes were liable to get out of order, and were a source of expense and trouble, and there was also considerable loss of power from friction, which was not the case in the pneumatic lift. He thought that by the latter plan a whole railway train might be raised a considerable height, without the motion being felt by the passengers.

REGISTER OF NEW PATENTS.

SAWING AND CUTTING WOOD.

Henry Francis, of Chelsea, Middlesex, engineer, for "*improvements in sawing and cutting wood.*"—Granted January 4; Enrolled July 4, 1849.

The improvements relate, firstly, to the construction and use of saws so as to improve and facilitate their cutting wood. Saws have hitherto usually consisted each of a series of teeth, and the teeth of a saw have each been alike, and they have been bent in alternate directions. The consequence of this construction has been, that the wood cut thereby has had larger or smaller saw-cuts on the surfaces, according to the teeth used; these observations apply to saws generally, both straight and circular. Now according to this part of the invention, the teeth are combined with cutters, and the cutters are made to alternate with the teeth, so that a tooth follows a cutter in regular succession, though this arrangement may be varied. The teeth are to be of any of the ordinary constructions, according to the class of saw which is to be made, and the cutters preferred are "fleur teeth," that is, they are not hooked or undercut, but incline both ways, and are bent alternately on either sides, as the teeth of saws have hitherto been bent; but the teeth are left unbent, by which means the cutters make a cut on either side, and the teeth remove the wood between the cuts. It is of great importance that the cutters on either side should follow one another with accuracy, in order that the cut made on either side may be smooth and true, and that the two cuts should be parallel,—for which purpose a file is fixed in a flat block, the file being at one edge, and at a distance below the surface of the block equal to that to which the cutters of a saw are bent, such block being eight or ten inches long and three or four inches wide; by which means the projecting cutters on either side are made correct, so as to follow each other in the same line. The flat block when used rests on the surface of the saw, and is to be moved to and fro so that the file will come against the cutters, and thus the cutters be filed away at the outer sides of the points till they are all sharp, and range correctly one after the other. This block will also be found useful when sharpening saws of the ordinary construction, and forms part of the invention. In using these saws in saw-mills, in place of causing them to move up and down vertically, or at right angles to the surface of the wood as heretofore, a better cut may be made and with less power by having the saw-gate so arranged as to move in an inclined position, generally at an inclination of about 67° to the surface of the wood. In cutting off thin slices of wood with the improved saws, it is preferred to employ a smooth metal plate or table, with a transverse slit or opening, the metal on the sides of the opening being formed to an inclination. The wood is moved longitudinally on this plate, and the saw used (which is to be straight) is inclined, so as to be parallel with the opening through the plate, and the edge of the saw protrudes a distance (in a direction to meet the moving wood), according to the thickness of wood to be cut off; a quick reciprocating motion is given to the saw as the wood moves forward on the bed-plate, and the portion cut off descends through the plate as a shaving in a plane.

The second part of the invention relates to improvements in mounting saw-gates, which are preferred to be inclined in place of vertical, and consists of employing springs; and the springs are formed of such strength, that they will lift the saw-gate, by which means the working is improved.

The third part of the invention is applicable to the sawing of wood into planks and boards from timber of irregular sides, to avoid shaping the timber first before it is fixed in a mill,—and consists of guiding each saw, so as to ensure the several saws stretched in a saw-gate to cut parallel boards or planks, in place of depending on the great tension now resorted to for preventing the saws being led away by knots or inequalities of the wood. In carrying out this part of the invention, a plate of wood is fixed to the irregular surface of a log of wood, the outer surface of the fixed piece being true, and moved against a guide-piece in the mill, so as to cause the log to pass through the mill truly, notwithstanding the irregularity of its sides; and thus the boards or planks cut off will be parallel, in order to ensure which a bar of hard wood is fixed across the saw-mill, having slits cut in it at the intervals apart at which the boards are to be cut, and this bar is so fixed that the backs of the several saws shall enter the cuts and move up and down in them, and are guided truly by them.

RAILWAY WHEELS.

William Edward Newton, of Chancery-lane, Middlesex, civil engineer, for "*a certain improvement or improvements in the construction of wheels.*" (A communication.)—Granted January 11; Enrolled July 11, 1849.

This invention of improvements in the construction of wheels relates to a new or improved method of constructing railroad-wheels, applicable to locomotive engines, tenders, and the truck-wheels of railroad cars, and for other purposes; and consists in constructing the wheel of three principal pieces—namely, the nave, the central part (which consists of plates of iron of a dished shape), and the rim; these three parts are connected and secured together in a peculiar manner, so as to form a strong, and at the same time, cheap wheel.

Fig. 1 shows the improved wheel in a side elevation; fig. 2 is a transverse section of the same, taken in the line x, x, fig. 1, showing the mode of holding the several parts together by small screw-bolts near the axle; and fig. 3 is a cross-section in the same line, showing another mode of holding and forcing the central plates together, so as to tighten contact with the rim—in this case the object is effected by a collar and screw upon the axle, and a different mode of attaching the plates to the rim by small bolts or rivets near the rim. Fig. 4 is a cross section, on an enlarged scale, showing the attachment of the side-plates to the rim, by the dovetail-mode; and figs. 5, and 6, are side and edge views of a cast-iron piece, to thicken and support the eye of the plates when made of sheet-metal.

Fig. 1.

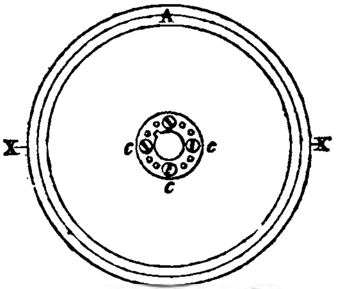


Fig. 2.

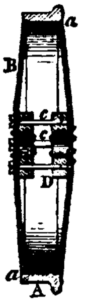
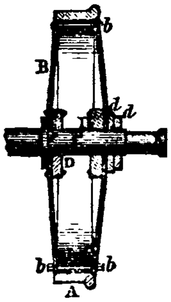


Fig. 3.



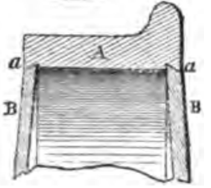


Fig. 4.

Fig. 5.

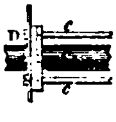


Fig. 6.

The two circular side-plates, which act as the spokes of the wheel, are made with plain surfaces, or corrugated in concentric or radiating lines; and, whether plain or corrugated, have a convexity outward, so that they may be forced against the rim, which will embrace their exterior edges or peripheries. The best mode of attaching these side-plates to the rim is to turn a groove, commencing at the inner side and edge of the rim, cutting the same outwards towards its largest circumference in depth; the thickness of the plate forming a seat for the same to rest upon, and terminating the groove, in its outward direction, with the largest diameter of cut inside, and the lesser outside, in the form of a dove-tail. The edges of the plates are then turned and fitted to correspond, excepting that the diameter of the plates is greater by about $\frac{3}{16}$ of an inch than the groove which has been turned in the rim. The rim is then sufficiently expanded by heat to admit of the greater diameter of the plates entering into the groove prepared for them in the rim; and, on the rim cooling, it will be made to shrink itself upon the edges of the plates. The side-plates are further secured in their places by screw-bolts near the axle; which bolts are intended to compress and draw together the convex parts of the plates at or near their centres, by which their peripheries are forced to expand until they come into close contact and form a tight joint with the rim. By means also of these bolts or screws the plates may be tightened upon the rim at any subsequent period, when, from use or wear, their contact becomes impaired, or they become loose in the groove. The inventor prefers to construct this wheel of wrought-iron, with the exception of the cast-iron pieces represented at figs. 5, and 6. The rim may, however, be of cast-iron (in which case its thickness should be considerably increased), either with or without a chilled running surface; or it may be made of wrought-iron, plated with steel, or made wholly of steel; and the side-plates may be of cast-iron, or other metal, or composition of metal.

In the drawings, A represents the rim-piece; B, are the side-plates; C, is the axle; D, are cast-iron pieces, to support the plate at the eye, when the same is made of sheet-iron, which pieces are firmly riveted to the plates. To make a wheel wholly of wrought-iron, the rim A, is rolled into proper shaped bars, in any convenient manner in common use, and is made 5 inches wide by 1 inch thick, with a flange raised $1\frac{1}{8}$-inch higher than the bar at one side; it is then bent into a circle and welded, and is heated and placed upon a suitable mandril, and made perfectly round; after which, it is chucked in a lathe, and the male part of the dovetail groove, as seen at *a*, *a*, fig. 4, is formed at each inner side and corner. The side-plates B, are made from plate or sheet-iron, of $\frac{3}{16}$ of an inch thick, a little more or less. They are first cut into a circle, and afterwards swaged, and made convex with a suitable press and swaging dies; or the press and dies may be constructed in such a manner as to cut the circle outside the eye at the centre and raise the convexity at the same operation.. The plate is then chucked in a lathe, and the edge turned tapering and outwardly towards the convex side, to form the female part of the dovetail joint, when the plates and rim are put together. The largest diameter of the tapering edge of the plate is made from $\frac{1}{8}$ to $\frac{3}{16}$ of an inch larger than the smallest inside circumference of the groove. The cast piece (figs. 5, and 6), is then drilled and tap-screwed, and well riveted upon the concave side of the plate, when the principal parts of the wheel are ready for putting together. The rim is then heated, and allowed to shrink itself upon the edges of the plates, which by this means are held in the dovetailed grooves formed in the rim,—the convex sides of the plates being outwards: four tap-bolts *c*, *c*, made of $\frac{5}{8}$ round iron, are screwed into and hold the centre of the plates together, and serve to compress the convexity of the plates, expanding their peripheries in such a manner as to tighten up contact at their edges upon the rim, if from any cause they shall at any time afterwards get loose. The above is the best mode;—these side-plates B, may however be joined to the rim by turning their edges square and sinking a recess the depth of the thickness of the plate at the inner side and edge of the rim, to fit and correspond with the edges of the plates; when, without expanding the rim, the plates are placed therein, and secured by screw-bolts or rivets, as shown at *b*, *b*. The centres of these side-plates may be held and forced inwards towards each other by means of a collar *e*, and screw-nuts *d*, *d*, on the axle.

The patentee claims the forming of a wheel of three principal parts—a rim-piece A, and nave, with two side-plates B, B, made with plain or corrugated surfaces, and formed more or less convex outwardly; the whole constructed, put together, fastened, and having tightening-screws, as described; and this he claims, whether these principal parts are put together by means of dovetailing the side-plates into the rim-piece, as shown at *a*, *a*, *a*, (figs. 2, and 4), or whether they are attached by means of screw-bolts or rivets passing through the plates near the rim, as shown at *b*, *b*, (fig. 3), or whether the plates are tightened upon the rim by means of screw-bolts placed near the axle, as shown at *c*, *c*, *c*, (figs. 2, and 6), or by a screw-nut and collar upon the axle, as shown at *d*, *d*, and *e*, (fig. 3), or whether by any other analogous means by which the outward convexity of the plates may be forced inwards or towards each other at or near their centres, thereby causing their peripheries to expand and come into full contact with the rim.

SCREW PROPELLERS.

Wakefield Pim, of Kingston-upon-Hull, engine and boiler-maker and builder of iron steam-ships, for "*improvements in propelling ships or vessels.*"—Granted January 25; Enrolled July 25, 1849.

The improvements relate to the propulsion of vessels by a screw propeller, placed at the stem or fore part of the vessel, in addition to, and in combination with, a propeller at the stern or hind part of the vessel. The propellers work in recesses formed to receive them in the stem and in the dead wood of the vessel, and are fixed upon the same shaft extending from one end of the vessel to the other, parallel with the keel; or they may be fixed upon two distinct shafts, connected by gearing, so that both will rotate in the same direction and act, the one to impel, and the other to draw forward, the vessel.

WHITE-LEAD PAINT.

Hugh Lee Pattinson, of Washington-house, Gateshead, chemical manufacturer, for "*improvements in manufacturing a certain compound or certain compounds of lead, and the application of a certain compound or certain compounds of lead to various useful purposes.*"—Granted February 14, 1849; Enrolled August 14, 1849. [Reported in *Newton's London Journal.*]

The patentee commences his specification by stating that he has discovered that when half an equivalent or thereabouts of lime, soda, potash, ammonia, or barytes, is added to one equivalent of chloride of lead, both in solution, the whole of the lead is precipitated as a definite compound of one atom of chloride of lead and one atom of hydrated oxide of lead, which, when dried at 212° Fahr., or under, has the composition just stated or $PbCl + PbO \cdot HO$, but when dried at a temperature varying from 212° to 350° it loses more or less of the atom of water and becomes or approaches to $PbCl + PbO$. If less than half an equivalent of the alkaline precipitant is employed, the same definite oxichloride of lead is precipitated, but some of the chloride of lead remains in solution. The oxichloride of lead, thus produced, possesses a brilliant white colour and great "body" qualities, which render it an excellent pigment and useful for most purposes to which white-lead is applicable.

The invention consists in the manufacture and application of this oxichloride of lead, or such other compounds of oxide of lead and chloride of lead as shall result from the following mode of manufacture:—The patentee states that lime will answer as well for the purposes of this invention as any other of the alkaline precipitants above-named; and he prefers to use it on account of its cheapness. He first makes a saturated lime water, by throwing an excess of slacked lime into a tub, filling the tub with water, and allowing it to stand until it becomes clear: the clear liquor will contain in from 770 to 780 parts, 1 part of lime; and therefore 1 cubic foot of it will contain 567 or 568 grains of lime. A solution of chloride of lead is then made by dissolving it in boiling water, in the proportion of 1 lb. of pure chloride of lead to 1 cubic foot and a fifth of water: as some water contains earthy salts (sulphates or carbonates, or both) which precipitate lead, the patentee prefers to use such an excess of chloride of lead, as will compensate for this loss. The solution is prepared by introducing the chloride of lead and boiling water into a wooden barrel, provided with a revolving agitator; and then it is run into cisterns to settle. The clear solution of the chloride of lead is mixed, while still warm (because if allowed to become cool it would deposit some of the chloride of lead), with an equal bulk of the lime water; on this taking place, the insoluble oxichloride of lead is immediately formed and speedily settles to the bottom of the cistern, leaving a clear supernatant liquor (a weak solution of chloride of calcium); and, after this liquor is drawn off, the precipitate is collected and dried.

As the operation of mixing the lime water and the solution of chloride of lead requires to be performed in an instantaneous manner, the patentee prefers to employ for this purpose two tumbling boxes, of about 16 cubic feet capacity, which are charged with the two liquids and simultaneously upset into a cistern, in which the oxichloride of lead is instantaneously formed, and from which the mixture flows into other cisterns where the oxichloride subsides.

The patentee states that although he has only mentioned pure crystallised chloride of lead in the description of the process, yet it is not absolutely necessary that it should be in this form; for a rough chloride, made from lead ore and its equivalent of muriatic acid, boiled to dryness, will answer, provided it be well washed, to free it from chlorides of iron, manganese, or other bodies likely to injure the colour of the oxichloride. The exact proportion of pure chloride contained in the rough chloride should be ascertained previous to use, in order that the proper quantity may be mixed with the lime-water. If, however, a solution of chloride of lead of uncertain strength is obtained, or lime-water not quite saturated, they can be used with but little disadvantage; for it is only necessary to be careful not to add an excess of lime (*i.e.*, not more than half the equivalent), which can be easily ascertained after a few trials, by filling the lime or lead tumbling-box more or less with its respective solution, as the trials may direct.

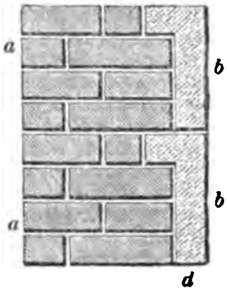
The patentee says that it will not be necessary to describe any particular mode of proceeding with soda, potash, ammonia, or barytes; for if ever it should happen that these bodies could be used in preference to lime, it would be merely necessary to make a solution of each of known strength, and to use it with chloride of lead in the same manner as the lime-water.

The patentee claims the manufacture of oxichloride of lead, having the composition of one atom of chloride of lead and one atom of oxide of lead, with or without an atom of water (or an oxichloride of lead as near this composition as the nature of the manufacturing operations may admit), by the use of chloride of lead and lime, soda, potash, ammonia, or barytes. And he claims the application and use of this oxichloride of lead as a white paint, as a base for coloured pigments, as an adhesive cement for joints, and for many other purposes to which white-lead is commonly applied.

WALLING.

John Taylor, of 22, Parliament-street, Westminster, architect, for "*an improved mode of constructing and fencing walls.*"*—Granted February 8; Enrolled August 8, 1849.

This invention relates to the construction of brick and other walls with a facing or ashlaring of stone, artificial stone, tiles, bricks, cement, earthenware, glass, or other suitable material. The facing is made into blocks of such form that each block may be suspended on the brick or other main work of the wall below, by a shoulder, and weighted by the brick or other work above, without bearing on the bed or under surface of the facing-block, so that it cannot be injured by the settling of the brickwork, as shown in the annexed figure. *a*, is the brickwork, three or more courses of which are first carried up, and the mortar-bed laid; then the facing-block *b*, is suspended thereon by the shoulder *c*; and, when the shoulder is weighted by the brickwork above, the bonding is complete. As a general rule, the height of the facing-blocks is to be such as to leave their weight suspended on the brickwork by the shoulder *c*, without the blocks bearing on the bed or lower surface *d*.



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* By a disclaimer, dated April 9, 1849, the patentee has struck out the words 'and fencing' from the title of his patent, which now reads thus:—'for an improved mode of constructing walls.'

PAPER-HANGINGS.

John Erwood, of Hoxton, Middlesex, paper-hanging manufacturer, for "*improvements in the manufacture of paper-hangings.*"—Granted February 15; Enrolled August 15, 1849.

These improvements relate to that class of paper-hangings known as coloured marble and granite papers, and such as are used for covering walls in houses and other buildings. In using the term "coloured marble papers," it is to be understood to mean all coloured marble papers, with the exception of those manufactured in imitation of white marbles.

In manufacturing marble and granite papers, two modes of operation are pursued in the application of the colour to paper to give the desired effect; one is by means of blocks having engraved surfaces, by which the colour is printed or transferred on to the paper; the other mode is by applying the colours by hand, by means of brushes and crayons, the veining and other effects required being executed according to the taste and skill of the workman. These modes of proceeding being well known, it is unnecessary to describe them further, the present improvements having reference to the hand-made marble and granite papers, or those in which the colour is applied with brushes and crayons by hand. To coloured marble or granite paper-hangings it has been usual to apply a coating of varnish after they have been hung or pasted to walls, to give them the glossy or polished appearance of the materials of which they are an imitation, but the colours used in the manufacture produce only a dull representation of the effect desired; whereas, by the patentee's improvements, the colours are so prepared and applied to the paper, as to be capable of receiving the desired polish in the ordinary manner of glossing or polishing papers known as "satin" papers; by which the necessity of varnishing the paper after it is hung is entirely obviated, the paper when so finished presenting a glossed or polished appearance, presented by the subsequent operation of varnishing.

In conducting this new manufacture of coloured marble papers, the patentee proceeds in a somewhat similar manner to the ordinary mode of manufacturing hand-made papers. The paper is previously prepared with a coating of colour as a groundwork, the colour used being suitable for the colour of the ground of the paper. The paper so treated having been properly dried, is laid on a board with the coloured surface uppermost, and the workman proceeds to give it a coating of the matter known in the trade as "satin white," or it may be satin white mixed with a colour; this is applied to the whole surface of the paper, by means of brushes; he then proceeds to delineate the marble on the moist or wet surface of the paper, produced by the application of the satin white, and, by preference, putting on what is called the veining first, which is performed with the ordinary crayons, the colours of which are suitable to produce the veining required for the character of the marble. The veining is next softened off by the ordinary softening brush, in order to blend the colour of the veining slightly with the groundwork or coating of satin white, so as to break the harshness of the outline; the colours are then applied, while the satin white is still in a moist or damp state, introducing them with brushes, in imitation of the kind of marble or porphyry to be represented; these colours are then smoothed down, or subdued and blended with the ground or coating of satin white. Thus it will be seen, the whole of the colours, with the exception of the preparatory coating mentioned, are introduced while the satin white is still wet, after which it will be complete, as far as regards the effect to be produced by the colouring matter, when it may be dried in the ordinary manner. The colouring matters used are the same as those employed in ordinary in the production of marble papers; but instead of being prepared simply as water colours, used in the ordinary manufacture of hand marble papers, they are prepared with a proportion of satin white, that the colour shall also present a surface capable of receiving the polish or gloss to be imparted to it.

In manufacturing granite papers according to this invention, the patentee also employs paper previously prepared with a coating of colour, as a groundwork, which, while in a dry state, receives a coating of satin white, coloured or otherwise, it being laid out on a board, as before described with reference to marble paper, while this coating of satin white is yet in a moist or damp state; the colouring matter is then applied in imitation of granite, by splashing or otherwise causing the colour to adhere in spots to the satin white. This operation being common in the manufacture of granite papers, further description of the process will be unnecessary.

The colours used in splashing in imitation of granite are also prepared with a proportion of satin white, in order to render the colours of the constituent proportions necessary to produce the desired effect, by rubbing or polishing. It is not necessary that the colour used as the preparatory coating should contain any satin white, either for the marble or granite papers. Marble and granite papers, when prepared in this manner, after having been thoroughly dried, are then subjected to the process known as "rubbing," for the purpose of imparting the desired gloss or polish; the machine known as a "rubbing machine" is employed for this purpose, and which consists of a cylindrical brush, of a sufficient length to operate upon the whole width of the paper. This brush is caused to rotate rapidly, and during such rotation, to bear against a surface or table, between which and the brush the paper is passed, having the marbled side of the paper next the brush, which marbled surface is previously dusted or rubbed with French chalk, in a state of powder, as a polishing material. The end of the paper having been introduced between the brush and the table, the rotary motion of the former draws in the paper from the roll, which is supported so as to unroll freely, yet taking care that a sufficient amount of friction is exerted on the paper as it passes over the table, to prevent its too rapid passage under the brush. The paper, as delivered from the machine, is in a finished state, presenting the glossed or polished appearance required on the marble or granite surface.

Enamels for Iron.—This invention, patented in America by Charles Stumer, consists in providing an enamel for iron and other metals which will retain its adhesion to the metal, and particularly it is not capable of being crumbled or broken off by blows or by heat, this possessing the quality of comparatively co-mingling with the surface of the metal. Thus it is far superior to any known enamelling for metals, and may be modified so as to render it in all the shades of colours, in full variety.—*Composition A*: 16 oz. of gravel sand, 10 oz. of silver glass (silver gilt or silver gilding), 2 oz. of white clay, ¾-oz. of saltpetre.—*Composition B*: 7 oz. of glass (common white glass), 4 oz. of gravel sand, 8 oz. of zean reanocks (or oxide of tin), 6 oz. of borax, 1½ oz. of soda, 3 oz. of saltpetre, 1¼-oz. of white-clay, 1 oz. of magnesia, ¼-oz. of white chalk, ½-oz. of oyster shells—this should be pulverised, like *Composition A.*, and then mixed with the gum water.

THE FLEXURE OF POSTS.

Remarks on the Resistance of Posts to Flexure. By H. Houpt, C.E.—[From the *American Journal of the Franklin Institute.*]

The ordinary formula for the stiffness of beams, supported at the ends and loaded in the middle, is

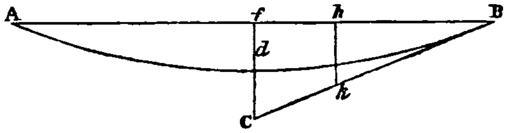
$$w = \frac{bd^3}{cl^3},$$

in which (w) represents the weight which produces a given deflection; b = breadth in inches; d = depth in inches, and l = length in feet; c is a constant, to be determined by substituting the values of the other quantities in the equation.

In making experiments to determine the constant from this formula, it is necessary to observe very accurately both the weights and the deflections produced by them, and then, by means of a proportion, find the value of (w), which will produce the deflection required to be substituted in the formula.

In reflecting upon the circumstances connected with the flexure of beams, the writer conceived the idea of deducing an expression for the weight which a post would support from the ordinary formula for the stiffness of a horizontal beam, by the following considerations:—If a beam is bent by an applied weight, there will be a tendency, from the elasticity of the material, to recover its form when the weight is removed; but if the ends are fastened by being placed between resisting points, so that the piece cannot recover its shape, there must be a horizontal force caused by the reaction of the material, and this force is such, that if the beam were placed in a vertical position and loaded with a weight equal to it, the deflection should be the same as that of the horizontal beam, and consequently the extreme limit of the resistance of the post to flexure would be determined.

To ascertain the force which is exerted by the reaction of a bent beam in the direction of the chord of the arc.



Let AB represent a beam, supported at the ends and loaded with a weight (w) applied at the middle point.

d = deflection caused by the applied weight.

BC = tangent of curve at B.

If the weight be removed, the reaction of the beam will cause it to regain its original figure if not resisted by a pressure at the ends. The force of this reaction will be proportional to the degree to which the fibres are strained, and as the strain upon the fibres is nothing at the ends A and B, and increases uniformly to the middle point, the force of reaction will be in the same proportion, and the point of application of the resultant of the whole of the reacting forces will correspond to the centre of gravity of a triangle whose base is Bf; it will consequently be at a distance from B = $\frac{2}{3}$ Bf.

The effect of this resultant acting at a distance $\frac{2}{3}$ Bf, must be the same as the weight $\left(\frac{w}{2}\right)$ acting at a distance Bf, and must consequently be in proportion to $\frac{w}{2}$ as 3 : 2. The value of the resultant is therefore $\frac{3w}{4}$.

The line of direction of the pressure at B being the tangent BC, the force of reaction at h may be considered as applied at the point k of its line of direction, and as $k\,h$ B and C f B are similar triangles, C f : f B :: $\frac{3}{4}w$: horizontal pressure at B $= \frac{3}{4}w \times \frac{f\text{B}}{f\text{C}} = \frac{3}{4}w\frac{\frac{1}{2}l}{2d} = \frac{3wl}{16d}$. Representing this force by P, we have

$$\text{B} = \frac{3wl}{16d}.$$

As the deflection of a beam within the elastic limits is always in proportion to the weight, if (w') = the weight that will produce a deflection equal to unity, the deflection (d) will require a weight = (dw'), and by substituting this value in the equation, we find

$$\text{P} = \tfrac{3}{16} \cdot \frac{dw'l}{d} \cdot = \tfrac{3}{16}w'l.$$

In this expression (d), which represents the deflection, has disappeared, and as (w') is a constant quantity for the same beam, representing the weight that produces a deflection equal to the unit of measure, it follows that P is the same with every weight and every degree of deflection within the elastic limits.

This result seems at first view to be contrary to fact; it would appear that if the weight is increased, the horizontal strain should be increased in the same proportion; but when it is remembered that the deflection increases with the weight, and that the former diminishes the value of P in precisely the same proportion that the latter increases it, the difficulty vanishes, and the reason why P should be constant for the same beam becomes obvious.

The practical importance of this result is very great, as it furnishes the means of obtaining a formula which will give at once the extreme limit of the resistance to flexure, or the weight which, applied to a post, will cause it to yield by bending.

As the formulæ used by Tredgold are calculated for a deflection of $\frac{1}{40}$th of an inch to 1 foot, or $\frac{1}{480}$th of the length, the weight which would cause a deflection of 1 would be $w\left(1 \div \frac{l}{480}\right) = \frac{480\,w}{l}$, and by substituting this value for w' in the equation $\mathrm{P} = \frac{3}{16}\,w'l$, we find $\mathrm{P} = 90\,w = \mathrm{A}$.

But from the ordinary formula for the stiffness of a beam supported at the ends we have

$$w = \frac{bd^3}{cl^2}. \quad \text{Therefore } \mathrm{P} = \frac{90\,bd^3}{cl^2} = \mathrm{B}.$$

The expression $\mathrm{P} = 90\,w$ shows that the extreme limit of the strength of any post whatever, of any length, breadth, or depth, or of any kind of material, is 90 times the weight which causes a deflection of $\frac{1}{480}$th of the length.

The second expression, $\mathrm{P} = \frac{90\,bd^3}{cl^2}$, will give the value of P directly, without first knowing the weight required to cause a given deflection in a horizontally-supported beam. In this expression, b = breadth in inches, d = depth or least dimension in inches, l = length in feet, and c = a constant to be determined by experiment for each species of material.

The value of c for white pine is ·01. By substituting this value, we find $\mathrm{P} = \frac{9000\,bd^3}{l^2}$, a remarkably simple formula, which give the extreme limit of the resistance to flexure of a white pine post.

The same expression may be used to determine the constant used in the ordinary formula for the stiffness of beams. For this purpose let the equation $\mathrm{P} = \frac{90\,bd^3}{cl^2}$ be transposed, which wil give $c = \frac{90\,bd^3}{\mathrm{P}l^2}$. Find P by applying a string to a flexible strip o the material to be experimented upon, in the manner of a chord to an arc, and ascertain the tension on the chord with an accurate spring balance. It will be found that, whether the strip be bent much or little, the tension on the chord, as shown by the spring balance, will be constant; and this tension, in pounds, substituted for P, will give the value of c without requiring, as is necessary with other formulæ, an observation of the deflection.

Experiments made upon these principles with strips of white pine, yellow pine, and white oak, 5 feet long, 1¼ inch wide, and ¼-inch deep, give the following results:—

The observed tensions were—

White Pine,	7¼ lb.	value of c	= ·0097
Yellow Pine,	6½ lb.	"	= ·0108
White Oak,	6¾ lb.	"	= ·0104

As the stiffness is inversely as their constants, it follows that white pine is stiffer than yellow pine or oak. The experiments of Tredgold give similar results.

New Kind of Gutta-Percha.—It is stated in a recent number of the ***Amsterdam's Handelsblad***, that there is every reason to believe that at Palembang, in the eastern possessions of the Dutch, in the interior of the country, gutta-percha, or *getah-pertja*, will be collected in great abundance. It would appear also that another substance has been discovered, called ***getah-matah-buey***, which is also obtained in great abundance, by merely bleeding the trees; and which, although not susceptible of the same extended applications as gutta-percha, may, nevertheless, when mixed with this latter, prove of very great utility.

DRY ROT.

An account of an extraordinary instance of the Rapid Decay of Timber from Dry Rot, which occurred in the Church of the Holy Trinity, at Cork. By Sir Thomas Deane.—(Paper read at the Institution of Civil Engineers of Ireland.)

The parish Church of the Holy Trinity in Cork, in the year 1827, having been found to be in a bad state of repair, and quite deformed from bad and unequal foundations, the parishioners resolved on building a new church; but, through want of funds, not being able to carry their design into execution, an extensive repair was decided on. The tower was taken down, and one side wall, and the end of the church was rebuilt.

This church is 100 feet long, by 60 feet wide, divided into a nave and aisles by double tiers of columns, the lower tier being of solid timber, supporting galleries, and resting upon rude rubble stone piers, in the vaults below, the upper tier being of built timber columns supporting the roof. It is necessary to describe the building, in order to show that from retaining a part of the old timber work, the evil of dry rot emanated.

For years there had not been anything intervening between a great part of the body of the old church and the burial vaults beneath, except a timber floor, and though the interior was spacious, and even handsome, this abomination long continued.

Immediately under the floor of the church, and open to the vaults, longitudinal beams of Irish oak, of from 12 to 14 inches square, had been placed, resting on piers, and forming supports for the joists. Though these oak beams were decayed for an inch deep at their surfaces, sufficient of the timber (as it was thought) remained sound, and it was decided that neither they, nor the piers upon which they rested, should be removed. The vaults were arched over, memel joists, 6 inches by 4 inches, were placed on the vaulting, and connected with the old oak beams which rested on the piers; the floors were removed, the old pews replaced, new columns, coated with scagliola, were erected over the galleries, the old ones in the lower tier retained; and the whole repairs having been thus completed, the church was re-opened for divine service, in April, 1829.

In November, 1830 (but eighteen months afterwards), the congregation was annoyed by an unpleasant smell, which, on examination, was found to proceed from dry rot of the most alarming nature.

On opening the floors under the pews, a most extraordinary appearance presented itself. There were flat fungi of immense size and thickness, some so large as almost to occupy a space equal to the size of a pew, and from 1 to 3 inches thick. In other places fungi appeared growing with the ordinary dry rot, some of an unusual shape, in form like a convolvulus, with stems of from a ¼ to ½ an inch in diameter. When first exposed, the whole was of a beautiful buff colour, and emitted the usual smell of the dry rot fungus.

Whatever may have been the surprise at the rapid growth of the plant, its action on the best memel timber was a source of greater astonishment. I took up, with nearly as much ease as I would a walking cane, that which, eighteen months before, was a sound piece of timber (one of the joists), from 12 to 14 feet long, 6 inches by 4 inches scantling; the form of the timber remained as it came from the saw, but its strength and weight were gone. The timber of the joists and floor over the new brick vaulting was completely affected by the dry rot, which was rapidly spreading to the lower part of the columns under the galleries, so that at the rate the infection proceeded, the total destruction of the building would soon have been effected.

During a great part of the time occupied in the repairs of the church, the weather was very rainy. The arches of the vaults having been turned before the roof was slated, the rain water saturated the partly decayed oak beams, before described. The flooring and joists, composed of fresh timber, were laid on the vaulting before it was dry, coming in contact at the same time with the old oak timber, which was abundantly supplied with the seeds of decay, stimulated by moisture, the bad atmosphere of an ill-contrived burial place, and afterwards by heat from the stoves constantly in use. All these circumstances account satisfactorily to my mind, for the extraordinary and rapid growth of the fungi.

The large sum of 4,000*l.* having been so lately expended on the church, caused great anxiety to the parishioners. The opinions of the most experienced professional men were taken, and all agreed that the first effort should be to cut off the communication with the galleries, the disease having already extended 3 feet upwards on the lower columns.

The new brick vaulting was found penetrated by the fungi, imposing the necessity of having the vaulting, as well as all the timber work in the lower part of the church, entirely and carefully removed. New and thicker vaulting was then substituted for that which was taken down, and the whole of the floor over it was laid with Yorkshire and Shannon flags set in Roman cement. New pews were erected, resting on iron chairs let into the flagging; the flooring of all the pews was constructed so as to be occasionally removed for inspection; Roman cement was internally used next to, and at the bottom of the walls; and iron columns were substituted for those of timber in the lower tier.

Here I must notice the clever plan of my friend, Richard Beamish, Esq., C.E., who caused a screw to be placed in the head of each iron column, which was screwed up so as to take the load before the temporary supports were removed, thereby avoiding the fracture consequent on ordinary wedging, so that all was effected without any disturbance or sinking of the galleries, and the columns which supported the roof, &c., the screws in each column being accurately adjusted so as to meet the pressure from above.

The expense incurred by these repairs was very considerable; but it is satisfactory to state, that there has not been a reappearance of the dry rot since that time, now a period of sixteen years.

BRITISH ASSOCIATION.

Nineteenth Meeting,—held at Birmingham, September, 1849.

(*From our own Correspondent.*)

Mechanical Section.

President—R. Stephenson, Esq. M.P. F.R.S.
Vice-Presidents—Messrs. W. Blake, W. Fairbairn, F. Osler, T. Webster.
Secretaries—Messrs. W. P. Marshall, C. Manby.
Committee—Messrs. J. G. Appold, W. Baker, R. Davison, C. Fox, J. Henderson, E. Hodgkinson, Rev. S. King, Messrs. J. G. M'Connell, R. Martineau, G. Nasmyth, R. S. Newall, R. Roberts, J. Taylor, F. Whishaw.

1. *On a Method of Supplying the Boilers of Steam-Engines with Water.* By Mr. W. S. Ward.

Mr. Ward proposes to use a small supplementary pumping engine, having a working cylinder with valves so arranged that the piston may be put in motion by either steam or water passing through it, to be supplied with steam, by a steam-pipe, the entrance to which is somewhat narrow, and inserted in the boiler to be supplied a little above the level at which it is desired to maintain the water therein. Such aperture should also be about the centre of a marine boiler. The working cylinder should be attached to a pump of such size as to be easily worked by the pressure of the steam. The exit-pipe of the steam-cylinder must communicate with the inlet-pipe of the pump, so that if the cylinder be actuated by steam, the steam will be condensed, and its heat communicated to the water to be supplied to the boiler; or if the working cylinder be worked by water proceeding from the boiler, a considerable part of such hot water will be returned by the pump. The mode of operation of such apparatus will be, that whenever there is a working pressure of steam in the boiler, the apparatus will be in action; but if the level of the water be below the aperture of the small steam-pipe, the action will be moderately rapid, and a supply of water be pumped into the boiler; and when the water in the boiler rises to the aperture, this being small, will be as though choked by the water, which will be forced through the working cylinder, moving the piston and pump very slowly; a portion of the water thus escaping from the boiler will be returned by the pump. Such last-mentioned action cannot continue long, inasmuch as the level of the water must be reduced; therefore the average level of the water in the boiler will be, with slight oscillations, maintained at the height of the supply-pipe.

Remarks.—Mr. Roberts stated that the principle had been applied more than thirty years, and he considered that many plans in use, especially that whereby the principle of gravity was made available, was sufficient for the purpose.

The President observed that at a certain point the pipe leading to the cylinder would admit water mixed with the steam. This was an insuperable objection, inasmuch as the admission of such a mixture into the working parts of an engine led to breakage. When the water got between the clack and the bucket it was almost impossible to work the pump. This was manifest in the difficulty experienced in supplying locomotives. In some of the earlier engines it was customary to fill the boilers as full as they could hold, run them as long as possible, and stop to take in a new supply of hot water directly into the boiler. His father, the late George Stephenson, obviated this difficulty by introducing a cock between the bucket and clack, which, from its office of humouring the action of the machinery, was called the "pet tap." He was afraid that the suggestion of Mr. Ward was not practically useful.

2. *On a Chain Pipe for Sub-Aqueous Telegraphs.* By Mr. F. Whishaw.

The pipe is formed of iron tubing in lengths of from 1 to 3 feet, and from 1 to 2½ inches diameter, and connected together by ball-and-socket joints; the length of the link is regulated according to the sinuosity of the river. The joints are not made water-tight, it being unnecessary, as the pipes form a jacket only to the wires, which are protected by a coating of gutta percha. The tubes are pinned down to the bed of the river, and are merely used as a protection to prevent abrasion of the wires. A similar chain has been in use for some time in conveying the wires across the rivers of Prussia and Germany: the longest length is 1,200 feet, for conveying the wires of the electric telegraph across the Rhine.

3. *On Correct Sizing of Toothed Wheels and Pinions.* By Mr. Richard Roberts, of Manchester.

Although much has been written on this subject, and on the best form of teeth, there is still much difference of opinion on both points; which difference is not confined to individuals, as it embraces the members of the trade or profession to which they belong. For instance, engineers, millwrights, and machinists in general, adopt the plan of extending the teeth of the pinion and wheel to the same distance beyond the pitch-line. A majority of them are agreed as to the best form of teeth—namely, the cycloid for wheels to work in straight racks, and the epicycloid for wheels to work in other wheels, or in pinions. But they are not so well agreed respecting the length of the teeth, as the makers of watches, clocks, and chronometers do not extend the teeth of the pinion beyond the pitch-line more than one-half as far as they do the teeth of the wheel; hence the preference given by those trades to the "bay-leaf" form for the teeth of the pinion, as no other form would pitch, with their sizing.

Mr. Roberts observes that various rules are given in works on horology for sizing wheels and pinions, but he believes "movement makers" generally, English and foreign, use an instrument called a "sector" (resembling a "two-feet rule"), which is divided into equal parts throughout its length, commencing about half a division from the centre of the joint. The numbers up to 10, or 12, on the sector are usually subdivided, for the use of artists who may prefer pinions a little larger than the corresponding number on the sector would give.

Knowing it to be essential to the correct performance of any machine where wheels and pinions are employed that they should be properly sized, Mr. Roberts thought it might be useful to parties whose experience on the subject has been more limited than his own, of whom there might possibly be some present, to be informed respecting the plan which he has adopted for more than 30 years for sizing toothed wheels.—With this object in view, he has constructed an instrument which represents on a large scale the sector used by clock and watch makers; excepting that in their sector the divisions are marked on the inner side of the limbs, whilst in his sector the divisions commence at the centre of the joint, and are continued in a straight line to within about ¾-inch of the outer side of the limbs at the other extremity.

It has long been the practise in Manchester to make those wheels which come under the denomination of "clock-work," with some definite number of teeth to the inch diameter, taken at the pitch-line, and to distinguish the pitch accordingly. Mr. Roberts has done this, and has adopted the same plan in respect to mill-gear; substituting the foot for the inch in designating the pitch, instead of naming it by the distance from the centre of one tooth to the centre of the next, which is, he believes the universal practice.

Before explaining the way in which his instrument is used, he mentioned that in the year 1816, he had a set of change-wheels made by a "factory clockmaker," which wheels were so much out of pitch as to direct his attention to the cause of the defect; and having found that the error had arisen from the defective principle of the sector, he immediately contrived his sector, which differs from the clockmakers' sector principally in the joint being adjustable like that of the proportionable compasses. The use of this kind of joint was to enable parties to pitch wheels correctly, and to suit themselves as to the depth of the teeth.

After he had sold a number of sectors of this kind, he found that, for all ordinary purposes, a fixed joint would answer equally well, provided the centre of the joint was equal to two of the divisions of the sector below zero. This circumstance led him to make sectors (bars of brass serrated on the edge) which are cheaper, whilst they are better suited for the workshop.

ROBERT'S SHEET METAL MOLDING MACHINE.

Fig. 1.

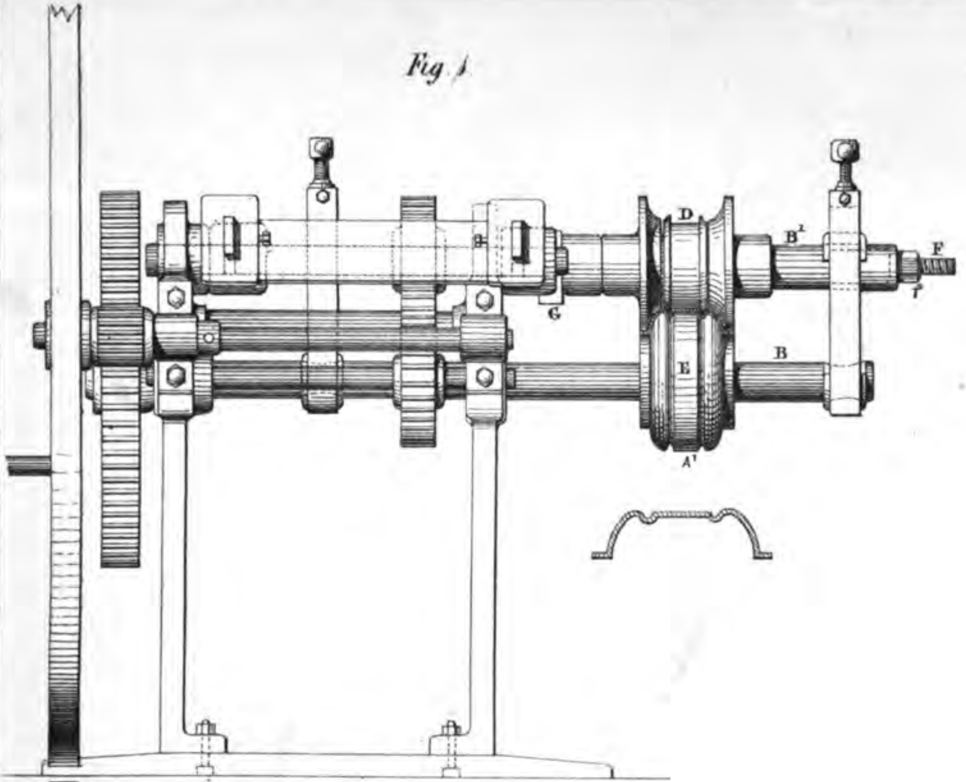


Fig. 2.

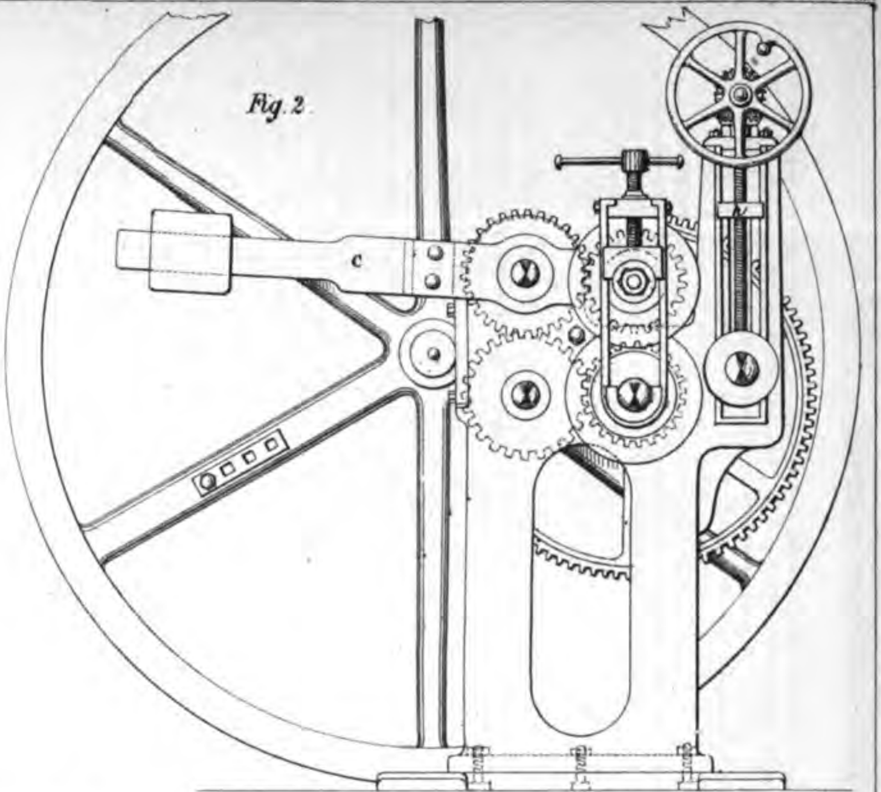


Fig. 3.

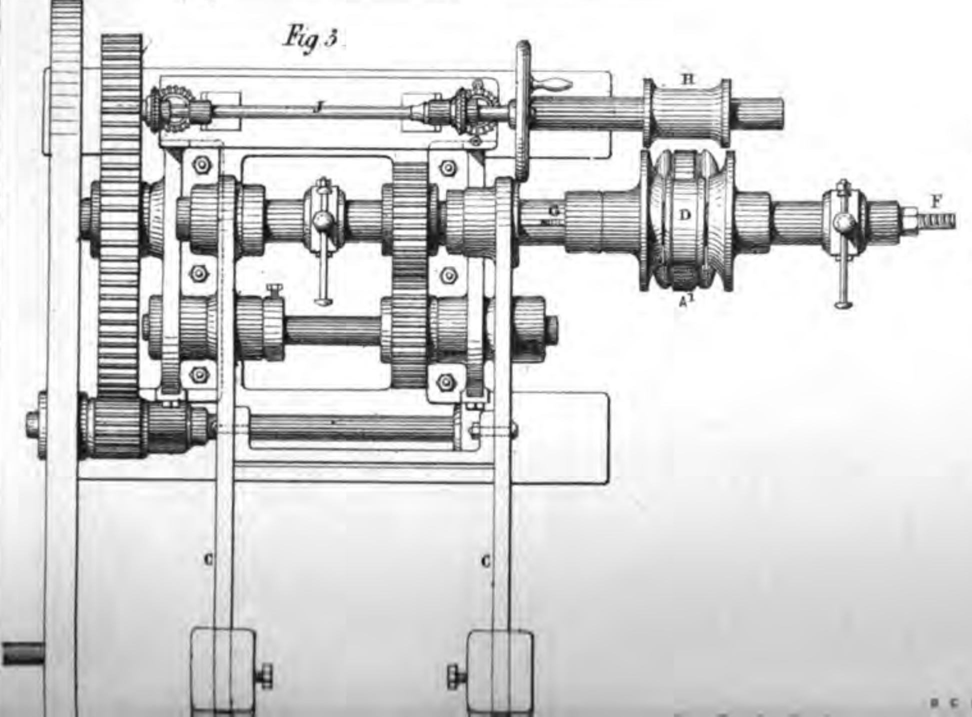


Fig. 4.

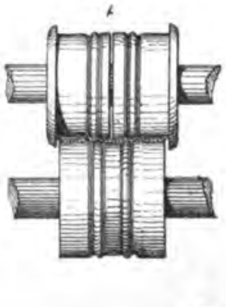


Fig. 6.

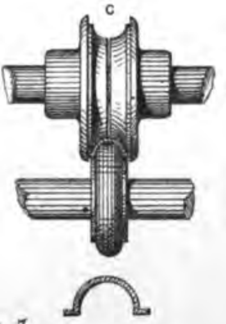


Fig. 5.

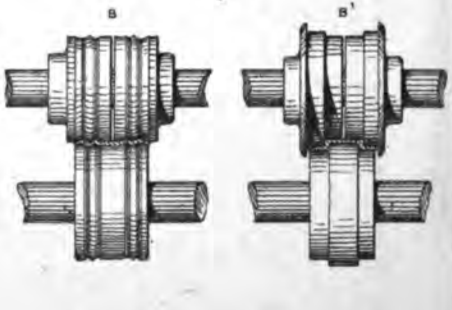
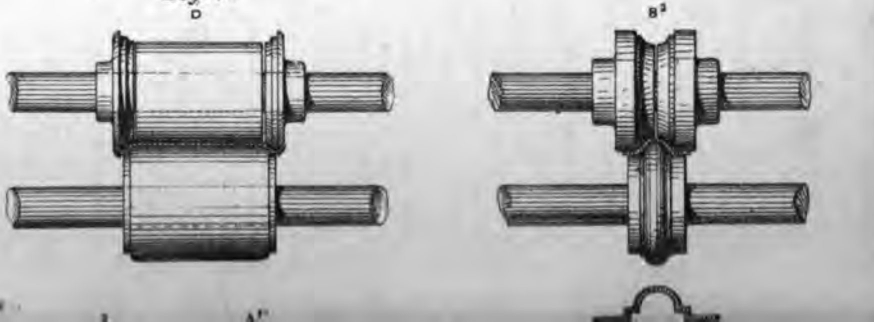


Fig. 7.



SCALE.

This kind of sector, which he believes is made by his firm only, has the tenth number at the twelfth division from the starting point; the two divisions being added for the depth of tooth beyond the pitch-line. There are two scales on each of these sectors, one on each edge; which scales are marked according to the number of teeth to the inch diameter (pitch-line) they are adapted for. They are made in sets ranging from 3 to 30 in the inch. One set of these sectors is used for sizing working-wheels, and another set for sizing pattern-wheels; the latter is one per cent. coarser than the former, to compensate for contraction of the metal in cooling.

4. *Sheet-Metal Moulding-machine.* By Mr. Richard Roberts, of Manchester.—(*With an Engraving, Plate* XIX.)

This machine is furnished with two shafts, B, and B′, which project beyond one of the side frames in which the lower shaft B, turns; the upper shaft B, is mounted in a balanced swing-frame, and is connected by spur gear with the lower shaft in such a way that the distance betwixt the shafts may be adjusted to any required extent without altering the depth of the wheels in gear.

On the projecting ends of these shafts the rollers D, E, are put, with which the mouldings are to be formed; the lower roller is in one piece only; but the upper roller is made in one or more parts transversely, as may be best adapted to form the required mouldings, as shown in the enlarged figure; the which parts, when more than one, are made to approach each other by being slid along the shaft B′, which is hollow, by means of a screw F, that acts within on the back part of the top roller D, by means of a cotter, which passes through the shaft and the screw, and on the front part by a nut *f*, which is screwed from time to time by hand. The advantage of making the rollers in two or more parts is, that it allows the metal to be gradually compressed sideways as well as vertically, and avoids puckering.

The curved mouldings, shown in the engraving, were made on the first machine of the kind that was constructed; and the straight mouldings on a similar machine subsequently made. Almost any degree of curvature may be given to the moulding by means of the third roller H, which, with its shaft and sliding bearings J, is lowered, by the gearing *h* (fig. 1) in front of the pair of rollers, to produce the required curvature.

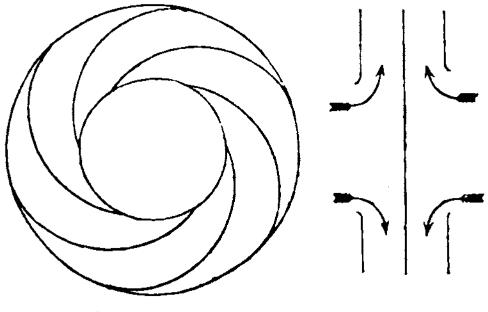
The engravings A (fig. 1) and A′ (fig. 4) are representations of two pairs of rollers for forming simultaneously the cap-mould of each of the two brass domes for locomotive engines; the rollers A, fig. 4, being for the purpose of creasing the metal, and the rollers A′, fig. 1, for finishing the two cap-moulds, which may afterwards be divided in the middle by a lathe or with a saw. Two mouldings are in this case made together, owing to the peculiar form of the moulding rendering it more facile to do so than to make one separately.

Fig. 5 shows three pairs of rollers for forming the "astragal," to which the upper and lower plates of the chimney of the locomotive are rivetted; these rollers B, B¹, B², are used in the order the drawings are lettered.

Fig. 6 shows a pair of rollers for forming the "base mould," and fig. 7, rollers for forming the body of the brass dome of the locomotive engine; one pair of rollers only being used in both these last-mentioned cases.

5. *A Centrifugal Pump for Draining Marshes.* By Mr. J. G. Appold.

The pump consists of a disc with two side-plates, hollow between and an opening in the centre; between the two plates are spiral fans or vanes as shown in the annexed diagram. The disc is mounted on a shaft, and turned by the aid of multiplying wheels, for the purpose of getting up a great velocity. The water flows into the disc through the centre opening, and by the rapid velocity with which the disc is turned, and its centrifugal force, the water passes out from the outer edge of the disc, and is elevated to a height according to the size of the disc and its velocity.—The model of a pump capable of discharging ten gallons of water per minute was exhibited. The disc was only 1 inch in diameter. One the same shape, and 12 inches diameter, will discharge at the same speed of the outside circumference, or one-twelfth the number of revolutions, 1,440 gallons per minute, which is according to the square of the diameter, and not according to the cubic contents. Mr. Appold considered that one 10 feet diameter, of the best shape, will pump 140,000 gallons per minute, and so on in proportion.



6. *The late Accident at the Britannia Bridge, Menai Straits.*

Mr. Stephenson, at the request of the meeting, explained the cause of the accident which lately occurred in lifting the tube at the Britannia works. He first explained the machinery adopted for raising the tubes, which it is unnecessary for us now to report; and stated that the plan originally proposed was by lifting the tube to the height of 6 feet at a time, and then allowing it to be suspended by chains to the cross-head during the time the masonry below was carried up: but this plan was abandoned, fearing that if an accident should take place, either by the bursting of the press or the breaking of a link of the chain, the tube would be totally destroyed if it fell through such a height as 6 feet, or even of 6 inches. He then considered that the only way to proceed was by packing in timbers, inch by inch, under the tube as it was being lifted; so that in case an accident did take place, the tube would not have to fall through a greater space than an inch,—and this was the plan adopted at the time of the accident. To show how necessary it was thus to proceed, Mr. Stephenson explained that although the tube fell through the space of only an inch, it broke down iron beams each sufficient to bear 500 tons weight. It will be seen that by this process the tube was never allowed to be suspended in the air; and as a farther precaution, he intended in future, when the raising was again in progress, to pack in underneath the cross-head of the press, by driving in iron wedges as the tube is raised, as well as under the tube; thus, if the press were to break down, neither the cross-head nor the tube could fall through a greater space than an inch.—He then proceeded to describe the nature of the fracture, which he showed by a sketch as per annexed figure. The press was 20 inches diameter, and the thickness of the metal 10 inches.

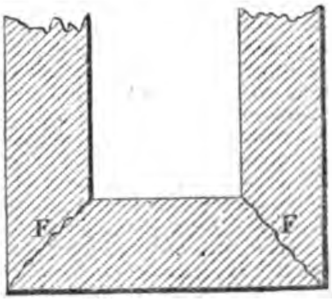


Fig. 1.

It was very curious to find that the fracture took place at that part of the press which was the strongest, for it broke through the angle of the bottom at F; and when it fell out, the piece formed the frustrum of a cone. At the time the presses were at work there was not one ton pressure to the square inch, the area of the fracture being 1,316 square inches, and the weight suspended on the press 1,000 tons. The press was calculated to bear 3¼ tons, a pressure to which hydraulic presses are frequently subjected for manufacturing purposes. The ram at the time of the accident dropped 2 ft. 6 in.; if it had been wedged up, as now proposed, the accident might not have occurred.

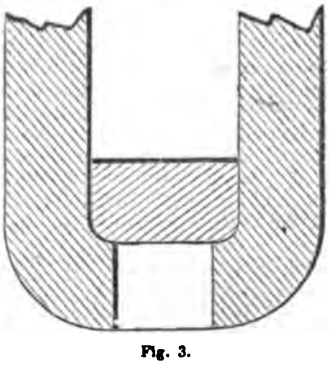


Fig. 3.

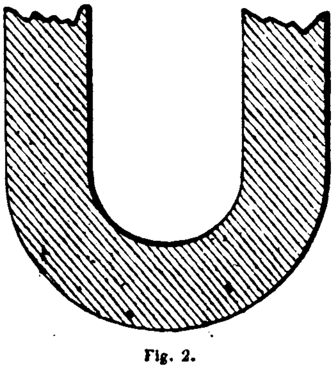


Fig. 2.

When lifting the Conway tubes, they commenced by lifting both ends simultaneously; but when the engines had been at work for a short period, it was observed the tube had got into a tremulous motion like a wave. In consequence, this operation was stopped and a consultation held, when it was considered that it was occasioned by working the pumps at each end of the tube simultaneously, and it was decided to work the engines at each end alternately: by adopting this mode, the motion was got rid of.—Mr. Stephenson believed the fracture took place in consequence of the unequal cooling of the iron at the angle of the press at F; he has therefore decided upon having two cylinders cast in some other form,—one, as shown at fig. 2, with a spherical bottom, the same thickness as the cylindrical part; and the other, as shown in fig. 3, with an open bottom, and a plate made to close the opening: but it is intended to use one of them only. Mr. Stephenson said some strong comments had been made because he allowed a faulty cylinder to be used—this was not the case; the original fault was a leak which appeared in the neck of the cylinder, where an accident could not take place. This leak was easily stopped, and did not in any way cause the accident: the part that gave way was at the bottom of the cylinder, and the other at the top.

Remarks.—Mr. Roberts observed, the way to prevent the oscillation or tremulous motion in the tube was to work the engine as irregularly as possible. He considered the shape of the press was bad for casting, and that the best mode of casting had not been adopted. It would greatly improve the strength of such work if *spiral* casting were adopted—that is, to pass the molten fluid into the mould in a spiral direction.

Some interesting observations were made by Dr. Robinson, Professor Willis, and Mr. Webster, on the cause of the oscillation and the severe trial it caused to the presses; they considered the accident might have been occasioned through pulsation of the press, arising from the oscillating motion, however small, of the tube.

7. *On the Superiority of Macadamised Roads for Streets of Large Towns.* By J. Pigott Smith, Surveyor to the Commissioners of the Birmingham Street Act.

There is a very prevalent and very natural feeling against the employment of broken-stone roads for streets, because, as they are usually managed, they are the cause of very great inconvenience to householders and others by the great dust and dirt they occasion, and also because their maintenance and repairs are very expensive, while the draught of vehicles upon them is very heavy.

The object of the present paper is to prove, from long-continued experience on a large scale, that those objections do not necessarily accompany the use of such roads, and to show how the inconveniences may be most completely and economically avoided.

This subject has been a matter of careful study to me for many years, during which I have had under my immediate charge 107 miles *lineal* of street-road, being an area of about a quarter of a million of square yards of macadamised surface, and also the general superintendence of a considerable extent of turnpike roads. The result of this extensive and continued experience has been to convince me that broken-stone roads, *if properly constructed and managed*, and well cleansed and watered, are the best adapted for the streets of a large town of any description of road yet tried.

Of whatever nature the surface of a road is to be, it is essential that its foundation should be of firm material, well consolidated and perfectly drained; if not, the crust becomes loosened and destroyed, the road is rough and uneven, and wears into holes and ruts.

Having obtained a good foundation, the next point is to cover it with a hard compact crust, impervious to water, and laid to a proper cross-section. The stones must be broken to one regular size, well raked-in, and fixed there by a binding composed of the grit collected in wet weather by the sweeping-machines, and preserved for this purpose. This binding must be laid on regularly, and watered until the new material is firmly set, which it will do very quickly, and with the regularity of a well-laid pavement: the sharp angles of the stones are preserved, and there is both great saving of material and a firmer crust formed than by the common method of leaving the material to work into its place without the use of binding,—in which case, the angles of the stones are worn off and reduced to powder, and at least one-third of the material wasted in forming a binding in which the stones may set. By the improved method the binding is formed of material that would otherwise be useless.

A practical illustration of the principle is evidenced in the street leading from the railway station in this town (Birmingham), which, from the great wear and tear to which it is subject, I found necessary to summer coat. This was done on the 28th of August ult.; on the 29th the binding was laid on; and on the 1st of September, it was well washed and cleansed by the machine, and presented a surface well consolidated, firm, and level: thus in five days was accomplished what under the old method would have required three months.

In the common method, not only is there great waste of material, but the loose stones occasion delay by their resistance, great fatigue to the horses, and danger to their feet, while the noise produced by their grinding together is annoying to the inhabitants. Upon the improved method, the inconveniences of road repair are incomparably less than those of pavement: both recoating and repairs may be made without stopping the traffic.

Under no circumstances must any imperfection of surface be allowed,—if a hollow be not immediately stopped it very quickly extends over the surface; and all loose stones carefully picked, as every loose stone passed over by heavily-laden carriages, if not ground to powder, breaks the crust of the road; and if water be permitted to lodge on the surface, it will cause great mischief. It is the neglect of these essential precautions that has led many to consider macadamised roads very expensive: they *are* expensive if neglected. On a well-made road heavy showers do good, by cleansing them; so also does artificial watering, if the road be clean or swept quickly after it is watered. A road which is perfectly dry loses its tenacity and the surface grinds into dust; whence the economy of judicious watering in hot weather, which preserves the road as well as prevents the annoyance of dust. The practice so common in London and elsewhere, of heavy watering a dirty road without cleansing it, is very injurious to the road, and merely changes one nuisance into another—dust into mud.

A great source of waste both to those who use and those who repair a road, is to allow it to be dirty. The draught upon a dirty road is twice as heavy as on a clean one—that is, a horse must exert double force to draw his load with the same speed. The cost, however, of employing double force is so great that the expedient of diminishing the speed is generally adopted, as a horse can exert greater pulling force at a slower pace, less power being required to carry his own body. It often happens that the extra resistance occasioned by dirt diminishes the speed one-fifth or one-fourth. The effect of the dirt, therefore, is to increase the work by 20 or 25 per cent. It will easily be believed that such a waste far exceeds the cost of the most perfect cleansing. This is the case when cleansing is done by scrapers (the greatest enemy a macadamised road has to contend against); by their use the stones are dragged from their places, and the adhesive dirt is not effectually taken away. Sweeping is the only mode of cleansing that should be allowed either on streets or turnpike roads. Sweeping by the wide brooms of the machine is preferable to all other modes of cleansing yet tried.

It must be evident that these wide brooms, sweeping longitudinally, with a pressure that can be adjusted according to circumstances, tends powerfully to preserve the road, and to consolidate its surface: they press most upon the ridges, and least upon the hollows, thus tending to reduce the former and fill up the latter. When the dirt is stiff, and adheres firmly to the stones, it should first be well watered, when it may be completely removed by the machine without disturbing the crust, leaving the surface firm and compact. The use of water for this purpose has been objected to by high authorities, on the ground that it *does* remove the useful grit: but the contrary has been proved by ample experience.

I have found that the use of the sweeping-machines, with the proper employment of water, has reduced the amount of material required for the repair of roads in Birmingham, one-third—viz., from about 20,000 to 13,000 cubic yards. The first-named amount is the average for seven years preceding the introduction of the machines; the latter, of the three years subsequent.

The entire cost of cleansing and watering Birmingham is about 5,000*l*. per annum, or less than one penny per week for each of its inhabitants.

8. *On the Manufacture of the Finer Irons and Steels, as applied to Gun Barrels, Swords, and Railway Axles.* By Mr. W. Greener, of Birmingham.

No manufacture has tended more to advance the improvement of the finer qualities of irons than that of gun-barrels, which has proceeded from the old stub-twist barrel of former days to the laminated steel of the present time, and has been attended with the advantages of increased security and greater projectile power of the gun. It might be naturally inquired why the principle, if so advantageous, has not been applied to other manufactures where even greater security to life and limb is required than in a gun-barrel. The first innovation on the old principle of manufacturing gun-barrels, or that of making them entirely from old horse-nail stubs; is due to the late Mr. Adams, of Wednesbury, who, twenty years ago, introduced what is yet termed Damascus iron, which is constructed of alternate layers of steel and iron, faggoted, drawn down into rods, and then twisted; and when welded into barrels, forms the beautiful Damascene barrel. The success of this experiment, not only in point of beauty but of strength, was so great as to be under-estimated at an increase of 50 per cent. compared with the strength of stub-twist iron.

The next improvement was to blend more intimately steel with the horse-nail stubs, in the proportion of one to two of the latter. This was effected by cutting scrap-steel into pieces, assimilating with the stubs very carefully, cleaning them, and then welding into a bloom, and rolling. The fibrous system seemed in this case to be more perfect, for though possessing less steel in its composition, yet it was quite equal in tenacity. The difficulty in obtaining old stubs of quality sufficiently good, arising from deterioration in the original iron, has rendered the manufacture of this variety nearly obsolete, or, in cases where it is yet produced, the quality is so inferior as scarcely to rank third in quality.

The next and most important improvement in metals is the manufacture of gun-barrels from scrap-steel entirely, and for this purpose old coach-springs are generally in request. By clipping these into pieces, perfectly cleansing them, and then welding in an air-furnace, a metal is produced which surpasses in tenacity, tenuity, and density, any fibrous metal before produced. The tenacity of it when subjected to tension in a chain-testing machine is as 8 to 2¼ over that of the old stub-twist mixture. The perfect safety of barrels produced from it is astonishing. No gunpowder yet tried has power to burst them when properly manufactured.

The progressive value attached to these various metals has induced Mr. Greener to try experiments on a more extended scale. To effect this he takes ingots of cast-steel, from the mildest made to No. 3 in the scale of carbonization; these after being rolled into flat bars, are to be clipped into small pieces, intimately mixed, and welded, as before, in an air-furnace; drawn down in the rolls, refaggotted, again drawn down, and then converted into gun-barrels, either with or without spirally twisting them to form the Damascene figure. Barrels made from this (which he terms laminated steel) are in reality perfectly safe. To ascertain this, breeches were screwed into both ends of a gun-barrel more than ordinarily light; eight drachms of gunpowder (or three ordinary charges) were then introduced; the breech was screwed in again, and the powder fired through an orifice the size usually found in gun-nipples. The density and tenacity of the metal are sufficiently great effectually to resist the enormous force of this great charge of powder, the exploding fluid passing through the nipple like steam from a safety-valve. The principle here developed is the perfection of the fibrous system with increased density of metal. The dissimilar carbonization of the metals forms dissimilar fibres when thus enormously extended, with a complete absence of any crystalline structure in the metal,—the existence of which in any material, either gun-barrels or any other manufacture which become subject to violent concussions, explosions, or blows, may safely be set down as of the negative kind.

Swords are another manufacture to which this improvement especially applies. Mr. Greener observed that all his investigations go to fully satisfy him that it is in a similar way the Arabs produce their finely-tempered Damascus swords—namely, using two steels of different carbonization, mixing them in the most intimate manner, and twisting them many fantastic ways, but observing method in that fancy. He is led to think that they do not temper by heating, and immersing the blades in a cooling liquid, as practised by us at the present day. If we subject a Damascus blade to the action of acid, the laminated structure is perfectly visible: if the blade be heated and immersed, crystallization takes place, and the lamina disappears for ever. He was not then going to discuss the merits of our mode of tempering swords, but would merely allude to the fact that no European weapon had ever yet been produced equal in tenacity to those of Damascus.

The government inspector of small arms gave in evidence before a committee of the House of Commons in May last, "that the swords manufactured in Birmingham were not fit to be issued to the army." If so, this question becomes of vital importance not only to that district, but to the whole empire. Mr. Greener's investigations satisfied him that tempering by crystallising the steel (*i.e.* tempering in the ordinary way) is far from the wisest course. He has found by experiment that the Damascus blade in its fibrous state, or hammer-hardened, is more difficult to break by 100 per cent. than the best English-made blade: but temper it in the same way, and it shows no greater tenacity than our own. The Damascene figure is destroyed by the carbon becoming equally diffuse; nor will acid develope it—it is entirely gone. But observe it with a glass attentively, and what is now a mere mass of crystal was previously a fibrous system of the most minute and beautiful arrangement. The tendency of all crystalline structures to lose tenuity, and separate by repeated actions of the waves of vibration, is evident to all scientific men. From these facts we may draw the conclusion, that swords constructed of dissimilar steels, tempered by condensation of its fibres, either by repeated rollings, hammering, or many other processes which our perfect machinery give us the opportunity of doing. Thus we may hope to see every soldier of the empire armed with a weapon as good, if not so costly, as the highly-prized Damascene.

Lastly, though not of least importance at the present day, is the construction of railway axles. If experience shows that the addition of one-third steel to two of iron doubles the strength of a mass so constructed, why not adopt this improvement in railway axles and other parts of machinery on which the safety of hundreds sometimes depend? A few months previously to the death of the late George Stephenson, Mr. Greener consulted him on the possibility of improving this essential material, and at his instigation proceeded to make a considerable number of experiments. It appeared to him a settled fact, that from the affinity iron evinces for the various gradations of electricity, to galvanic electricity may be traced the rapid crystallization which takes place in railway axles, after having travelled over a given number of thousand miles. It is well known to all acquainted with engineering, that axles constructed of the most fibrous homogeneous iron, are changed into a crystalline state of the most perfect kind, extending some inches from the journal. This, it may be assumed, is effected by the galvanic electricity generated by the bearings and the journal while in rapid motion. To this also, he apprehends, may be attributed the great tendency of axles to heat. To ascertain this fact, Mr. Greener subjected wire of various metals, from the ordinary iron wire to wire constructed of his laminated steel, to a strong and lengthened current of electricity, for a period of two hours, which effectually changed the fibre of the inferior irons to a crystalline state,—their tenacity was entirely destroyed, and breaking with the brittleness of glass. The highly fibrous state of both the mixtures of steel and iron, and the fibrous steel, was not affected in the like ratio—not even after enduring the passage of the current for double the period. Hence he inferred that mixtures of steel and iron in axles would not only add to their durability and safety, but materially lessen the consumption of the lubricating material. This result will also be materially advanced by the adoption of a hollow axle,—not *hollow* axles, which require increased diameter or surface, but an axle of precisely the present dimensions, with a perforation not exceeding ¼-inch in diameter: but this is a question of importance enough to demand a paper exclusively devoted to it.

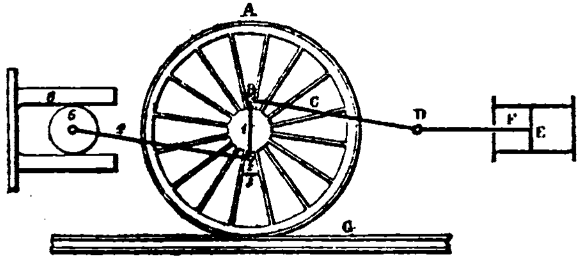
To the adoption of mixed steel and iron is attributed the successful use of the gun-harpoon; for many years no iron could be found which would effectually resist the rapid motion given to it by gunpowder. It is a fact beyond dispute, that all gun-barrels will only stand a certain number of explosions: an ordinary iron barrel will seldom stand a repetition of four proofs,—and be their quality even the best, a certain number of years' use changes their nature, and they become unsafe. So it is with railway axles, and, in short, all structures of this metal, which, after a given time, part with every quality that renders them valuable. And thus arises a question whether the construction of horizontal bridges of iron is calculated to endure the many years their projectors hope. The waves of vibration, from the rapid passage of the locomotive, partakes much of the nature of concussion, and as such, is peculiarly liable to be classed as one of those injured by excessive vibration.

Remarks.—The PRESIDENT (Mr. Stephenson) remarked on the danger of assuming facts and reasoning from that assumption. With respect to the influence of vibration on the structure of iron, he considered there was good room to doubt that the bearing force or pressure upon metals caused crystallization. It was by no means proved that railway axles were subject to the passage of currents of electricity, and therefore granting the assumption that the passage of the electric current changed the character of the iron, there was a link wanting in the chain of reasoning, inasmuch as it was not proved that axles were subject to this electrical influence. Moreover he was inclined to doubt whether if a piece of iron was at first perfectly fibrous, vibration would ever change the structure of the metal. The beams of Cornish engines, for example, were subject to vast pressure; they never became crystallised; the connecting-rod of a locomotive was subject to great vibration, strain, and pressure, vibrating eight times a second when the velocity is 40 miles an hour: he had watched the wear of a rod for three years, and no change was perceptible in the structure of the iron. He doubted, therefore, the correctness of the assumption made by Mr. Greener.—After a few words from Mr. Roberts in support of this opinion, the discussion terminated.

9. *On the causes and means of prevention of the Oscillation of the Wheels of Locomotive Engines.* By Mr. Heaton.

Mr. Heaton exhibited a machine representing a locomotive engine, to prove the cause and prevention of their oscillation on railways. He first showed the machine simply with the piston, rod, and connecting-rod attached to the wheel. When the machine was set in motion slowly, it remained steady on the table; but by increasing the velocity of the wheels, it began to oscillate and jump about, although each wheel had a balance-weight in it, equal to the weight of the crank-pin and the connecting-rod. He then showed the machine with weights placed in the wheels equal to the weight of the pistons and gearing, or all that moves in a horizontal line. When the wheels of the machine were set in motion with great velocity, the machine did not oscillate, but it jumped perpendicularly up and down.

Mr. Heaton then attached to the machine his improvements, for the purpose of showing the importance of placing moving weights in opposite directions to each other at high velocities. He observed that when an engine of 20-inch stroke with 6-feet driving-wheels goes 15 strokes per minute, or 3 miles per hour, it required one-tenth of the weight moving horizontally (that is, the piston and gearing) to stop it and turn it again; at 35 strokes per minute, one-half its weight; at 74 strokes per minute, once-and-a-half its weight; and at 100 strokes per minute, four times its own weight.



Reference to parts preventing Oscillation.

1. Auxiliary Crank fitted on crank pin B.
2. Crank-pin to ditto.
3. Weight to balance crank-pin in Wheel.
4. Connecting-Rod.
5. Roller or balance-weight travelling in an opposite direction to piston E.

Reference to parts causing Oscillation.

A. Driving-wheel of a Locomotive Engine.
B. Crank pin in wheel.
C. Connecting rod.
D. Slide Gear.
E. Piston and Rod.
F. Steam Cylinder. G. Rail.

If a weight (6), with connecting-rod (4), and an auxiliary crank (1), be attached to the head of the crank-pin (1), equal to the weight of the piston (F) and its gearing, so as to make the weight run to the left hand at the same instant the piston goes to the right, the blow to stop the piston and make it return will be received in the auxiliary crank (1), instead of in the wheel, producing thereby a neutral point in the centre and steadiness of motion; for when the blow is received in the wheels, the cranks being at right angles, it is communicated through the axle, and gives a twisting motion to the whole framing of the engine: this oscillation is found to be greatest when the engine is running most regular for speed, and the piston going the same way with the oscillation of the carriage.

Mr. Heaton then set in motion the machine with his improvements, as shown in the annexed engraving, when there was not the slightest oscillation or jumping to be seen.

10. *On a Machine for Ventilating Coal Mines.* By Mr. William Brunton, of Newport, Monmouthshire.

Mr. Brunton stated that he proposed to describe the ordinary means used to effect rarefaction of the air in coal mines, so as to ventilate the works; to make some practical observations on the amount of power generated by these means, and the effects of the ordinary application of them; to point out what appears to be the inherent defects of the principle of heat as a ventilator to a coal mine; and, lastly, to describe the apparatus invented and erected for Thomas Powell, Esq., of the Gaer, near Newport, and which he would recommend as a mechanical substitute for the furnace, possessing much greater power of rarefaction, and in many respects better adapted to the varying circumstances of coal mines generally.

Mr. Brunton stated that the ease and facility with which atmospheric air moves upon its receiving an increase of temperature is the principle upon which the ordinary method of ventilation is conducted. In sinking a shaft, the heat communicated to the air in descending, and its contact with the bodies of the men, is usually sufficient to create an ascending and descending current for the supply of fresh air; and this is greatly promoted by a partition dividing the shaft into two compartments, the downcast on one side, the upcast on the other. The same thing is accomplished by sinking two contiguous shafts. But little progress can be made in working a colliery till a more effectual means of ventilation is applied. For this purpose, a furnace, or large open grate, is constructed near to the upcast-shaft, upon which a constant fire is maintained, over which the air passes, and is rarefied in its progress from the workings of the colliery to the upcast-shaft, when its buoyancy creates a draught through the ramifications of the mine back to the downcast-shaft.

In order to judge of this mode of rarefaction, Mr. Brunton constructed a Table (No. I.) of easy application, showing the expansion and weight of air at every 10° of heat from freezing to 252°; also a plain way of applying it to any particular case.

Table No. I.
Effect of Heat on the Expansion and Weight of Atmospheric Air.

Degrees of heat.	Weight of a cubic foot in grains.	Volume.
Freezing 32	550	100
42	549	102
52	529	104
62	518	106
72	506	109
82	495	111
92	487	113
102	479	115
112	470	117
122	461	119
132	453	121
142	446	123
152	439	125
162	432	127
172	426	129
182	420	131
192	413	133
202	407	135
212	401	137
222	394	139
232	386	142
242	381	144
252	376	146

Table No. II.
Pressure of Aerial Currents, and Force expended.

Velocity in feet per second.	Pressure in pounds per square foot.	Pressure per minute in pounds falling 1 foot.
1·0	·0022	0·13
2·0	·0092	1·10
3	·0206	3·70
4	·0365	8·64
5	·0570	17·1
6	·0822	29·5
7	·1120	47·0
8	·1465	70·0
9	·1850	99·9
10	·2280	136·8
11	·2770	179·2
12	·329	236·2
13	·385	300·3
14	·447	375·4
15	·518	461·7
16	·583	559·6
17	·661	674·2
18	·740	799·2
19	·825	940·5
20	·935	1122·0
22	1·11	1465·2
24	1·32	1790·0
25	1·49	2235·0

It must be evident that the ascension of air in the upcast is owing to its being volume for volume lighter than the air in the downcast, and that lightness is obtained by heating, and that the expansion consequent on heat is the true measure of its levity or tendency to rise.

Let the figures A, and B, represent two shafts of equal depth of 900 feet; A, the downcast, B, the upcast. Let us suppose the air in A, 62°, and the average heat in B, 182°. It will be sufficient for all practical purposes to carry out the calculation in perpendicular feet of 1 foot area, then we have (see Table I.)—

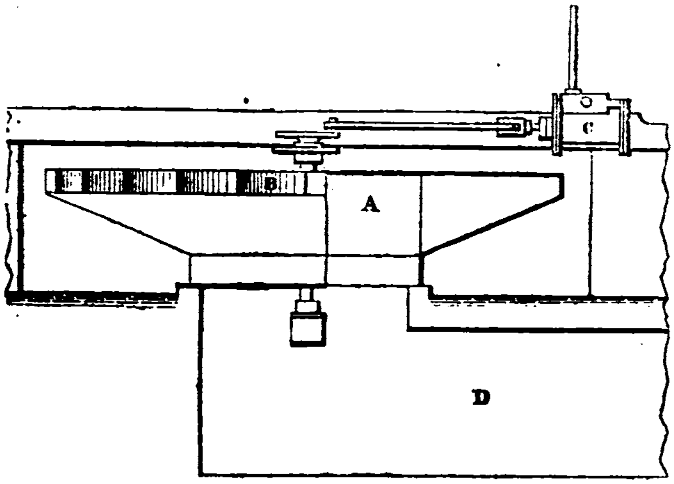
grains. grains.
A, 900 cubic feet, 62° at 518 = 466,200
B, 900 ,, 182° at 420 = 378,000 ÷ 518 = 730
88,200 grains.

Showing that 900 feet at 182° is balanced by 730 feet at 62°, as in the diagram, leaving 170 feet at 518 = 88,200 grains, or about 12·5 lb. on the square foot, as a gravitating power to propel the air upward in the shaft B.

Mr. Brunton was aware of various rules that have been laid down for calculating the velocity and force with which the air ascends the upcast-shaft; but he has never found them to tally with experience, but often imposing a notion of security where danger ought rather to have been apprehended. This induced him to investigate the subject, admitted to be on all hands an intricate one, and to submit the following hypothesis, which, if correct, may prevent the furnace as a power of rarefaction being rated beyond its capability, as it has been many times, to the fearful destruction of human life.

The principle upon which Mr. Brunton thinks the velocity of the air in two shafts A, and B, acting alone and unconnected with the working of the colliery, should be calculated, is analogous to two weights A, B, suspended by a line passing over a pulley (supposed without friction), and the length of the line may represent the depth of the shafts. Whilst the weights A, and B, are equal, there can be no motion, for they neutralise each other; but if a weight (C) is added to one of the weights A, or B, then motion will take place, but the added weight C, will not descend as it would if it descended alone freely, for it cannot move without communicating an equal motion to the two weights A, and B; an equal force must therefore be distributed through the three weights A, B, and C, and that force can only come from the gravitating force of the latter (C), this force being that with which it would actually descend if left to itself. If A, and B, be each 10, and C = 1, then the mass through which the force is diffused will be equal to 21 times the weight of C. The force actually existing in each portion of the mass is therefore the 21th part of what it was in each portion of the added weight C, and will in this combination descend with the 21th part of the velocity that it would do if it descended freely, that is, the 21th part of the ordinary effect of gravity. Having thus endeavoured to explain the principle upon which the furnace rarefaction proceeds, let us now further illustrate it.

Fig. 1.—Sectional Elevation.



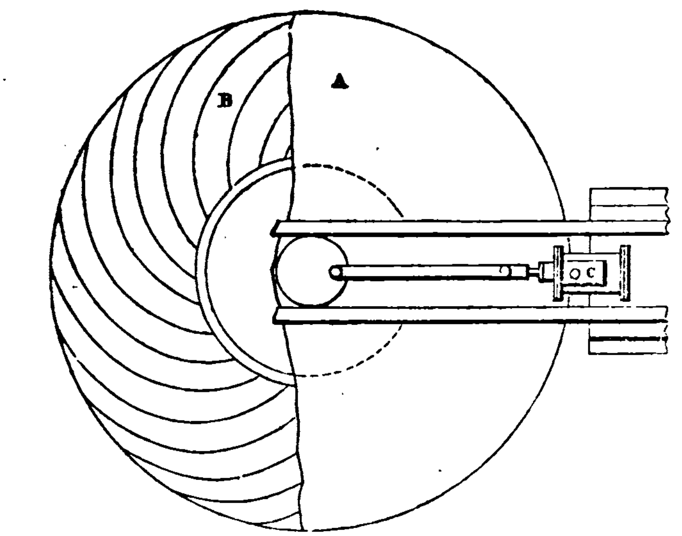


Fig. 2.— Plan.

Suppose 900 feet in B, and 730 in A, represent the weights A, and B, balancing each other, and 170 the weight C, with a fall of 900 feet, the velocity acquired thereby when falling freely is theoretically 240 feet per second; but 170 is the 10·6th part of 1800 (the sum of 900, 730, and 170), consequently 240 divided by 10·6 gives us 22·7 feet per second for the real velocity in the upcast-shaft.

Thus we have an approximation at least to the velocity of the air in the two shafts; but which is after all of little practical use or application; for, the direct opening between the shaft being closed, the weight C, 170 (which in the supposed case is equal to 12·5 lb. upon the square foot) immediately becomes a gravitating force descending with more or less velocity as it is enabled to propel the air through the workings of the colliery; and, taking 12·5 as the first mover or cause, we may look for 9 as the mechanical effect in moving the air through all the air-courses of the colliery, and ultimately discharging it through the upcast-shaft into the atmosphere; and though it is impracticable to balance the account by estimating the actual weight of air in the colliery, the different velocities with which it is propelled, together with the amount of retardations, which if obtained would accurately express the force applied, yet the aggregate may be satisfactorily ascertained by the application of the water-gauge to any single partition or door which stops the direct passage of the air between the shafts, and constrains it to take the circuit of the colliery workings; that is, where the downcast and upcast shafts are contiguous, and one side of the door is directly and freely connected with the influent current from the bottom of the downcast, and the other side similarly connected with the effluent current as it enters the upcast, the difference of the height of the water in the tubes of the gauge will express the force applied to maintain the current between the bottom of the two shafts passing through the workings of the colliery analogous to the amount of force required to draw a long rope through a winding passage.

Mr. Brunton next described the mechanical means of the ventilator he has erected for Thomas Powell, Esq., of the Gaer, near Newport, Monmouthshire, upon one of his collieries, and the particular advantages it possesses over the furnace as a ventilator. Over or near to the upcast shaft is constructed a hollow drum, with curvilinear compartments, through which the air is discharged with that degree of force due to the velocity with which the drum revolves upon its axis. The diagrams figs. 1, and 2, represent a plan and elevation of the ventilator. A, is a drum, 22 feet exterior diameter, with curvilinear compartments B, 16 feet mean diameter; C, is a steam-engine to give motion to the ventilator, the centrifugal force of which at 120 revolutions per minute will be 39·25, which, multiplied by the weight of 6 cubic feet of air = $\frac{441}{1000}$ of a pound, will give a pressure of 17·5 pounds on the square foot, as the amount of rarefaction produced in the interior of the drum, and consequently in the upcast shaft with which it is connected (by D, the air culvert), which is much beyond what can be obtained by the furnace, yet greatly within the limits of the capability of this machine, as shown below. The amount of rarefaction is governed by the speed of the engine, and is also under constant and visible inspection by a water or mercurial gauge: thus when the drum revolves

60	times per minute	the rarefaction is	4·3 lb.	on square foot.
90	"	"	9·7	"
120	"	"	17·8	"
150	"	"	27·0	"
180	"	"	39·0	"
210	"	"	53·0	"

In order better to understand the peculiar self-adaptation of this apparatus to all the circumstances that present themselves in the ventilation of collieries, let us suppose it altogether unconnected with any length of air-course, the air from the atmosphere having free access to the centre, and space for free discharge from the circumference, and a velocity given to it of 150 revolutions per minute, creating a rarefaction of 27 lb. per square foot in the middle of the drum; then the velocity of the air through the machine would be 108 feet per second, and the aggregate amounting to 8424 cubic feet per second, or 505·440 per minute.

Then let us suppose a state the very reverse of the above—viz., that no air be permitted to enter the drum at the centre part, of course none can be discharged at the circumference; therefore, there being no resistance to the motion of the drum from discharge of air through the curvilinear compartments, but the power of the engine continuing the same, is consequently expended in increasing the velocity of the drum, and thereby the rarefaction. In the former case the effect is exhibited in the discharge of air; in the latter by the degree of rarefaction maintained in the middle of the drum.

From consideration of these two cases, it is manifest that the power required to work the machine will be as the quantity of air ascending the upcast-shaft, and the amount of rarefaction required to draw it through the colliery; and such is the principle of self-adjustment of this apparatus, that if from any cause a less quantity of air is passed through the colliery at one time than another, the engine (always exerting the same power) will of its own accord accelerate the velocity of the drum and increase the rarefaction, for, the power applied being the same, the effect will be commensurate in the quantity of air discharged, the amount of rarefaction attained, or both combined.

The machine is an entirely new modification of the fan. Its construction is of the most simple integral character; it has no valves or separate moving parts; has no attrition, and all the friction is resolved into a foot pivot moving in oil; when at rest offers no impediment to air ascending from the shaft, is very inexpensive, and liable to no derangement; in short, it is a simple mechanical implement, whereby any degree of rarefaction necessary to ventilation is rendered certain and regular, being subject to the law of central forces, which is as fixed and determinate as that by which a stone falls to the earth.

In imitation of our Cornish method of estimating the lifting of water from the mines, Mr. Brunton has, in Table No. II., denominated the power necessary to propel the air by pounds falling 1 foot per minute; but in the use of this table it must be borne in mind that the pressure per square foot is that due to the velocity, and, to produce this current, an increase of 25 or 30 per cent. must be made, as in ordinary mechanical operations, where 100 may represent the power or cause and 72 the effect.

11. *The Desiccating Process for Drying and Seasoning Wood and other materials.* By Mr. R. Davison, C.E.

Mr. Davison stated that all other methods consisted in generating heat by simple radiation, or throwing off heat from a heated surface, whether the surface be brick flues, cockles, steam or hot-water pipes. Heat is easily attainable in this way, and to almost any grade of temperature; but heat is not the only essential required for drying, or why does the bleacher or laundress hang out their articles to dry on a cold March morning. It is true that heat facilitates the evaporation of the watery particles; but a current is likewise necessary, otherwise all the water which is thus converted into vapour will only tend to charge the chamber with steam; and it is not until this steam has arrived at a certain excess, or pressure, that it will make its escape, and the operation of drying really commence.

The amount of current obtainable in this way is proportioned to the rarefaction, and quantity of air admitted and allowed to come in contact with the heated medium: if little is admitted, there is little current, an increased temperature, and likewise an increased volume of vapour,—or, *vice versa*, if a larger amount of atmospheric air is admitted, there will be a corresponding increased current, a lessened temperature, and much less vapour. The ordinary current obtainable in this way may be taken at 3 or 4 feet per second.

To subject any article to a slow current of heat in a comparatively close chamber, or where there is an exceedingly small aperture for the escape of vapour, whereby that article (whatever it may be) is enveloped in an atmosphere of its own steam, is (to give it its proper name) not drying, but *stewing*. If there is next to no escape at all, as in the case of an oven, it is in reality *baking*.

Mr. Davison stated that it is not only a moving but a rapid current which is the great desideratum for all drying purposes; and that it is the impulsion of atmospheric air, at the velocity of the hurricane, or upwards of 100 miles per hour (or any other speed), combined with the element of heat under perfect control, which in fact constitutes the desiccating process.

Mr. Davison next proceeded to describe the means by which the two operations of current and heat are created and kept up; and some applications which have been made of the process, together with the practical results.—The drying apparatus, consisting of a series of cast-iron pipes, so united together as to form one continuous pipe bent vertically into an arch form, and set in a casing of brickwork, with a common furnace, surrounded on the sides and top by the pipes, comprehends at once the heating medium. The current of air is created by a common blowing-fan, which can of course be driven at any required speed either by hand or a steam-engine. For all ordinary drying purposes, every thousand cubic feet of space of the drying chamber requires 28 superficial feet of heating surface in the pipes forming the furnace.

So far as regards the construction of the apparatus, and the mode of conveying the heated air into, and the escape from, the chamber or stove, the same plan is carried out in all cases where mere drying is required, whether it be for wood, yarns, fabrics of all kinds, starch, sugar, leather, paper, or indeed any article whatever which simply requires moisture evaporated from it. The arrangement is as follows—viz. one, two, or more, channels or pipes being laid in or upon the floor of a building, whose sectional area corresponds in the aggregate with the heated outlet of the apparatus; the currents of air being driven into these by a fan, is allowed to escape through small perforations made on the top or sides of the channels or pipes as the case may be, these perforations corresponding again in amount of superficial area with the heated outlet: in this way a uniform amount of current as well as temperature is distributed throughout the chamber, and rises towards the regulating orifices provided in the roof or sides of the building for the escape of moisture.

Mr. Davison then proceeded to explain the application of the desiccating process to the purifying of brewers' casks, which had been adopted at some of the leading breweries in England and Ireland; at the brewery of Messrs. Guinness, of Dublin, upwards of one million casks in four years had undergone the process. He then explained the application of the process to the *drying or seasoning of wood.*

The advantages of this process for drying wood are that it is a true imitator of those elements which are said to be the best seasoners of wood, viz. the March wind with a summer heat; with this addition—that a current of air exceeding by far that of any ordinary wind, and a heat beyond that of any ordinary summer, is instantly and constantly at command, and kept up until every grain of moisture is expelled. The greener the wood, the easier and more perfect is the expulsion of moisture, and at the same time the native strength of the fibre is secured by the immediate evaporation of all vegetable juices or moisture likely to ferment and carry on decomposition. The gums, instead of being removed, are coagulated and hardened, and the texture of the wood generally (having been brought into its most complete state of aggregation and density) is much less liable to imbibe atmospheric moisture, and altogether less prone to decay. The colour of mahogany and other fancy woods is not only preserved but improved, thus avoiding everything approaching to a stain, as is too frequently the case according to the ordinary method of seasoning such woods. Shrinking is entirely obviated. The cost of desiccating is inexpensive—not exceeding the interest of money sunk in laying-up wood to season in the ordinary way.—The process has been adopted at the Tower of London for the seasoning of gun stocks; and by Messrs. Hall and Co., ship-builders, of Aberdeen, who have applied the process to seasoning wood for vessels, particularly the decks of vessels; and also by numerous builders in London.

The annexed Table will show the comparative strength and deflection of desiccated specimens, and their duplicates after four months' seasoning in the ordinary way.

Desiccated or otherwise.	Dimension.	Broke with Pounds' Weight.	Deflection.	Increase in Strength by Desiccation	Average Increase.
	Sq. Feet.	lbs.	Inches.	Per Cent.	Per Cent.
Yellow Pine.					
Desiccated ..	1	45½	6	11·3	17·6
Not ..	1	40½	11		
Desiccated ..	1½	138	6	22·5	
Not ..	1½	107	4½		
Desiccated ..	3	884	3⅞	19·1	
Not ..	3	716	4½		
Riga Pine.					
Desiccated ..	3	996	3¾	20·4	20·4
Not ..	3	793	4⅛		
Mahogany.					
Desiccated ..	1	70½	9⅛	11·4	12·4
Not ..	1	62½	8¾		
Desiccated ..	1½	185½	6¾	16·0	
Not ..	1½	156	6⅛		
Desiccated ..	2	436	5¼	10·0	
Not ..	2	394	5¼		
Desiccated ..	3	1514	4¾	12·3	
Not ..	3	1318	5⅝		
English Oak.					
Desiccated ..	1	54¼	9⅛	12·9	14·0
Not ..	1	47½	11½		
Desiccated ..	2	385	4½	15·1	
Not ..	2	327	4¾		

NOTE.—The above experiments, so far as they relate to strength, are not offered as positively accurate, owing to the specimens being prepared more with a view of ascertaining the rate of seasoning by the desiccating method compared with natural seasoning. For this purpose, the specimens were in some instances planed or pared, so as to bring both to the same weight. The specimens, however, of which there was a doubt, having been left out of the Table, the above results may be considered sufficiently correct for all practical purposes.

Before closing these brief remarks on this portion of the subject, it ought to be mentioned in reference to impregnating timber with any preservative mixture, that timber which has thus been so completely exhausted of all aqueous particles is in the best possible condition to receive ingredients of any kind, but more especially if timber instead of being allowed to cool after it is removed from the desiccating chamber, is immediately plunged into a cold antiseptic: it will be clear that a very considerable charging of the pores must inevitably take place. A variety of fencing, railway sleepers, keys, &c. having been treated in this way, and the very best results having so far been observed, the plan is with confidence recommended as one which ought to be more closely followed up. In most cases, immersion, it is believed, will be quite unnecessary, for if the desiccation of the timber is only complete, all that can be wanted will be a thorough coating of some oleaginous fluid to close the external pores.

For *calico printing* the process is most advantageously adapted; it enables the operator, with the mere turning of the hand, to regulate the heat and current so as to suit the style of goods which are being thrown off from the machines. One heating apparatus can be rendered available for one, eight, or more machines, each printing perhaps a different kind of fabric, as well as a different amount of colour; and when it is borne in mind that these machines are known to print from 4,000 to 6,000 yards per day, it cannot be a trifling consideration to have a command of drying power, as thus described.

12. *On a Patent Water-Meter.* By Mr. Parkinson.

This instrument is constructed for measuring water as supplied from the water-mains in the streets to private houses, factories, and other places. Mr. Parkinson stated that it was simple in construction, uniform in motion, nearly free from friction, and not subject to derangement; it takes an accurate account of the water passing through it, whether it enters under several hundred feet elevation, or the smallest stream under half-an-inch pressure. The measuring-wheel or drum is a modification of Crosley's gas-meter drum; the water under pressure enters at the back, where a self-acting apparatus reduces the pressure to that only which is necessary to pass it into the measuring-drum. The quantity is recorded on an index, similar to the gas in gas-meters. From the measuring-drum it falls into a small cistern, which, in filling, shuts off the supply to the meter by means of a ball-tap valve; from this cistern the water is drawn off as required, the act of which draws down the float and sets the meter to work, and supplies the quantity drawn off, to be ready for farther demand. As the cistern is only a small one, it is indispensable that the pressure from the works should be always on, to be ready to enter the meter; but if the supply be intermittent, as is now generally the case, a large cistern, to hold a day or two's supply, must be provided. And it would require a meter large enough to fill the cistern in the allotted period allowed by the company for this purpose; but it is expected now that companies can get paid for all they sell, that it will be to their interest to keep the pressure always on.

It is calculated that a meter to supply a twelve-roomed house, will not cost more than 30*s*., and be able to supply water to the extent of 50 gallons per hour. In fitting-up new houses, the cost of the meter will be much less than the cost of a cistern on the old principle; besides the advantages of a constant supply, no annoyance from stoppages from frosts, &c., as the meter and pipes may be all internal.

[From some remarks that were made after the paper was read, it was elicited that the pressure of the mains was reduced by allowing the water to flow into a small regulator or cistern attached to the apparatus into which the water first enters before it passes through the drum to record the quantity; and that when the small cistern was full, the water was shut off by a ball-cock until it had discharged its contents. When this was done, the ball-cock was again opened by a contrivance in a second reservoir, below the first.].

13. *On the Present State of Telegraphic Communication in England Prussia, and America.* By Mr. F. Whishaw.

Mr. Whishaw first described the extent of telegraphic communication in England, and its direction. The whole length is about 2,000 miles, the course of the wires invariably following that of railways. Not so in Prussia and America. In the former country there were 1,700 miles of wire, in the latter about 10,000. In both places it was not considered necessary to follow the course of railways. In Prussia the wire sometimes skirted the highway, and crossed the Rhine. In America the vast prairies and agricultural districts were linked together in one chain of communication. In Prussia the system recommended by Mr. Whishaw, of coating or insulating the galvanised wire with gutta-percha, and burying it underground, was partly adopted. He strongly recommended this system, for besides the expense of posts, there were several disadvantages attending the present practice; they were liable to be damaged by trains getting off the rail, the electrical action was frequently disturbed by the state of the atmosphere, and the wires were often damaged by malicious persons. This was more particularly the case on the continent, where political inquietude often assumes a formidable shape. It has been found after considerable experience that gutta-percha so buried was as perfect when it was dug up as the day it was put down. He had recommended this system to the East India Company, who were preparing to lay down no less than 10,000 miles of wire. Morse's telegraph was the one principally in use in Prussia, and it was worked with the greatest ease and facility by mere boys.

The expense of laying down a mile of wire in these countries varied considerably. In England it was about 150*l*., in America 20*l*., in Prussia 40*l*. In the two latter places a single wire was used. The charges in America and England differed considerably, and considering that in the former place a dividend of 6 per cent. is paid, he could not help coming to the conclusion that the economical system of charges is by far the most profitable. The difference is the following:—

American Scale of Charges.

From Washington to	Distance.	20 Words.		50 Words.		100 Words.	
		s.	d.	s.	d.	s.	d.
Alexandria	10 miles	1	1	2	4	4	5
Fredericksburg	60 miles	1	3½	2	6½	7	7½
Raliegh	292 miles	2	8	5	2	9	4
Columbia	509 miles	4	0	7	9	14	0
Macon	1,107 miles	7	9	15	3	27	9
Columbus	1,200 miles	8	6¼	16	9¼	30	6¼
Mobile	1,523 miles	10	3¼	20	3¼	36	11
New Orleans	1,716 miles	12	6	25	0	45	10

Electric Telegraph Company's Charges.

Distance.	20 Words.		50 Words.		100 Words.	
	s.	d.	s.	d.	s.	d.
10 miles	2	6	9	0¼	20	0
60 miles	4	7	12	7¾	26	1
100 miles	6	3	15	7½	31	3
200 miles	8	4	20	10	41	8

South-Eastern Railway Charges.

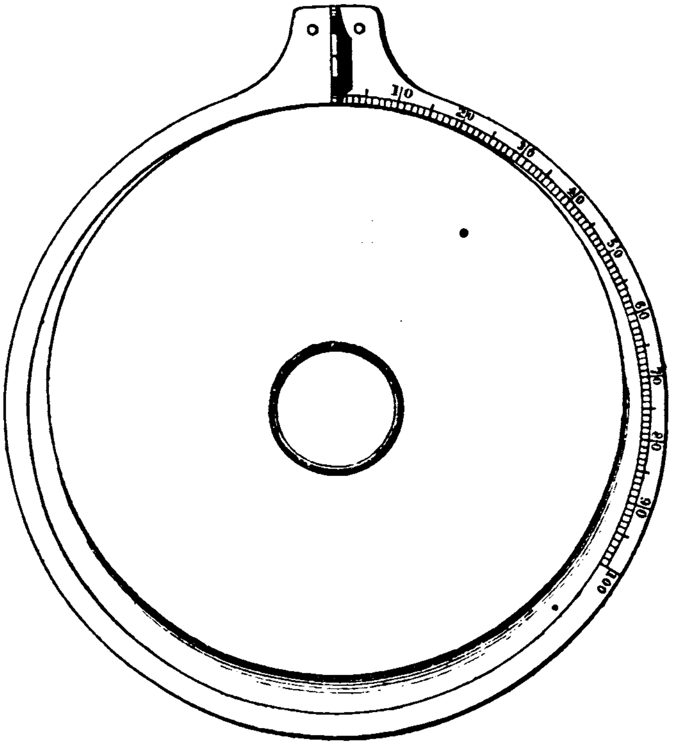
From London to	Distance.	20 Words.		50 Words.		100 Words.	
		s.	d.	s.	d.	s.	d
Merstham	19 miles	5	0	12	6	25	0
Ashford	68 miles	8	6	21	3	42	6
Dover	88 miles	11	0	27	6	55	0

14. *On the Copying Electric Telegragh, and other Improvements in Telegraphic Communication.* By Mr. Frederick C. Bakewell.

In the copying telegraph the corresponding instruments are made as exactly alike as possible, so as to impart equal and steady movements to a cylinder on each instrument. Motion is given to the cylinders by weights, accelerated velocity being prevented by rapidly-revolving fans. Parallel to the cylinders are screws which turn with the cylinders, and carry traversing nuts. To those nuts ivory arms are attached, at the end of each of which there is a binding screw to hold a metal point that presses on the cylinder, and is carried by the revolution of the screw from one end to the other. Upon the cylinder of one of the instruments, the message to be transmitted is written on tin-foil with a pen dipped in spirit varnish, which is quite sufficient to obstruct the passage of the electric current. On to the cylinder of the corresponding instrument the paper to receive the message is applied; it is moistened thoroughly with a solution which electricity will readily decompose, so that a mark may be made on the paper whenever the electric current is completed. The solution used consists of a mixture of muriatic acid and prussiate of potass; the marking point being steel wire. The metal points which press on the cylinders are connected with the poles of a voltaic battery, and are insulated from the other parts of the instrument by the ivory arms. The cylinders are also placed in the electric circuit, which is completed by the electricity passing from the point to the cylinder of each instrument. By this arrangement, when the point of the transmitting instrument is pressing on the exposed tin-foil, the electric circuit is completed through the moistened paper of the receiving instrument, and a mark is made; but when the point of the transmitting instrument is pressing on the varnish writing, the marking ceases. In this manner, as the cylinders rotate, and the points are moved gradually along by the traversing screw nuts, spiral lines very close together are made on the paper, excepting in those places where the electric current is interrupted by the varnish; and if both cylinders rotate exactly together, the point of the transmitting instrument, by passing several times over different parts of each letter, will cause the marking point to produce forms of the letters on the paper, as in the specimens shown. By this arrangement, copies of writing may be made at any distance to which an electric current can be conveyed, provided the two instruments are moving exactly together. To obtain synchronous movements in the two separate rapidly-revolving instruments, there is attached to each cylinder an electro-magnet, to the keeper of which there is a detent, which catches against projections on a wheel fixed to the euber of the cylinder, the projections on both wheels being placed at exactly equal distances. The electro-magnets are brought into action at regular intervals, by means of half-second pendulums, actuated by clockwork. These pendulums are connected with separate voltaic batteries, in such manner that at each connection they make and break connection, and put the magnet into and throw it out of action: thus affording the means of regulating the cylinders every half-second.

15. *The Eccentric Sheet Metal and Wire Gage.* By Mr. Richard Roberts, of Manchester.

The gage is thus constructed:—A plate of brass, about $4\frac{5}{8}$ inches diameter and $\frac{1}{4}$-inch thick, is recessed on the upper side to the depth of $\frac{1}{8}$-inch and 4 inches diameter, leaving a margin $\frac{3}{16}$-inch broad. In the centre of the recess is a hole into which is fitted a steel pivot whose upper end is rivetted into a steel disc 3·8 inches diameter and $\frac{1}{16}$-inch thick; the pivot is eccentric to the disc $\frac{1}{16}$th of an inch, and consequently one point in the periphery of the disc touches the inner edge of the brass margin, with which the top of the disc is level. To the under side of the brass plate a small slide is fitted, to the outer end of which a piece of steel is attached (by screws), that passes up through a notch in the brass margin about $\frac{1}{4}$-inch, and forms the inner or sliding jaw of the gage: the outer jaw is formed of a similar piece of steel also passed through the notch in the brass margin, and is secured to the brass plate by screws. The inner edge of the sliding jaw is rounded to a radius of $\frac{1}{16}$-inch, and is kept in contact with the periphery of the eccentric disc by a spring (under the disc), which acts against a stud in the slide projecting through the brass plate. The margin of the brass plate is divided through one-fourth of its circumference, commencing at the centre of the sliding jaw, into 75 equal parts, which are numbered decimally. The extremity of the disc is then set at zero on the scale, and the jaws accurately adjusted to touch each other, after which the extremity of the disc is turned to the fifth division, and a line is made on the disc to correspond with zero on the scale, at which point the jaws will be opened a little. The disc is turned to the required gage *number* by means of a milled button, or by two studs, and is fixed there by a milled nut on the end of the pivot below.



It may be convenient to have the *numbers* extended from 75 on a fourth of the circumference, and to 100 on a third, but the law of increase in the figures beyond 70 would be reversed. It will be obvious that gages having different *numbers* and dimensions may be more suitable for certain descriptions of work, and likewise that the eccentric principle may be applied to gages in many various ways.

This gage possesses the following properties:—

1st. A corresponding gage may be made without expensive tools from a written description of the means employed to make the original.

2nd. It admits of accurate construction and easy re-adjustment.

3rd. Each succeeding *number* being larger than the preceding in a progressively increasing ratio, adapts the gage equally well for high and low *numbers.*

16. *On Hosmer's Self-Acting House Cistern.*

Mr. Wood read this paper, and exhibited a model of the apparatus. It consists of two separate divisions (A, B), in the same cistern, the larger division being for domestic purposes, the other for cleansing the drains and sewers. There is a two-way inlet-cock C, with ball and lever, one aperture opening into the small, the other into the large division. The water from the main being turned on, the small division B, of the cistern becoming first filled, flows over into the other A; the water rising in A, lifts the ball and lever, until stopped by the pressure of the fluid column upon a valve at the bottom of the small division B, with which it is connected by a chain. The water continuing to rise, the ball becomes nearly immersed, when its superior buoyancy overcoming the pressure upon the valve, lifts the latter suddenly to such a height as to allow of a free flow through a large syphon-trapped pipe into the drain. The larger division of the cistern becoming filled, is retained for domestic purposes.

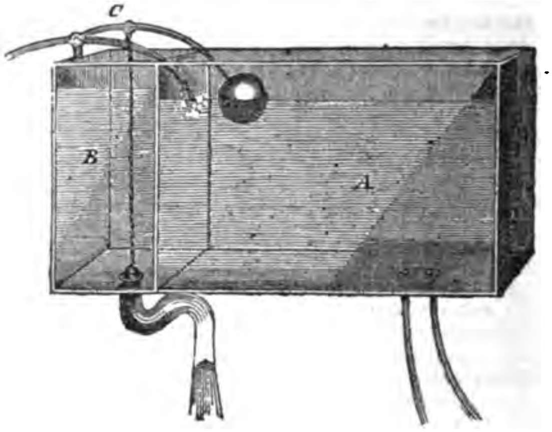


Fig. 1.—Self-Discharging House Cistern.

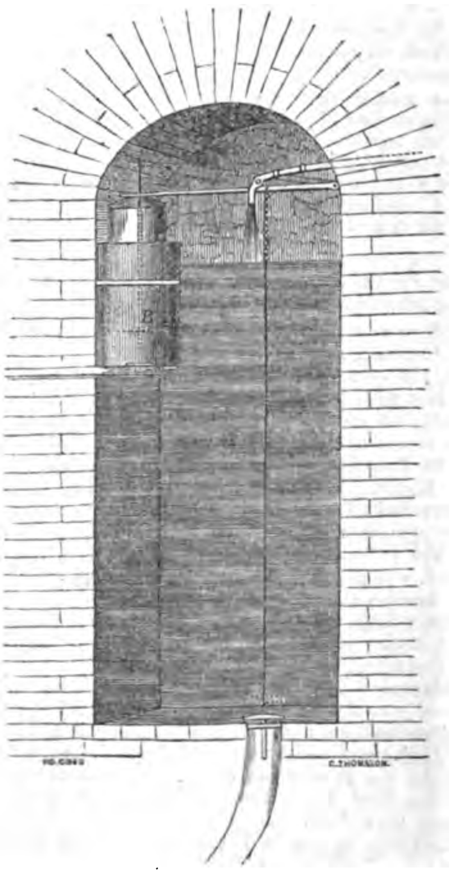


Fig. 2.—Self-Discharging Street Tank.

The above tanks are in use in the City of London, by order of the Court of Sewers.

17. *Patent Tide-winding Apparatus.* By Mr. Richard Roberts, of Manchester.

This apparatus is for the purpose of rendering tidal power available for raising heavy bodies, or for winding clocks. Figures 1, 2, and 3, are diagrams to explain the machinery. C, is a weight twice raised by every tide, in the following manner. M, and N, are chain-wheels, placed loose on the shaft K, and provided with studs on their peripheries, to prevent the chain *k*, from slipping; P, is a pulley placed on a stud in the framing, under which pulley the chain *k*, also passes; A, is a hollow weight which ascends and descends with the tide, and B, is a counter-weight, heavy enough to hoist the weight C, and and preserve the tension of the chain *k*, whilst the tide is rising, the hollow weight A, being sufficiently heavy to hoist the weights B, and C, during the ebbing of the tide. Whilst the hollow weight A, is rising with the tide in the tank R, the pulley N, which is loose upon the shaft K, rotates in the direction of the arrow in fig. 3, and carries with it ratchet clicks over the teeth of the wheel P, whilst the chain *k*, passing from the hollow weight A, over the pulley N, under the pulley P, and over the pulley M, to the weight B, allows the weight B, to descend; and the clicks placed upon the pulley M, by operating upon a ratchet-wheel O, effect the rotation of the shaft K, in the direction of the arrow in fig. 2. The weight C, operates upon the shaft L, which is in connection with the clockwork or other mechanism, in the following manner. G, is a pulley made fast upon the shaft L, and furnished with suitable projections on its periphery for preventing the endless chain *l*, from slipping; H, is a pulley which is also provided with projections similar to those on the pulley G; and I, is a ratchet-wheel, fixed with the wheel H, on the shaft K. The ratchet-wheel I, with its click, are only used when the works are being put together. The endless chain *l*, *l*, passes over the pulleys G, and H, and is kept in close contact with them by the weight C, and counter-weight suspended from it by the pulleys *c*, and *d*. During the ebbing of the tide and consequent descent of the hollow weight A, the weights B, and C, are made to ascend and the counter-weight D, to descend in a corresponding ratio. During both changes of the tide, the weight C, descends and maintains by its gravitation the motion of the clockwork or other mechanism to which it is connected, until the influx or efflux of the tide rewinds it as before described. As the endless chain *l*, cannot slip upon the pulley G, the rotation of the shaft L, will be maintained continuously in the same direction. The effect of the weight C, upon the clockwork or other machinery is rendered equi-motive by the chain *l'*, which is attached at its extremities to the weight C, and the counter-weight D, and extends downwards lower than the weight C, consequently as the weight C, ascends or descends, the weight of chainis diminished as much at one end of the weight as it is increased at the other.

Fig. 1.

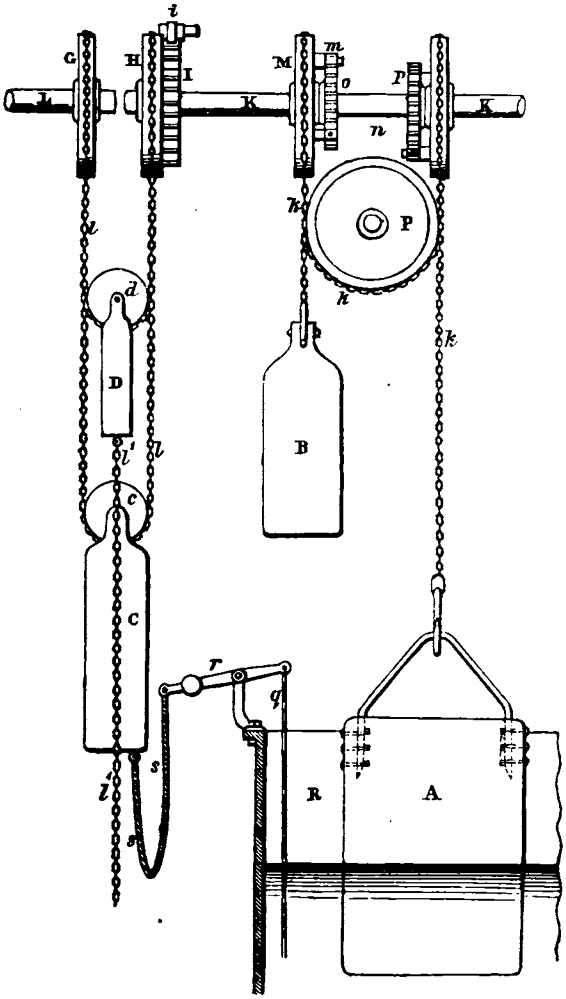


Fig. 2.

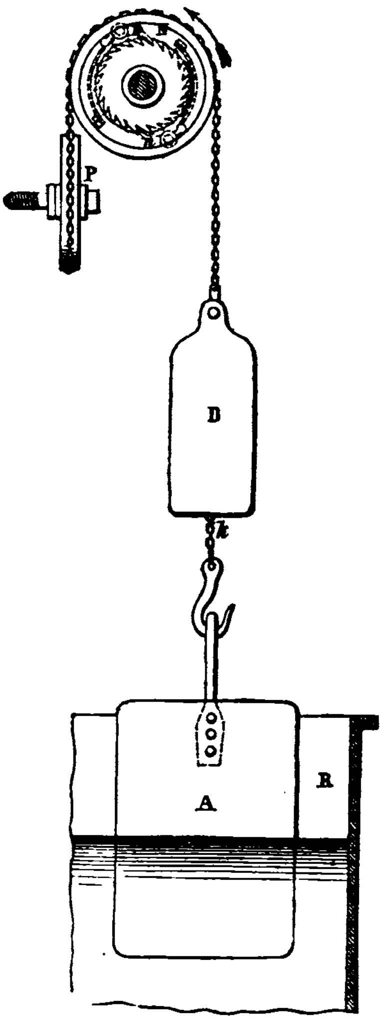
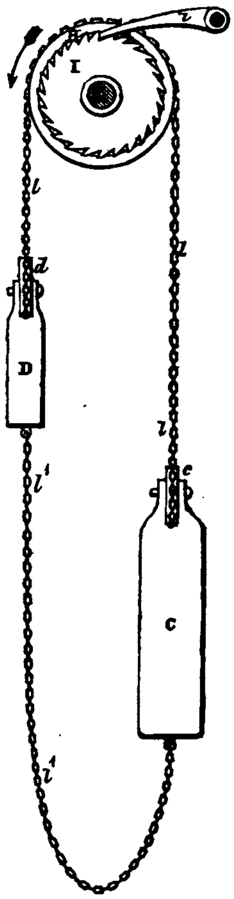


Fig. 3.



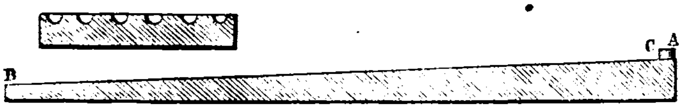
On the ebbing of the tide, the hollow weight A, descends; and the clicks *n*, *n*, acting upon the ratchet-wheel *p*, effect the rotation of the shaft K, in the direction of the arrow in fig. 3.

The advantages of this arrangement are, that whether the hollow weight A, is ascending or descending, the rotation of the shaft K, is invariably in the same direction.

As the levels of high and low water will vary considerably at different seasons, it is evident that some limitation of the height to which spring tides would raise the hollow weight A, in the tank R, must be effected, inasmuch as unless this were done, the ebbing of these tides would cause the weight C, suspended from the endless chain *l*, to be overwound. This limitation may be effected in various ways.

18. *On an Oil Test.* By Mr. G. Nasmyth.

The test consists of a metal inclined-plane with six grooves, as shown in the annexed figures 1, and 2. At the top is a small cup C, to contain the oil; the oil is allowed to flow out and trickle down the inclined plane AB; and after a space of three or four days, it is noticed the distance each description of oil has travelled. That which has passed over the longest length is considered the best oil.



Remarks.—Mr. Roberts remarked that no test could be satisfactory unless the conditions in which oils would be when used were present. Again, some thin oils might preserve their fluidity, but they were not necessarily good lubricators. An oil good for light weights was perfectly useless for heavy ones. For instance, neat's-foot oil is good for clockwork, but bad for railway purposes. He had long ago invented a machine whereby the practical value of the oils was tested by the material being subjected to an action equivalent to that it would sustain in actual use. That was the only reliable test. He also observed that there was a very common but erroneous idea, that smaller the pivot the less the friction.

Mr. Stephenson remarked that oils sometimes changed their character by the operation of the atmosphere.

19. *On a New Rotary Engine.* By Professor McGauley.

A mode was exhibited by which it appeared that the peculiarity of this engine is that the cylinder and working parts form the fly-wheel also. The whole of the machinery revolves by the action of gravitation; that is to say, side weights are attached to the cross-head of the piston,—when that rises the weights overbalance the parts, and the cylinder rotates; the return of the piston throws the weight in the opposite direction, and so maintains the rotary action.—This engine appears to be similar in principle to one described in a patent by Witty, of Hull, in 1810-11.

20. *On Neudstadt and Barnett's Patent Calculating Machine.* By Mr. Knight.

This machine is the invention of M. Slowmiski, a native of Poland. The addition and subtraction tables consist of a thin plate of metal moulded on a box. In this plate are perforated holes, around which are engraved the several digits from 0 to 9. By a peculiar arrangement the wheels inside the openings, when turned by a stile, exhibit the results required, either in addition or subtraction. The operation of multiplication is performed by a larger instrument. As no detailed explanation of the machine was given, we cannot enter into its principle.

21. *On a Plan for Ventilating Coal-Mines.* By Mr. Nicholson.

This plan consists of having the furnace for the rarefaction of the air at the top instead of the bottom of the shaft.—The plan, it was stated by some members, was not new; it had been in use nearly a century.

THE EXHIBITION AT BIRMINGHAM.

To those tolerably acquainted with the resources of English manufacturing skill, the Exhibition at Birmingham, held during the meeting of the British Association, presents little that is novel or remarkable; but taken in another point of view, this Exhibition has considerable interest. It is to us small, but it shows sufficient development of power to enable us to institute a comparison with the great Exposition at Paris, and to form an estimate of the probable success of a National Exhibition here.

In France, the Exposition held once in four or five years is a rarity, which is particularly striking to the visitors; and the experiment being once made, it could not fail to become a permanent institution. Here it seems wonderful that a great manufacturing country should have no National Exhibition; but, inasmuch as it is a great manufacturing country, is it in truth less wonderful that such a want should be felt? The English are a travelling people, and are familiar with illustrations of mechanical skill. In the metropolis, there are always one or more polytechnic galleries open, besides the special engineering sights,—the mint, the dock-yards and arsenals at Woolwich and Deptford, the bank weighing-machines, the breweries, Bishop and Pell's distillery, the saw-mills, marble-works, carving-works, Apsley Pellatt's glass-house, the shipyards, Broadwood's pianoforte-works, the silversmiths', besides the numberless works of a great manufacturing and trading town, famed for the skill of its handicraftsmen. In travelling, the sight-seeing is not in picture galleries, but in mines, cotton-mills, docks, ironworks, and potteries. There is a *carte du pays* for these things; and there are few Englishmen who have not seen many of these sights and brought home porcelain from Worcester, cutlery from Sheffield, and cotton prints from Manchester. The Londoner goes to these things; when they are brought within his ken, he will think less of them than the Parisian, who is home-tied. We say this, not in depreciation of an exhibition, but as explanatory of its non-existence. It is because we are rich in private libraries that we feel less the want of public ones; it is because we travel we feel less the want of having mechanical sights gathered together in our own neighbourhoods.

This, too, is the reason we say the Birmingham Exhibition has little that is novel to the sight-seeing public; though a foreigner would look with admiration on productions, of which he has heretofore seen no example. In most cases, it is not allowed *parva componere magnis;* but here we can fairly compare little things with great, for quality, as in a national gallery of the great masters, is of more importance than quantity; and in quality, the Birmingham Exhibition, in many important articles, goes beyond the Paris Exposition; and in many others in which the French have a high reputation, it does not yield to them.

In porcelain, glass, papier-maché, plate, electro-plate, and brass fittings, there is no need to be ashamed of competition with the French; and yet there are articles requiring much taste and artistic skill in their manufacture, beyond the mechanical manipulation.

Parian statuettes and gutta-percha, are almost peculiarly English. The bronzes are good, and there are many good specimens of mixed materials, metal, glass, and porcelain.

Saws, files, and rough tools are expected to be found at Birmingham, of the highest class; and so too the higher productions of locks and stoves. Many of the large wrought pieces and castings were of the soundest character. In ornamental casting there were, however, few great works. The largest was a bracket. The mathematical instruments in quality far surpass those of the French.

In buttons and toywork of all kinds, Birmingham is able to beat the world.

The Exhibition committee having charge of the arrangements consisted of manufacturers of universal reputation: such men as Messrs. Chance, Osler, Westly Richards, Elkington, Gillott, Winfield, Jennens, Messenger, and Minton, who have establishments of colossal magnitude, and whose works and wares are sent throughout the world.

The Coalbrook Dale company had some ornamental castings in iron, of a common character—the old Warwick vase, and so forth. There were likewise various smaller articles of interest.

Some cannons were shown by Messrs. Thomson and Astbury, of Smethwick.

The illustrations of the process of stamping metal, looking common enough in an ironmongery or a kitchen, were here interesting, as showing the results of a peculiar process; and one could look with complacency on copper jelly moulds, teapot bodies, iron funnels, extinguishers, nozzles for candlesticks, and egg-cups; in the production of each of which considerable mechanical power is brought to bear.

Of guns there were several exhibitors, and the productions were of a very high order.

In wood carvings and machine carving we seem to go beyond the French; whether we should beat the Flemings or High Dutch is another matter. Mr. W. H. Rogers, of Soho, London, sent carved brackets, bread-plates, paper-knives, and so forth.

The cabinet-sawing of Messrs. Prosser and Hadley, of London, was very good, and included brackets, trusses, bannisters, panels for pianoforte makers, and ventilating plates. Messrs. Taylor, Williams, and Jordan, of London, had very good machine carvings.

The stoves, as we have already hinted, were highly praiseworthy. There were some by Messrs. Brettel and Roberts, of Northampton; and Mapplebeck and Lowe, of Birmingham.

Buttons and buckles were shown by Messrs. Smith and Kemp, Chatwin and Son, Hardman and Iliffe, and John Aston.

Messrs. Allen and Moore exhibited various specimens of ornamental stamping, as medals, taper-boxes, snuff-boxes, whist-markers, picture-frames, pen-cleaners, egg-cups, and labels.

The show of iron pens was a good proof how a small object may become an important manufacture.

Mr. Grainger, of Worcester, showed what he called semi-porcelain. A set of twelve dessert plates, celeste ground and gold, with coloured convolvulus border, was beautifully drawn and painted.

Messrs. Wedgewood had a few specimens of art in porcelain of a high character.

The stained glass exhibition we do not consider to possess merit deserving of special remark.

A curious series was a set of cotton stockings, manufactured severally in 1700, 1716, 1816, and 1817, shown by Messrs. Allen and Solly, of Nottingham, and bearing out the great progress of the manufacture through Arkwright's exertions.

Messrs. Newton and Son, of London, had a pair of thirty-inch globes, a class of work for which the metropolis holds a very high rank.

The mathematical instruments we have before named. A glass lens, 18 inches diameter; showed the resources of the glass-workers, and the brass-finishing was of the highest quality. The lens was by Messrs. Chance.

Messrs. Chamberlain, of Worcester, had a choice display of porcelain, fully bearing out their established reputation.

Messrs. Minton and Co. had likewise a large collection of equally meritorious works in porcelain and parian, including above a hundred articles.

The glass collection of Messrs. Richardson, of Wordsley, was equally large. We may observe, that the glass collections showed the great progress lately made in this manufacture. The shapes of some of the vases and claret jugs had much taste; and the colours and compositions in the Venetian and Bohemian styles were equal to the best foreign works.

The lamps, candelabra, and gas-fittings, by Messrs. Potts and Winfield, were very good.

Messrs. G. R. Collis and Co. had an exhibition of their own, including a great variety of articles in many branches of art, illustrating the resources of their celebrated establishment.

The specimens of crystal glass, by Messrs. F. and C. Osler, included a magnificent candelabrum, of the height of seventy feet, and which was one of the wonders of the exhibition. realising the fairy tales of the East, glittering, as it seemed, with gems and colours.

Messrs. Copeland displayed their accustomed merit in a choice collection of objects in parian, porcelain, and earthenware.

The silver, bronze, electro-plate, and or-molu of Messrs. Elkington formed an exhibition, which merited and obtained the honour of a separate catalogue. The presentation silver goods were magnificent, both in design and workmanship.

Messrs. Hardman had a large show of church furniture and fittings.

The papier maché was by Messrs. Jennens and Bettridge, Richard Turley, M'Callum and Hodson, Frederick Walton, Thomas Farmer, showing all the resources of Birmingham and Wolverhampton in this great manufacture.

The cut glass by Messrs. Bacchus and Son, of Birmingham, and the pressed glass, was in great quantity, and of high merit. Mr. Rice Harris, of Birmingham, had another large collebtion, which included some rich ruby tints.

The collections of Messrs. John Rose and Co., and of the Cut Glass Company, showed no less beauty. Messrs. Lloyd and Summerfield, of Birmingham, were also among the meritorious exhibitors of glass.

Mr. Lane, of Birmingham, showed enamel, pearl, glass, and papier maché.

The bronzes of Messrs. Messenger were numerous and good.

Nottingham and Coventry sent many specimens of their manufactures.

Saddlery and saddlers' ironmongery being local trades, were fully represented.

There was a considerable collection of models and machines of much interest to scientific men and the public. Messrs. Roberts, of Manchester, were large contributors.

Metal rolling and tubing are important arts, and were well illustrated.

The glass water-pipes of Messrs. Coathupe and Co., of Nailsea, were exhibited.

The embossed horn buttons, by Ingram, are worthy of the highest commendation. It is wonderful to see the perfection to which such articles are brought.

On the whole, we can say this was an exhibition of very high character; and although we have named many contributors, we regret we have left out many of great merit.

THE EXPANSIVE ACTION OF STEAM.

On the Expansive Action of Steam, and a New Construction of Expansion Valves for Condensing Steam-Engines. By Mr. Fairbairn, of Manchester.—(Paper read at the Institution of Mechanical Engineers, Birmingham.

The innumerable attempts that have been made to improve the principle of the condensing steam-engine since the days of its celebrated inventor, Watt, have almost all of them proved failures, and have added little if anything to the claims, next to perfection. of that great man's ideas. It would be idle to speculate upon the various forms and constructions from that time to the present, which have been brought forward in aid of the original discovery of condensation in a separate vessel. All that has been done is neither more nor less than a confirmation of the sound views and enlarged conceptions of the talented author of a machine which has effected more revolutions and greater changes in the social system than probably all the victories and all the conquests that have been achieved since the first dawn of science upon civilised life.

It would be endless to trace the history of the successful and the unsuccessful attempts at improvement, which for the last half century have presented themselves for public approval; suffice it to observe, that no improvement has been made upon the simple principle of the steam-engine as left by Watt, and but few upon its mechanism. Among the latter may be enumerated the improvements in the construction and mode of working the valves; and of these the D-valve by the late Mr. Murdock, and the use of tappets, as applied to the conical valves, appear the most prominent and the most deserving of attention.

In the construction of the parallel motion, the application of the crank, the governor, and the sun-and-planet motions, all of which have risen spontaneously from the mind of Watt. there is no improvement. The principles upon which all of them are founded have been repeatedly verified beyond the possibility of doubt, and their mechanism is at once so exceedingly simple and so ingeniously contrived as to limit every attempt at improvement in those parts of the steam-engine. What appears to be the most extraordinary part of Mr. Watt's engine is its perfect simplicity, and the little he has left to be accomplished by his successors.

It will be in the recollection of most persons conversant with the steam-engine, that the hand gear for working the valves by the air-pump or plug-rod, gave a self-acting and continuous motion to the machine; and the facility which these means afforded for moving the engine in any direction and at any required velocity, gave it a degree of docility and power beyond the expectations of its most sanguine admirers.

For a considerable length of time the hand gear was the best and most effective mode of applying the motion of the steam-engine to the valves; subsequently the oscillating and revolving tappets, fixed upon a shaft and driven by wheels or an eccentric, came into use, and by means of vertical rods communicated motion to the valves, and thus a similar effect was produced as by the hand gear; next came Mr. Murdock's D-valve and eccentric motion, which for simplicity has never yet been equalled. The D-valve, and the flat-plate valve, are nearly synonymous—with this difference only, that the D-valve presses with less force upon the face, and consequently works easier than the flat-valve, which in every case is exposed to the full pressure of steam. It is true that means have been adopted to obviate this objection in large engines, by a preparation on the back of the valve, which is made steam-tight, and by a communication with the condenser, a vacuum is formed over a proportionate area of surface, sufficient to equalise the pressure and admit an easy motion of the valve.

The expansive principle upon which steam-engines are now worked, and the economy which this system has introduced in the expenditure of fuel, has effected considerable changes in the working of the valves, and has rendered the D and plate valves almost inadmissable for such a purpose. To the skill, ingenuity, and careful attention of the Cornish engineers, we are indebted for many of the improvements connected with the use and application of expansive steam; and taking into account the high price of coals, and the urgent necessity of economy in those districts, which combined with a system of registry and encouragement held out by premiums as described by Mr. John Taylor, we may reasonably conclude that other parts of the kingdom have been greatly benefitted by the excellent examples set before them by the Cornish miners and engineers.

For a great number of years, and up to a recent period, the economy of steam and the working of the steam-engine expansively, were but imperfectly understood in the manufacturing districts; and although the Cornish miner set an excellent example and exhibited a saving of more than one-half the fuel, there were nevertheless few if any attempts made to reduce what is now considered an extravagant expenditure in most if not the whole of our manufactories. But in fact the subject was never brought fairly home to the millowners and steam navigation companies, until an equalization or reduction of profits directed attention to the saving attainable by a different system of operation.

Ten years ago the average or mean expenditure of coal per indicated horse-power was computed at from 8 to 10 lb. per horse-power per hour, but now it is under 5 lb. per horse-power per hour in engines that are worked expansively, and even then they are far below the duty of a well-regulated Cornish engine, which averages from $2\frac{1}{4}$ to 5 lb. per horse-power per hour.

This difference in the consumption of coal may be attributed to two causes; first, the conditions under which the duty of the two engines (that of the Cornish miner and the manufacturer) are respectively performed. The first being chiefly employed in pumping water, has the benefit of alternate action in overcoming the inertia of a large mass of matter, which when once in motion is easier continued, for a definite time, than a continuous power of resistance, such as exhibited in corn and cotton mills. Another cause is the greater care and attention which the Cornish man pays to his boilers, steam-pipes, &c.; they are never left exposed, but are carefully wrapped up in warm jackets and well clothed, to prevent the escape of heat. Even at the present day, it is lamentable to see (in the coal and iron districts) the great and extravagant waste that is continually going on, for want of a little considerate attention in this respect: the only excuse is the cheapness of the fuel—but that is not an excuse, for if one-half can be saved, and coal could be got at 1*s.* per ton, it is certainly desirable to save sixpence out of the shilling, when that can be accomplished at a trifling expense. But one of the chief, if not one of the most important reasons for the exercise of economy in fuel, is the reduction of profits on articles manufactured by power; under these circumstance, a saving in coal becomes a consideration of some importance, and to these reductions alone may be traced the powerful stimulus which of late years has been prevalent in that direction. The low rate of profit in manufacturing operations, and a desire to economise and reduce the cost of production to a minimum, has been of great value in its tendency to improvement in the economy and efficient use of fuel, and also to the use of high-pressure steam and its expansive action when applied to the steam-engine. In France and most other parts of the continent this system has been long in use, and although its effects as well as its economy have been long known in this country, it was only within the last few years that the benefits arising from it were appreciated. For a great number of years a strong prejudice existed against the use of high-pressure steam, and it required more than ordinary care in effecting the changes which have been introduced: it had to be done cautiously, almost insidiously, before it could be introduced. The author of this paper believes he was amongst the first in the manufacturing districts who pointed out the advantages of high-pressure steam, when worked expansively,[*] and for many years he had to contend with the fears and the prejudices of the manufacturers, before the present system of economical working was adopted.

The first attempt was by improvement in the construction of boilers,[†] and subsequently in the valves of the steam-engine, adapted to either low or high pressure steam when worked expansively; the latter of which it is the principal object of the present paper to develope.

The expansive action of steam has been variously estimated by different writers, but all seem to agree in opinion that a considerable saving is effected by that process. It therefore becomes a question of importance in a community whose very existence almost depends upon the steam-engine, how to work it advantageously and at the least possible cost. The great variety of schemes and forms which have been adopted for the attainment of these objects have been exceedingly various, ingenious, and interesting; and the investigation of the different theories and applications that have been submitted for public approval, would form an exceedingly attractive if not a useful history of the various discoveries to which we are in a great measure indebted for the present improved construction of the steam-engine.

The elastic force and expansive action of steam were well known to Mr. Watt, and some of his immediate contemporaries and successors, such as Smeaton, Cartwright, Woolf, Trevithick, and others: but the fears entertained of explosion at that early period, and the difficulty of constructing vessels strong enough to contain high-pressure steam, were probably the greatest drawbacks to its introduction. Woolf and Trevithick were probably among the first to grapple with this dangerous element; and the former, in order to economise fuel, introduced the double-cylinder engine, whereby a great saving was effected by increasing the pressure of steam in the boiler, and allowing it to pass from one cylinder to another of three or four times the capacity, by which its volume was expanded, and by these means a saving was effected and an extra duty performed. If, for example, taking a double-cylinder engine, the high-pressure cylinder being one-fourth of the capacity of the cylinder from which the steam is condensed, there will be for one cylinder full of steam an expansion of four times its volume, —this of course with a diminished pressure in the ratio of the capacities of the two cylinders. Comparing this with a similar process in a single cylinder equal in capacity to the two cylinders, and fitted with a well-constructed apparatus, regulated so that only one-fifth of the contents of the cylinder (equal in capacity to the small cylinder on Woolf's plan) is filled with steam of equal density, and the remaining four-fifths (equal in capacity to the larger cylinder) is allowed for expansion, it is evident that the communication being thus suddenly cut off from the boiler after the piston has been urged through only one-fifth of the length of the stroke, the expansive force is then used in completing the remaining four-fifths of the stroke, and the result must be nearly the same as that obtained with the two cylinders on Woolf's plan. The advocates of Woolf's system, however, insist upon its superiority, not from the actual force given out (which is rather in favour of the single cylinder than the double, in consequence of increased condensation in the steam-passage between the two cylinders), but from the superior action and greater regularity of motion which in the former case is produced. To some extent this is the case, but not to any appreciable amount provided the fly-wheel is well-proportioned to the pressure and power at which the engine is worked. In the double engines which are now in common use, that is, when two single engines are coupled together with the cranks at right angles to one another, there is less occasion for a heavy fly-wheel, as the effect of a large expansion is less felt, if not effectually neutralised. The results, therefore, of the double-cylinder engine and the single engine working at equal rates of expansion, are virtually the same as regards power and economy of fuel, if the comparison be not in favour of the single engine.

Having come to the conclusion that the same duty can be performed by the single as by the compound engine, and considering the important advantage of simplicity in mechanical construction, in opposition to complexity however ingeniously contrived, it becomes a question how to obtain an effective as well as a simple process for the attainment of that object.

The first attempt was by revolving tappets, which had been long in use; these being formed and regulated in such a manner as to cut off the steam at such a point of the stroke, as to give the exact quantity of expansion required. These tappets, to say the least, were from various reasons objectionable, as the weight of the vertical rods and slowness of motion prevented them from producing the desired effect. The steam valves could however be fixed so as to cut off the steam at the required point of the piston-passage in the cylinder, but the motion is not effected with the velocity essential to an efficient process of expansive action. Other processes have been tried for working steam-engines expansively besides those already noticed; amongst them may be noticed the equilibrium valve, worked by double cams from the crank-shaft. This method is generally used and adapted to the marine and old engines, but its application is seldom of much value unless the engines and boilers are capable of bearing a pressure of 15 lb. to 20 lb. on the square inch.

Another fault to which this description of valves is subject is their distance from the steam-ports into the cylinder, and the large quantity of steam which occupies the space between the cut-off valve and the working cylinder of the engine. To remedy these defects, and to apply a better system of expansion to the common condensing engines, the following apparatus and mode of working the valves was introduced.

In giving a description of this effective and simple apparatus, it is but fair to state that the first idea of this invention was suggested by Robert Brownhill,—at first imperfectly constructed, but since greatly modified and perfected by the author of the present paper.

The annexed engraving represents a section of the valves. It will be observed that the cylinder A, the steam-chests C, D, and

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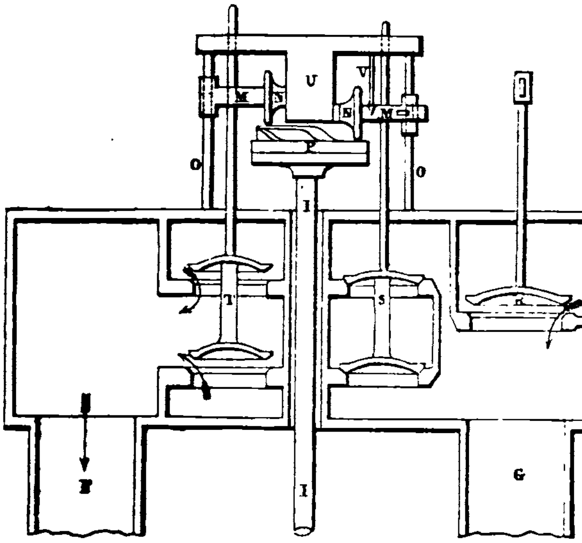
[*] See Paper read before the Geological Society of Manchester in the year 1840, on the Economy of Fuel.

[†] See Report on the Prevention of Smoke and Economy of Fuel.—Transactions of the British Association, 1844.

the side-pipes F G, are common to every engine of this description; the internal construction of the steam-chests, valves, and the mode of working, arepeculiar and constitute the chief merit of the invention.



In the construction of a steam-engine, two important considerations present themselves, the attainment of a maximum of force, and the minimum in the consumption of fuel; to acquire the first it is requisite to form such an arrangement of the working parts, as to obtain the closest approximation to a perfect vacuum under and above the piston, and the other is accomplished by having as small an expenditure of steam as possible. These desiderata are to a great degree attained by the principle upon which these valves are constructed, and the way in which they are worked. Referring to the engraving, which is a section of one set of valves, it will be seen that each set contains two double-beat valves S, T, also the shut-off valve R, and the throttle-valve Q; these valves constitute the whole of the openings by which the steam is admitted and returned from the cylinder; the valves S, next to the steam-pipe E, are the valves by which the steam is admitted to the cylinder; and the valves T, are the exhaust, or the valves by which the steam escapes from the cylinder to the condenser. All the four valves are of the same area and dimensions, but the steam-valves are not lifted up so high as the exhaust-valves, for the reasons which are afterwards given. The direction of the arrows exhibit the passage of the steam in its ingress to the cylinder, and its ultimate escape to the condenser. The double-beat valves of this construction have certain proportionate areas, the upper portion being larger than the bottom, in the ratio of 1·158 to 1·000. The object of this enlargement of the upper part of the valve being to give a preponderance to the pressure of the steam on the top side, in order to overcome the pressure of the packing in the stuffing-box which embraces the spindle, and to assist the gravitating force of the valve in its descent when liberated from the cams P.

The mode of working the valves is by the shafts I, and wheels; they derive their motion from the crank-shaft and revolve at the same speed; the vertical spindle I, upon which the two circular discs P, are fixed, passes through the steam-chests C, and by its rotary motion the cams which are fixed upon the discs P, raise the valves as they pass under the rollers N, N, which are connected to the valve-spindles by the cross-heads M, M, and by these means the valves are raised and retained open or shut for any definite period. The rollers N, N, are steadied by the cross-heads M, M, sliding upon the vertical guide-rods O, O, at their outer ends, and sliding at their inner ends in vertical grooves in the centre boss U, which is supported by the guide-arms O, O.

To work this engine economically much depends upon the pressure of the steam and the amount of expansion given to the valves; the usual practice is to work with steam at 15 lb. on the square inch, and cut off at one-half the stroke, and expand the other half; but in other cases, when the engines and boilers are calculated to bear a high pressure of steam, say from 30 to 40 lb. on the inch, the cams are formed so as to cut off the steam at one-third or one-fourth of the stroke. As is shown at P, there are generally three and sometimes four cams upon each of the discs, so as to cut off the steam at one-half, one-third, or one-fourth, or at any other point corresponding with the force of the steam and the load respectively.

To obtain this range of expansion the rollers N, N, which work the steam-valves, are moveable, by brass strips which slide in the grooves in the cross-heads M, M, so as to bring the roller over any one of the cams that may be required; and the fixed pointers V, show by a graduated scale on each brass slide, the exact point of the cylinder at which the steam is cut off, and by these means the extent of expansion is regulated and brought under the eye of the engineer.

It has already been stated that the steam-valves are not lifted so high as the exhaust-valves, and the reason of this is, that as the exhaust-valves are not variable in their action, and always require full openings into the condenser, it is desirable to retain them open throughout the whole length of the stroke. This process is effected with a greater degree of certainty than by any other description of valve; the exhaust-valves are raised suddenly by the short inclined planes of the cams, and having allowed time for the escape of the steam from the cylinder through a wide passage into the condenser, they suddenly fall by gravitation, and thus a more complete vacuum is formed under the piston than is probably attained by any other process.

The working of these valves is effected with a degree of certainty and simplicity which renders them very satisfactory both as regards their efficiency in conducing to the economy of steam, and the perfect ease with which they are worked.

Remarks made at the Meeting after the reading of the foregoingPaper.

The Chairman observed that the principal part of the improvement described in the paper, appeared to consist in the arrangement for effecting the expansion action by cams revolving horizontally.

Mr. W. Smith said he had seen several engines working with this expansion gear, and could testify as to the superiority of their action; the expansion gear was very simple and worked exceedingly well; he had taken indicator diagrams from the engines. He was not acquainted with any cases where this plan had been at work for a long time, and he had some doubts as to the lasting of the parts.

Mr. McConnell remarked that was a matter on which they could scarcely express an opinion unless furnished with accurate data respecting the working. The Cornish engine reports were very complete as to the performance of the engines and the consumption of fuel; and if they had such information with reference to the working of the invention in question, it would be highly important as regards the improvement of the engine and in economical results.

Mr. Cowper suggested the desirability of making a collection of indicator diagrams in the Institution, and expressed his willingness to co-operate with other members in supplying some.

Mr. W. Smith said it was his intention at an early meeting to lay before the Institution several hundred indicator diagrams which he had taken from engines in Staffordshire and the surrounding district.

Mr. McConnell observed that the meetings of the Institution would afford parties connected with large manufacturing establishments an excellent opportunity for comparing the working results of engines in full action, not only in Staffordshire, but in Lancashire and other districts; and it was desirable that this class of information should be as perfect as possible.

Mr. Slate thought the diagrams referred to would read an important lesson to the parties employing steam-engines, and induce them to look after their own interests and not waste their power. He had seen a number of Mr. Smith's indicator diagrams, and the results of them would surprise many; most of them showed a very inferior action, and some showed only 5 lb. per inch of vacuum with 13 lb. per inch of steam; but there were a few good diagrams amongst them.

Mr. Gibbons remarked that one important thing they would have to attend to was the description of fuel used, which varied so greatly in Staffordshire as to render it a matter of great difficulty to collect accurate data.

Mr. W. Smith thought it very desirable to know the description of fuel and the consumption, wherever it was practicable; but all that he proposed at present was to lay before the Institution diagrams exhibiting the economy of the engine, and not the consumption of fuel.

Mr. McConnell suggested that they should not confine themselves to the relative economy of the different constructions of engines, but they should also take into consideration the different constructions of boilers and the relative consumption of fuel for the power produced, as well as the kind of fuel employed. He saw no reason why the reports of engine performance should be confined to Cornwall, for it would be highly important to have them for the various other districts, more especially Staffordshire, Lancashire, and Newcastle.

Mr. Gibbons remarked that this would be extremely difficult to obtain in Staffordshire, because the quality of fuel varied to an extraordinary extent. In that district they had a considerable boiler surface, and in many cases used only coal-slack for fuel, which was good for nothing else; but in Cornwall the quality of fuel was tolerably uniform, and the best qualities of coals were used.

Mr. Slate proposed to omit the consideration of the consumption of fuel, as the fuel was not bought in the coal districts, but merely taken from the heap as required; and it would not be practicable in most cases to obtain any accurate return of the consumption.

Mr. W. Smith said the question of fuel could not be included in the iron districts because it was customary in many cases to generate the steam by the waste heat of the puddling furnaces, and in consequence those cases would show no consumption of fuel; but on the contrary, in other cases the consumption was greatly above the usual proportion, either from the inferior quality of fuel used, or from the engines being often worked much below their boiler power, and wasting from the boilers even more steam than was used.

Mr. C. Beyer observed that it took a great deal at first to induce the proprietor of a steam-engine to look well after its working, but in Manchester considerable attention was now paid to the subject. There were many works where the consumption was as low as 4 lb. per horse-power per hour, but he should say that the average of Lancashire engines was twice that amount of consumption, if not more.

Mr. McConnell thought that was a strong argument for taking up the question in the broad view; for without considering any particular district, it was very important for a manufacturer or other proprietor of a steam-engine to know what his engine was doing as compared with the engines of other parties. Those engines in the same town or district could be fairly compared, and any particular causes for exception could be stated in the return.

Mr. Slate observed that there were a few pumping engines in Staffordshire which were worked by contract, and their fuel was all measured, so that the consumption could be correctly ascertained; but those engines were an exception in the district.

REVIEWS.

Weale's Rudimentary Treatises.—The Elements of Plane Trigonometry. By James Hann, Mathematical Master of King's College School, London.

This is one of the best of Mr. Weale's series, and a very cheap book. It is a subject which can be well treated in an elementary form, and Professor Hann has evidently taken very great pains to produce a volume which shall be worthy of his reputation.

The Drainage of Towns and Buildings. By G. Dysdale Dempsey, C.E. London: Weale, 1849.

This is another of Mr. Weale's cheap issue; it contains a collection of useful data connected with the subject of drainage. We conceive that Mr. Weale will injure the usefulness of his project if he allow authors to occupy the preface in making public their schemes. In the present instance it would have been as well both for Mr. Weale and for Mr. Dempsey had the preface and the map of London been omitted; but as Mr. Dempsey has thought proper to make public his scheme for the drainage of London, we must pronounce our opinion that it is as bad as bad can be. He proposes to drain the metropolis by 200 pumping stations, planted at nearly equal distances in all parts of London, each having tanks for collecting the refuse of the sewers, and to contain three days' sewage;—but how this sewage refuse is to be distributed from these 200 pest-houses, Mr. Dempsey does not tell us. One of these establishments is shown in the map close to the house of His Grace Field-Marshal the Duke of Wellington, and another at or near to Northumberland House. Fortunately for Mr. Weale, his premises will be midway between two of the stations—was this studied?

We hope next monthto be able to offer some remarks on drainage of towns, and to expose some of the errors that are now being adopted in what is called the modern and *cheap* system of drainage.

Tables for Setting out Curves for Railways, &c. By Archibald Kennedy and R. W. Hackwood, civil engineers. London: Weale, 1849.

These tables are published in a small book which may be carried in the waistcoat pocket; consequently, will be useful to those employed in the field operations. They vary from a radius of five chains to three miles. We cannot see that they are more useful than the tables we published in this *Journal* as far back as 1840, (Vol. III.), by which curves varying from five chains to eight miles radius may be set up.

Form and Sound: can their Beauty be dependent on the same Physical Laws? By Thomas Purdie. Edinburgh: Adam and Charles Black, 1849.

The pressure of other subjects upon our time and space, has caused a delay in noticing this work, which is one of considerable interest and importance to the architectural profession. It is devoted to an investigation of the principles of beauty in form as affecting architecture and decoration, and in direct antagonism to the theory proposed by Mr. D. R. Hay, which has been lately so favourably received. We now give only this acknowledgment of the work, intending to discuss it at some length hereafter.

A Treatise on the Coal Field of South Wales. By Frederick Moses, C.E. London: Simpkins, 1849.

This is a work on a local and theoretical point in geology of considerable importance, in which the author lays down a new theory of the position of the coal measures in the South Wales field, and demonstrates the subsidences lying between Llynvi and Penllergaer. He likewise enters on the subject of cosmogony generally. It will be read with interest by those engineers connected with coal mining.

Geology of the Lake District. By John Rooke, of Akehead.

This is a sketch, by a well-informed local observer, of the geology of Westmoreland and Cumberland, with special reference to the author's views of the scheme of geological formations.

Wyld's Map of London and the Environs.

Mr. Wyld, the eminent geographer, has brought out a very laborious map of London and the metropolitan districts, and which has the further advantage of having the levels marked, as supplied by the Commissioners of Sewers.

The Auckland Islands. By Charles Enderby, F.R.S. London: Pelham Richardson, 1849.

Proposal for re-establishing the British Southern Whale Fishery. By Charles Enderby, F.R.S. London: Effingham Wilson.

These relate to a subject of importance, but which is not technical enough for our discussion, though we cannot but feel an interest in the colonization of the Auckland Islands, as likely to open a new field for engineering employment; and this, it is to be observed, has been much extended of late by the progress of colonial enterprise.

On the Construction of Public Buildings and Private Dwelling-Houses, on a Fire-proof principle, without Increase of Cost. London: Mudie and Sons, 1849.

This pamphlet is by Messrs. Fox and Barrett, and its title sufficiently shows the purpose to which it is devoted. Any attempt to extend fire-proof constructions is worthy of attention.

NEW ARMAMENT OF THE FRENCH FLEET.

(From the *Nautical Standard.*)

Seven first-rates, to carry 112 guns—viz., four 80-pounder howitzers (*a*); six howitzers (*b*); six 50-pounders (*c*); twenty-two 30-pounders (*d*); twenty-eight 30-pounders (*e*); thirty-four 30-pounders (*f*); twelve 30-pounders (*g*).

Twelve second rates, to carry 90 guns—four 80-pounder howitzers (*a*); six howitzers (*b*); six 50-pounders (*c*); twenty-two 30 pounders (*d*); twenty-eight 30-pounders (*e*); twenty-eight 30-pounders (*f*).

Eleven third-rates (new model), to carry 82 guns—four 80-pounder howitzers (*a*); six howitzers (*b*); six 50-pounders (*c*); twenty 30-pounders (*d*); twenty-six 30-pounders (*e*); twenty 30-pounders (*f*).

Five third-rates (old model), to carry 80 guns—four 80-pounder howitzers (*a*); four howitzers (*b*); twenty-six 30-pounders (*d*); twenty-eight 30-pounders (*e*); eighteen 30-pounders (*g*).

Four fourth-rates (new model), to carry 74 guns—four 80 pounder howitzers (*a*); four howitzers (*b*); four 50-pounder guns (*c*); twenty 30-pounders (*d*); twenty-six 30-pounders (*e*); sixteen 30-pounders (*f*).

Eight fourth-rate ships (old model), to carry 70 guns—four 80 pounder howitzers (*a*); twelve 30-pounders (*g*); twenty-four 36-pounders; thirty 18-pounders.

Frigates.

Sixteen 50-gun frigates, to carry two 80-pounder howitzers; two 50-pounder guns; twenty-eight 30-pounders (*d*); eighteen 30-pounders (*f*).

Twenty-three second-class, to carry 46 guns—two howitzers (*b*); two 50-pounder guns; two 30-pounders (*d*); twenty-four 30-pounders (*e*); sixteen 30-pounders (*g*).

Eighteen third-class, to carry 38 guns—two howitzers (*b*); two 50-pounder guns; four 30-pounders (*d*); twenty-four 40-pounders (*e*); two 30-pounders (*g*).

Corvettes.

Eighteen corvettes, to carry 20 guns—two howitzers (*b*); two 30-pounders (*d*); two 30-pounders (*e*); fourteen 30-pounders (*f*).

Eight second-class, to carry 16 guns—two 30-pounders (*e*); fourteen 30-pounders (*f*).

Twelve third-class, to carry 16 guns—two 12-pounders, fourteen 18-pounder carronades.

Brigs.

Twenty-seven brigs, to carry 12 guns, 30-pounders (*g*).

Twenty-seven brigs, to carry 10 guns—two 12-pounder carronades; eight 18-pounder carronades.

Schooners.

Twelve schooners, to carry eight 18-pounder carronades.

Gun-Brigs.

Nine gun-brigs, carrying four 30-pounder howitzers.

Transports.

Fourteen transports, from 600 to 800 tons, to carry two 30-pounder howitzers.

The rest of the fleet are to remain armed as they are at present.

(a) Howitzer, 80-pounder, 8⅔-inch bore, 8 ft. 9 in. length, 72½ cwt.
(b) Howitzer, 80-pounder, 8⅔-inch bore, 7 ft. 5 in. length, 53¾ cwt.
(c) 50-pounder French } 56-ditto English } 10 ft. 2 in. length, 81¼ cwt.
(d) 30-ditto French } 33-ditto English } 8 ft. 9 in. length, 60 cwt.
(e) 30-ditto French } 33-ditto English } 8 ft. 2 in. length, 50¾ cwt.
(f) 30-ditto French } 33-ditto English } 7 ft. 4 in. length. 42½ cwt.
(g) 30-ditto French } 33-ditto English } 7 ft. length, 86½ cwt.
(h) 36-ditto French } 40-ditto English } 8 ft. 10 in. length, 70¼ cwt.
(i) 18-ditto 8 ft. 2 in. length, 40¾ cwt.
(j) Howitzer, 30-pounder, 8 ft. 10 in. length, 30¾ cwt.
(k) Carronade, 18-pounder, 2 ft. 8 in. length, 6¾ cwt.
(l) 12-pounder gun, 6 ft. 10 in. length, 22¾ cwt.

A French 80-pounder would be equal to an English 89-pounder, did it exist.

THE NORTH-WESTERN RAILWAY STATION.

The new station of the London and North-Western Railway Company, in Waterloo-road, which is reached from Edge-hill by the recently-constructed Victoria tunnel, contains five acres of land, the entire of which is either occupied by warehouses or covered with zinc shedding. The span of this shed is 183 feet, covering seven lines of rails—the whole cotton quay—from which can be loaded 20,000 bales of cotton daily. The principal entrances to this station are from Waterloo-road on the one side, and from Great Howard-street on the other, and these two thoroughfares form its eastern and western boundaries; Stewart-street stands on the north, and a block of warehouses on the south. This is the largest goods station in England. It has eight lines of rails, with a space of 8 feet between each line, to allow horses and men to pass with safety. The warehouses erected here are the finest, perhaps, in the kingdom. They are far larger than any other warehouses in Liverpool, and are constructed on the best principles. The rooms are each 102 feet by 90, containing an area close upon 1,000 square yards. All the work will be done on these premises by steam-power, and an engine of 50-horse power is here erected; but, fearing this amount of power may not be sufficient, the engine-house has been built large enough to allow a second engine, of the same power, to be put up. The warehouses and all the premises are recently whitewashed, and the appearance it wears is clean and lightsome.

In connection with the warehouses are two admirably-designed offices, which overhang the rails, and are supported by iron beams; these offices communicate with the warehouses, and the men engaged here will be enabled to superintend the business of the warehouses. In each of the rooms there are two water-plugs, which, in case of fire, can be at once turned, and a plentiful supply of water obtained.

To form this station, upwards of 120 separate properties, consisting of more than 150 dwelling-houses, warehouses, sheds, yards, &c., had to be purchased and pulled down.

At the top end of Stewart-street, adjoining Great Howard-street, is a vacant plot of land, on which the general offices of the company will be built. These offices will be of great extent and magnificence. Passing upwards from the Waterloo Station, you find that the station extends under Great Howard-street, which is supported by a neat iron girder-bridge, of 116 feet span, erected by R. Daglish, jun., St. Helen's; and, a little further on, the station passes under the gigantic brick arches which support the Lancashire and Yorkshire goods station at such an altitude over Great Howard-street. This arch is, we believe, the largest of the kind in England. It has a span of 100 feet, and contains upwards of 5½ millions of bricks. Here the Irish pig traffic will for the future be taken, the pigs being made to walk into the trucks by a very simple arrangement; cattle will continue as usual to be got into the wagons at Edge-hill, where the company's cattle station contains 102 pens, capable of holding 1,200 head of cattle.

The station accommodates the Liverpool market, and takes you to the mouth of the tunnel, the dimensions of which are as follow:—Dock to tunnel, 500 yards; tunnel to Byrom-street, 854 yards; Byrom-street, under 69 yards; tunnel from Byrom-street to Edge-hill, 2,717 yards; total, 4,140 yards. The wire rope for this tunnel is 3 miles long. The whole inland business of Liverpool may be done at this station; when complete, 5,000 tons of goods at least may be easily despatched to all parts of the kingdom. Trains are drawn up the new tunnel by means of four separate engines of 100-horse power each.—*Liverpool Standard.*

SEA-WALLS.

Sir—In reprinting in your number for September a portion of proceedings of the Institution of Civil Engineers containing my paper on Sea-Walls, I observe that you have introduced some lettering, in order to simplify the diagrams. It is desirable that it should be explained, that in fig. 4, the letter A, denotes the point below which the stones were *built dry;* and not, as in the other figures, the level of high water of equinoctial spring tides.

I am, &c.,

W. J. Macquorn Rankine,

NOTES OF THE MONTH.

The Chlorides of Gold.—Great difficulty has hitherto occurred in preparing the chloride of gold, of the yellow and red colours, perfectly soluble in water, and without suffering reduction. The following processes are recommended for this purpose:—In order to prepare the yellow salt of gold, take aqua regia prepared with three parts of hydrochloric acid, one part of nitric acid, and one of distilled water. Then put one part of pure gold into a porcelain capsule with a plate of glass, and heat it in a salt-water bath, the heat being continued till red vapours cease; the cover is then to be removed, and if the gold is not entirely dissolved, some aqua regia is to be added to it, the capsule being again covered, the heat is to be continued till vapours cease to appear; the glass plate must then be removed and replaced by folds of blotting paper, the heat being continued in the bath until a glass rod, upon being immersed in the capsule, becomes covered with yellow solid chloride of gold. The capsule is then to be removed from the salt-water bath, and the chloride of gold soon crystalises in small prismatic crystals, of a fine yellow colour, with an orange tint. The chloride thus obtained is perfectly soluble in water without reduction; it is successfully employed in daguerreotype and other operations. The red chloride of gold (res-chloride) is prepared in the same manner, except that the aqua regia employed is prepared with two parts of hydrochloric, and one part of nitric acid. The operation is commenced by acting upon gold with excess of aqua regia on a sand bath, the salt-water bath not being used until the gold is entirely dissolved; the remainder of the operation is conducted in the same manner as that for the yellow chloride.

Shot.—In America a new method of making shot has been patented by David Smith, of New York. The plan is to use an iron tube of 50 feet in height, in place of the ordinary towers of 150 feet. By the old process, great height was necessary to enable them to make all sizes of shot, for the reason that the shot must be cooled to a certain point before entering the water receiver below, and it could only be so cooled by contact with the necessary amount of air to which to impart its heat while falling. In the process of Mr. Smith, a current of air is made to ascend the tube by means of an ordinary fan, the amount of air used being in proportion to the size of the shot. By this method the elevation of lead for the largest sizes is reduced 100 feet, the cost of immense towers is dispensed with, and a common sheet-iron tube of about 18 inches diameter made to answer its purpose.

Iron Buildings for California.—The absence of anything like human shelter in the valley of the Sacramento, and the absolute want of lodging room for the accommodation of emigrants to San Francisco, has developed a new source of industry in this country—that of the erection of portable iron houses, of various dimensions, to be shipped for California, and which can be completely put up within four days after arriving at the destined spot, and taken to pieces in 24 hours. Several of moderate size have been built in London, and one is just completed in Liverpool, 110 feet long, 30 feet wide, and 20 feet high, which has taken but one month in construction. The framing and foundation are of wood—the covering and roof being of corrugated iron, which gives it a pleasing appearance. At Manchester, some iron cottages are also being constructed for shipment; they are 20 feet long, 10 feet wide, with an arched roof, also of corrugated iron, giving a clear height of 9 feet, and divided into two rooms. Every arrangement is made for light, security, ventilation, and warmth, with a portable cooking apparatus. The iron contained in one of those cottages is about 2½ tons, and the cost is about 60*l.*; if lined with wood, 10*l.* extra is charged.

Engineers' College, Putney.—Mr. Clegg, jun. has been appointed Professor of Engineering at this College, and gave his inaugural lecture on the 23rd ult.

New Survey of England.—Government not being satisfied with the triangulation of the Ordnance Survey of England, have decided upon measuring the angles again. For this purpose, a party of Sappers and Miners are now engaged on Salisbury Plain in measuring the base-line.

Screw Steamers.—The best proportion for the screw propeller has been found by experiment to be—the pitch to be the same length as the diameter of the screw, and that the vane or blade should not exceed one-sixth the length of the worm.

Drainage of the Haarlem Lake—The difficult operation of draining the sea or lake of Haarlem is being carried on with the greatest activity. The works are not even suspended on Sundays or fete days; nay, they are sometimes continued during the night. During the month of August, the waters of this immense lake were lowered to the extent of 27½ inches, Dutch measure. It is hoped and expected that they will be entirely drained off before the month of March, 1850.

Novel Suspension Bridge at Chester.—As the bridge which has lately been constructed by Messrs. Mc Kean and Co., of Liverpool, at Curzon-park, in this city, has excited considerable attention and discussion, a description of so novel an example of engineering skill may not be uninteresting. The situation in which this bridge was required rendered it expedient to do away with piers and suspension-bars projecting above the level of the road; and the ravine to be crossed, from the Grosvenor-road to the park, being upwards of 150 feet span, while it was doubtful whether a proper foundation could be obtained for the erection of heavy stone piers capable of sustaining so great a strain, the present self-adjusting principle was adopted, and has been found in practice to answer admirably. This principle is capable of being carried out to a much greater extent in point of strength and durability, as well as in appearance; but the sum allotted for the erection of the Curson-park bridge being limited to a small amount, these improvements could not there be adopted. The chain rods are made of the best ⅞ths round iron, in lengths of 15 feet each, with secure lock-joints placed alternately, across which are fitted flat bars, above and below, at about 6 feet apart, and upon which the wooden planks forming the platform, of 7 feet wide, are firmly secured by T-headed bolts and nuts, screwed up from beneath. The chain-rods are secured at one end of a massive stone pier, by stone cramp-plates and bars, built in from the foundation on Lord Westminster's embankment, on the Grosvenor side; and the stone pier at the Curzon-park end of the bridge is formed into a pit, upon the top of which, resting on cast-iron girder-beams and pedestals, is placed a very strong grooved barrel, around which each of the chains (in these parts formed of short links), takes one turn, descending to and being fixed in a strong cast-iron plate, suspended near the bottom of the pit, at a depth of 30 feet, upon which is built a mass of masonry, forming a weight sufficient to counter-balance the whole, keeping the chain bars in a proper state of tension, as well as providing for every degree of contraction or expansion. The bridge is also further secured by back stay-rods at each end, running to a considerable distance from the piers to a great depth under ground, and bolted to heavy blocks of oak; having thus a resisting force of many hundred tons of earth, exclusive of the massive stone piers on which the bridge rests. A light iron trellis diamond fence is carried along the platform on each side between double standards, and arched facia plates are fixed underneath, giving a finish to the bridge, which has altogether a light and neat appearance, remarkably well adapted for the situation in which it is placed; while the many thousands of persons who have already passed over it form a very fair test of its stability, and the soundness of the principle on which it is constructed.

Iron Roofing.—At the Liverpool Polytechnic Society, Mr. R. Turner, of Dublin, furnished the following interesting particulars of a new galvanised iron roofing and other works of a railway station at Liverpool, which he is now constructing. The roof covers an area of 6,140 square yards, being about 360 feet in length, and 153 ft 6 in. in width. There are no intermediate columns; but this great space is spanned over by one stupendous arch, rising in a segment of a circle to a central height of 30 feet from the spring, or chord. The roof consists of 17 curved girders of wrought-iron, resting at one side upon the walls of the offices, and at the other upon cast-iron columns of the Doric order, connected by ornamental arches in perforated iron. These girders are trussed vertically by a series of radiating struts, acted on by tie-bars, connected with the extremities of the girders; and they are trussed horizontally by a series of purlins and diagonal rods—thus forming one rigid piece of framing from end to end. Upon this framing will be laid plates of galvanised corrugated-iron, and three ranges of plate-glass, in sheets about 12 ft. 6 in. in length, and of great thickness, extending the whole length of the roof. In consequence of the great extent of surface exposed to the variations of temperature, provision has been made for expansion and contraction of the iron without injury to its bearings. The roof, when finished, will weigh about 700 tons. The whole of the work, with the exception of the cast-iron columns and ornamental arches, is of wrought iron. The iron columns upon which the roof rests, on the south side of the yard, are 2 ft. 3 in. in diameter at their bases. Six of the girders are fixed; and having struck the centres under three of these girders, it was found that in not one of them was there the least perceptible deflection. Mr. Turner produced specimens of the various parts of the ironwork employed in the roof in question, and explained the manner in which they were applied, so as to make a perfect whole. Though these samples are very massive, it was stated that the huge roof, though of great strength, would appear to the eye as light as a cobweb.

Ivory as an Article of Manufacture.—At the meeting of the West-Riding Geological and Polytechnic Society, Mr. Dalton read a paper on this subject. He said there were several sorts of ivory, differing from each other in regard to composition, durability, and external appearance, and also in value. The principal sources from whence ivory was derived were from the western coast of Africa and Hindostan. Camaroo was generally considered the best, on account of its colour and transparency. In some of the best tusks the transparency could be discovered even at the outside of the tusks. Gentlemen were apt to be deceived with regard to transparency, because the manufacturer could mislead them by making it transparent by a process of his own. But the finger of time would soon indicate the deception. It was as well not to insist on having the most transparent kind; for if they got the genuine article, though somewhat brown at first, it would eventually become white. The African was the kind of which the best cutlery was made; and though its degree of transparency was not so great as the Camaroo, it was sufficiently beautiful in its colour and fineness of grain as to render it suitable for the best kind of cutlery. But there was a third description, called the Egyptian, which had lately been brought into this country, which was 15 per cent. lower than the Indian, but was very wasteful in working. Mr. Dalton next gave a description of the specific gravity of the different kinds of ivory he had referred to. He had been furnished with an analysis to show the relative amount of animal matter in the three principal varieties of ivory. The African showed a proportion of animal over earthy matter of 101 to 100; the Indian 76 to 100; and the Egyptian 70 to 100. Thus, though the composition was much alike, yet there were those differences between the animal and earthy matter. He also showed the difference as to the quantity of dust used in the manufacture of gelatine. With respect to the increase in the manufacture of ivory, he said that it was now within the memory of man that there were not more than 15 per cent. workers of ivory in Sheffield; but now they were upwards of 40 per cent. Forty years ago there was only one dealer of ivory in Sheffield; at present there were five or six. The value of the annual consumption in Sheffield was about 30,000*l.*, and about 500 persons were employed in working it up for trade. The number of tusks to make up the weight consumed in Sheffield, about 180 tons, was 45,000, the average weight of each being only 9 lb. Many weighed from 60 to 100 lb., so that some must be very small indeed. According to this the number of elephants killed every year was 22,500; but supposing that some tusks were cast and some animals died, it might be fairly estimated that 18,000 were killed for the purpose. This was a matter which was not generally known, it being a prevalent opinion that the tusks used for ivory were such as were cast by the elephants when alive.

Steam Factory in Sweden.—The largest mechanical work in Sweden, is the Motala Factory on the Gotha Canal. It is said to be fitted-up with good steam machinery, and of late has been greatly improved. It builds steamboats and marine engines, among other works, and has turned out the steamers "Svithiod," "and Ganthiod," as well as the "Laubeck," which runs on the East Sea.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM AUGUST 23, TO SEPTEMBER 20, 1849.

Six Months allowed for Enrolment, unless otherwise expressed.

Malcolm Macfarlane, of Thistle-street, Glasgow, coppersmith, for certain improvements in machinery or apparatus for the drying and finishing of woven fabrics.—Sealed August 30.

Thomas Symes Prideaux, of Southampton, gentleman, for improvements in puddling and other furnaces, and in steam-boilers.—August 30.

James Robinson, of Huddersfield, orchil and cudbear manufacturer, for improvements in preparing or manufacturing orchil and cudbear.—August 30.

Isidore Bertrand, of France, engineer, for an improvement in protecting persons and property from accident in carriages.—August 30.

Onesiphore Pecquer, of Paris, civil engineer, for certain improvements in the manufacturing of fishing and other nets.—August 30.

A grant of an extension for the term of five years from the 23rd of October, 1849, of a patent to George Baxter, of Charterhouse-square, Middlesex, engraver, for his invention of improvements in producing coloured steel-plate, copper-plate, and other impressions.

Charles Morey, of the United States, now residing at Manchester, gentleman, for certain improvements in machinery or apparatus for sewing embroidery, and uniting or ornamenting, by stitches, various descriptions of textile fabrics.—August 30.

Alexander Haig, of Smith-street, Stepney, engineer, for an improved apparatus for exhausting and driving atmospheric air and other gases, and for giving motion to other machinery.—September 6.

Alexander Robert Terry, of Manchester-street, Manchester-square, engineer, for improvements in the manufacture or preparation of firewood.—September 6.

Josiah Marshall Heath, of Hanwell, Middlesex, gentleman, for improvements in the manufacture of steel.—September 6.

Sir John Macneill, Knight, of Dublin, and Thomas Barry, of Lyons, near Dublin, mechanic, for improvements in locomotive engines, and in the construction of railways.—September 6.

John Hosking, of Newcastle-upon-Tyne, engineer, for an improved pavement.—September 6.

Richard Archibald Brooman, of Fleet-street, patent agent, for certain improvements in draught-horse saddlery, harness, and saddle-trees. (A communication.)—September 13.

David Stephens Brown, of the Old Kent-road, gentleman, for certain improvements in apparatus or instruments for the fumigation of plants.—September 13.

Henry Atwood, of Goodman's-fields, Middlesex, engineer, and John Benton, of Bromley, in the same county, engineer, for certain improvements in the manufacture of starch and other like articles of commerce, from farinaceous and leguminous substances.—September 13.

Edme Augustin Chameroy, of Rue du Faubourg St. Martin, Paris, for a new system of railway (denominated Helicoide), heliacal railway, and a circular chariot.—September 13.

Napoleon Pierre Preterre, of Havre, in France, for improvements in the construction of coffee and tea pots, and in apparatus for cooking; also in apparatus for grinding and roasting coffee.—September 13.

Edwin Heywood, of Glosburn, Yorkshire, designer, for improvements in plain and ornamental weaving.—September 13.

Robert Griffiths, of Havre, engineer, for improvements in steam-engines, and in propelling vessels.—September 13.

Thomas Marsden, of Salford, Lancaster, machine-maker, for improvements in machinery for hackling, combing, or dressing flax, wool, and other fibrous substances.—September 13.

Benjamin Goodfellow, of Hyde park, Chester, engineer, for certain improvements in steam-engines.—September 13.

James Potter, of Manchester, mechanist, for certain improvements in spinning and doubling machinery.—September 13.

Charles Marsden, of Kingsland-road, for improvements in traps to be applied to closets, drains, sewers, and cesspools.—September 20.

William Edward Newton, of Chancery-lane, civil engineer, for certain improvements in pumps, and in machinery and apparatus for working the same, which latter improvements are also applicable for working other machinery. (A communication).—September 20.

William Handley, of Chiswell-street, Finsbury, confectioner, George Duncan, of Battersea, engineer, and Alexander Mc Glashan, of Long acre, engineer, for improvements in the construction of railway breaks.—September 20.

Henry Bessemer, of Baxter-house, Old-street, St. Pancras-road, engineer, for improvements in the preparation of fuel, and in apparatus for supplying the same to furnaces.—September 20.

Elijah Galloway, of Southampton-buildings, Chancery-lane, engineer, for improvements in furnaces.—September 20.

Joseph Rocke Cooper, of Birmingham, gun and pistol maker, for improvements in fire arms.—September 20.

Edward Staite, of Lombard-street, gentleman, and William Petrie, of King-street, gentleman, for improvements in electric and galvanic instruments and apparatus, and in their application to lighting and motive purposes.—September 20.

William Pearce, of Haigh, near Wigan, Lancaster, and Edward Evans, of Wigan, engineers, for improvements in steam-engines and in pumps.—September 20.

Josiah Lorkin, of Ivy-lane, merchant, for an improved instrument or apparatus for beating or triturating viscous or gelatinous substances.—September 20.

Benjamin Wren, of Yarm, Yorkshire, miller, for an improvement in cleaning and treating certain descriptions of wheat.—September 20.

David Owen Edward, of Sydney-place, Brompton, surgeon, for improvements in the application of gas for producing and radiating heat.—September 20.

John Baptiste Vauldy, of Mile-end, dyer, for improvements in giving a gloss to dyed silk, in skeins or hanks.—September 20.

Thomas Griffiths, of Islington-row, Birmingham, for improvements in the manufacture of tea and other pots and vessels, and other articles made of stamped metal.—September 20.

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DANUBE RIVER.

Fig 1.

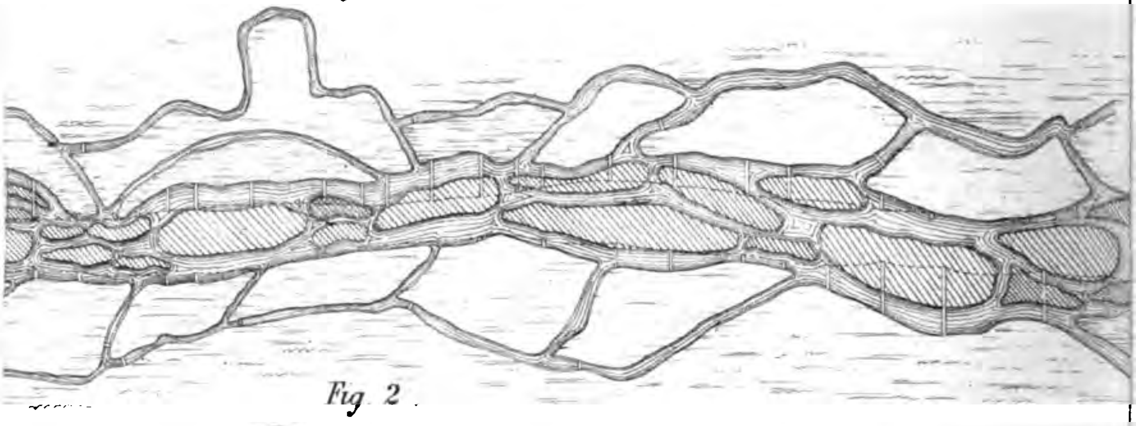
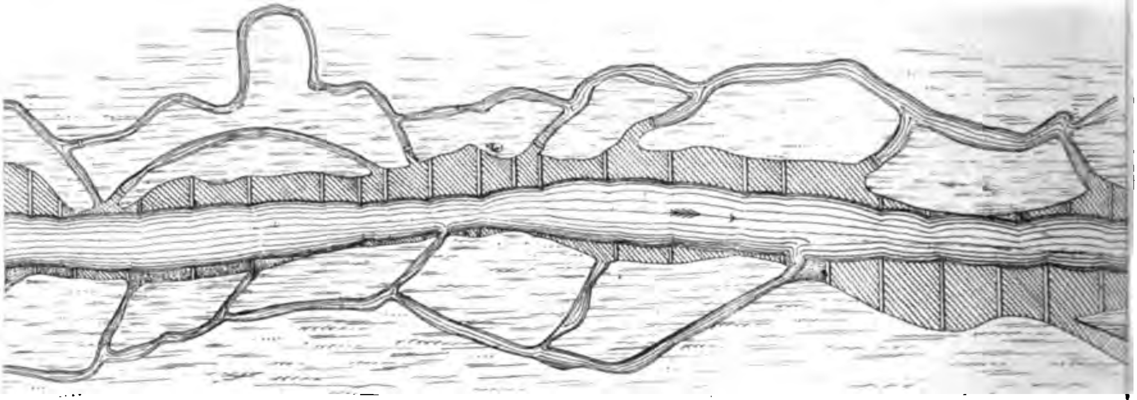
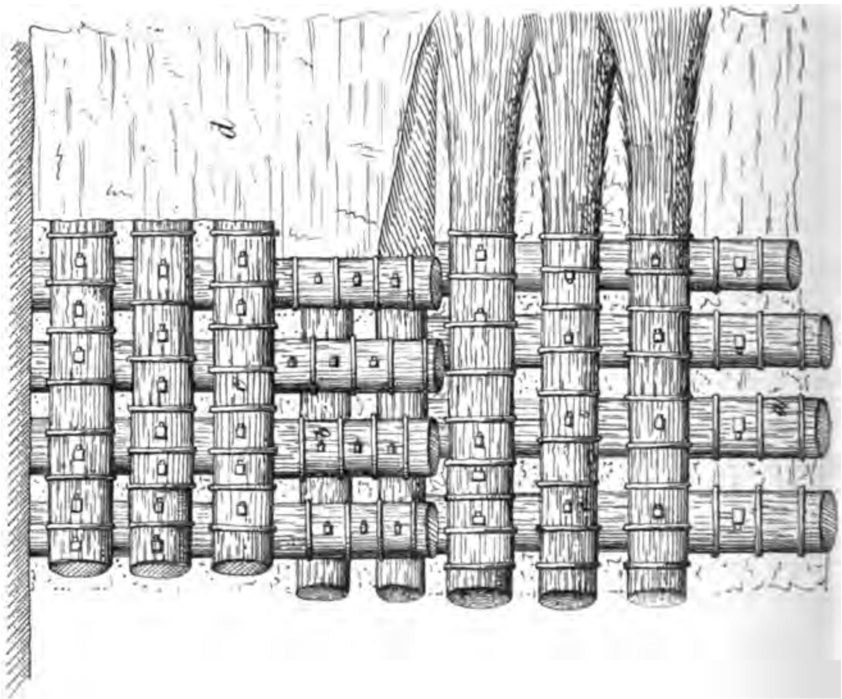


Fig 2.



PLAN OF THE SPURS.

Fig. 4.



THE IMPROVEMENTS IN THE DANUBE RIVER, FOR THE STEAM NAVIGATION, APPLICABLE TO THE INDIAN RIVERS.

By G. Shepherd, C.E.

(*With an Engraving, Plate* XX.)

I have read with pleasure in the *Journal* a notice of Mr. Bourne's work on the 'Navigation of the Indian Rivers,' in which he has detailed the great advantages which would be derived by suitable steam-vessels on those waters, and it is to me highly gratifying to find some attention being directed by this country towards so desirable an object as the improvement of the internal communication of our vast Indian territories. I know of no subject more interesting, nor could there be a more profitable speculation carried out than the establishment of a sufficient number of such vessels for carrying purposes, both merchandise and passengers. But there would be much to be done. We have not in England rivers whose banks have for ages been neglected, and their waters divided into numerous insignificant channels—where every flood causes further devastations in every part of the country through which the stream flows. Similar to the Danube, in Europe, of which I have had much experience, in India fresh channels are continually forming, and the *débris* deposited in other parts of the rivers in the shape of shoals, sandbanks, and quicksands, in places which frequently, previous to the flood, contained from 15 to 20 feet of water. These subjects are but little understood in England, from the absence of experience on similar rivers here; and Mr. Bourne appears to think that it is impossible to improve these streams by the concentration of the water into one channel; but formidable as these obstructions may appear, with your permission I shall endeavour to show to your readers that they may be so far overcome, as no longer to prove obstacles to the navigation of rivers of this shoaling character, and this at a very trifling cost. Mr. Bourne's proposal, as I can attest, is no visionary scheme, nor is there anything new in constructing iron steamboats of 200 tons burden, of 120-horse power, drawing from 14 to 18 inches of water, going at the rate of 10 miles an hour against the stream, and 18 miles per hour with it.

In bringing this subject before your numerous readers, I must allude to the state of the Danube, its traffic, and the boats used in navigating that river, previous to English skill and perseverance being brought into action. The introduction of steamboats upon this splendid river is due to Mr. Joseph Pritchard, formerly a shipwright in the Woolwich dockyard. Numerous attempts had been previously made by German engineers and others, but each attempt proved a signal failure.

The first attempt to navigate the Danube river by steam was attended with great difficulty, in consequence of the numerous sandbanks, quicksands, and shoals which then existed in many parts of the river. These were continually shifting from one place to another. The channels which, previous to a flood, had been navigable for steamboats drawing 20 feet of water, after the water had fallen were found to be entirely blocked up; and in a great many instances, these before deep places, might be walked over. In some cases the current would take a different direction, or else become so divided that scarcely any one stream could be found containing sufficient water to float a vessel drawing 12 inches, so that for several years the steamboats were continually getting aground. So treacherous, indeed, were these obstacles, that sometimes the steamers got aground during the floods, or just as the waters began to subside; and before assistance could be procured, these vessels so stranded have been left high and dry on the sandbanks, and have only been floated again by the aid of two or more steamers, together with the united efforts of from forty to fifty oxen and horses, which have been shipped from one island to another for this purpose. It is obvious that these obstacles were found very expensive to the steamboat company.

I trust that the *Civil Engineer and Architect's Journal* is not so strictly devoted to science, as to preclude me from making a few political observations, which will no doubt be found of general interest, and more especially at the present moment. During "Metternich's rule," the Austrian government had permitted no scientific progress whatever to be made in Hungary; and so jealous was this statesman of Hungary, that it really appeared his desire to entirely isolate the Hungarians from the rest of the Empire. The police commissioners in Vienna were instructed to use every species of insolence to scientific persons applying for a passport to Hungary,—in one word, the conduct of this statesman (who was so deservedly kicked out of his own country) was most base and tyrannical towards that then loyal people, and the late disasters must eventually recoil upon his own family.

The oppressions thus unceasingly heaped upon the Hungarians at length found an opposer in the noble and indefatigable patriot, Count Szechenyi, who saw that unless the feelings of the nation could be aroused, his unhappy country was doomed to remain in absolute ignorance. This nobleman having made several tours through Europe, at once commenced a crusade against the Austrian government. The following were the objects or base of his political creed.

> "The favourite objects of their desires were,—after strengthening the nationality of Hungary,—freedom of commerce, and an improved commercial code; the navigation of the Danube, and the improvement of internal communication; increased freedom and education of the peasantry; the repeal of laws preventing the free purchase and sale of landed property; perfect equality of all religions, and the freedom of the press. For the greater part of these objects they are still struggling."—Paget's *Hungary and Transylvania*, vol. i., p. 162.

After undergoing a series of persecutions from the Austrian government, which served but to increase the flame now kindled, this public leader was, with the view of keeping him quiet, made His Excellency Count Szechenyi, Minister of Public Works in Hungary; but this title, rather than abating the zeal of so anxious a patriot, gave him free toleration to harrass the government until he obtained permission to improve the state of the Danube river, in order to give every facility to the steam navigation. Ultimately the government agreed to advance an annual sum of 100,000 florins (10,000*l.*) to improve the river in Austria; and the Hungarian Diet also granted a small sum annually for the improvement of the river in Hungary. Operations were at once commenced under the control of the Count.

The engraving, Plate XX. fig. 1, shows the state of the river, taken from a survey between Presburgh and Comorn, before the improvements; and fig. 2 the state of the river a short time after the operations were commenced, the numerous shoals and sandbanks shown in fig. 1 being now to a great extent removed. The following description will explain the principles that were adopted.

The sandy districts were the first places where the operations commenced. The water, as will be observed in the engraving, fig. 1, branched out into numerous channels, while the central stream was nearly blocked up with sandbanks and shoals. On each side of the river were stationed a number of men; some were employed in cutting and binding faggots on shore; and others in constructing spurs (as shown in fig. 2), placed at right angles with the stream. The spurs were constructed as shown in elevation and plan of the spur, figs. 3 and 4. In the diagrams it will be observed that the series *a* and *b* of the brushwood is bound or woven together so as to form one continuous line throughout the entire length of the spur; each row is well secured to the ground with short piles or stakes, and the space between each row is filled-in with earth such as is found upon the spot. The transverse bundles of faggots *c*, *c*, are made to the required length, laid on the others, and secured in the same manner, with this exception—the ends toward the stream are left open or in the bushy state.* These rough ends are then covered with earth *d*, *d*; the operations being carried on when the water is very low in the river. When the main spurs are completed, the arms of the river are dammed-off in the same manner.

The rapidity with which the spurs are made is truly surprising; and it will be observed from their construction that they offer but little resistance to the water in the first instance, but as soon as the sandbanks begin to move, the *débris* is deposited between and in the spurs, which renders them immoveable; the current at the same time is thrown into one channel, which has the effect of entirely scouring the river of the sandbanks previously deposited.

In carrying out this operation, care should be taken to keep the ends of the spurs in a line with each other, and the stream in a straight line—that is, to such given distances as might be determined upon, as shown in the engraving; and great care should also be taken to make the spurs very strong in every place where it is liable to be exposed by any bend in the stream.

The brushwood is generally laid in the rivers in its green state, there to take root and grow again; consequently, after a few years, each of the spurs forms a thick massive hedge, which prevents the stream from making further ravages on its banks, and confines the stream to one central channel; scouring out to a width and depth sufficient for all purposes of navigation.

This system of embanking with faggots has been the means of rescuing thousands of acres of land from the flood, at a cost of not 1*s.* per acre. By following up this system, in the course of a

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* Any person who may have made the following experiment, will be able to form some idea of the system for river regulating, for instance. Let a small branch of a tree or bush, with several arms projecting from it, and the branched end be buried under from 3 to 4 feet of earth; and see what amount of power it will take at the stem to extricate the branch.

few years the sandbanks to a great extent ceased to exist, and the obstructions to the navigation were less frequent. These improvements having been effected in the most dangerous parts of the river, together with the systematic arrangements which have been made in the pilotage, the immense traffic of the Danube is now carried on almost uninterruptedly; for it is a rare occurrence to hear of any of the steamers getting aground.

Having brought this subject before the English public, I have no hesitation in saying, if the same means are resorted to in the Indian rivers, that, in a very few years, the impossibility represented by Mr. Bourne will cease to exist, and the rivers be made navigable at a remunerative profit. Certainly, if such people as the poor Hungarians can afford to spend sufficient per annum for regulating the rivers in that country, I consider that 100,000*l.* per annum might be spent by the Indian Government for the same object, leaving the navigation of the rivers to private enterprise: and with 100,000*l.* per annum, for a few years, thousands of acres of land would be rescued from the rivers; swamps, in a great measure, would cease to exist; the banks would be converted into healthy and fertile districts, giving employment to thousands in agricultural pursuits.

It is my intention to resume this subject, and to explain some other improvements connected with the Danube and Hungary.

G. S.

CANDIDUS'S NOTE-BOOK, FASCICULUS XCIX.

> "I must have liberty
> Withal, as large a charter as the winds,
> To blow on whom I please."

I. To return to my remarks on the Army and Navy Clubhouse:—besides being disfigured by such gross negligences as those pointed out, and being totally devoid of anything like contrivance or study in its arrangement, the plan is such that it has not even convenience to recommend it; on the contrary, is so decidedly inconvenient in that respect, that it is astonishing how the professional gentleman who *assisted* the committee at the second competition could have passed over so many positive defects without pointing them out to those to whom he acted in the capacity of adviser, and urging the necessity for their being corrected if that design was to be adopted. Infinitely greater contrivance was displayed in some of the plans sent in at the first competition, for they provided not merely commodious, but handsome corridors or other approaches to the further rooms: instead of which, the Strangers' Coffee-room and House Dining-room can now be reached only through a long and most inconveniently-narrow passage—barely wide enough to allow of two persons passing each other without jostling. That passage, too, takes a very awkward bend just where—in consequence of such bend—there is no light, and where there are several doors—those of back-stairs, servants' places, and waterclosets,—immediately close by all which gentlemen will have to pass. In the Strangers' Coffee-room, the windows which are at one end of it, look into a mere area, only 7 feet wide, with the prospect, however, of three other windows—those of back staircases and passages immediately facing them:—strange, yet perhaps therefore characteristic disposition, of plan, the room being intended for strangers. Unless there be some sort of skylight besides (though none is indicated in the plan) the room must be an exceedingly gloomy one; and if, on the other hand, there be a skylight or lantern, there was no occasion at all for other windows, unless it was for the sake of the prospect just mentioned. In one respect, indeed, convenience has been attended to, although not very delicately, nor is it so well managed as it might have been—a door opening into a watercloset being placed immediately next, and at a right angle to, that of the House Dining-room. Of the upper floor plan, I have no means of judging; but guessing at it from the arrangement of the lower one, I take it to be at the very best, exceedingly commonplace.

II. I have not yet quite done with the Army and Navy Clubhouse: let us now consider the exterior. In the first place, it now appears that what looks like a separate entresol or mezzanine over the lower floor, is not such in reality, those small openings forming internally a second series of windows over the others. By means of this arrangement, the ground-floor rooms are made to appear externally much lower than they really are; and the basement is cut up into two stories, when it might as well have been made to show itself as a single lofty one,—and even much better, since there is assuredly no beauty whatever in the design of its present windows—either the upper or lower ones; and as assuredly, too, that part of the building being an express copy from Sansovino is rather an aggravation than an excuse, copying being in itself a confession of inability to invent or produce; and the copying what is at variance with actual circumstances showing, in addition to such inability, strange perverseness of judgment also. As it has been managed, it is one exceedingly disagreeable defect in the composition, that the small windows alluded to, rise up higher than the arches of the loggia of the east front, instead of ranging with them. Why were not arches, similar to those of the loggia, continued throughout the whole basement, and filled-in with windows, either continuously from bottom to top, or divided into two openings by a transom corresponding with the impost,—which might then have been enlarged and enriched, and the upper semicircular openings made to form lunettes in a cove in the rooms within? Even had there been an actual entresol, that might have been done; and greater consistency and nobleness of design would have resulted from it. The balconies before the principal-floor windows are, at the best, in rather coarse and uncouth taste, and by projecting forwards and resting immediately upon the cornice of the basement, they occasion a most awkward and ungainly effect, and seem to clog up and encumber that part of the front. As to the windows themselves, on that floor, though they are intended to present the appearance of being lofty arched ones, the openings themselves, do not even rise so high as the imposts of the arches, being square-headed, and the remainder filled-up with brick-work. Deception of that kind would have been allowable enough, had it been resorted to to make a single window look like all the others in the same range, although in reality different from them; but to perpetrate deception of the kind quite gratuitously and by wholesale, accuses the architect most strongly of either ignorance or disregard of logical design, and of inability to accommodate design to the requirements of the particular case. In this case, the deception practised is so far from being at all ingenious, or exhibiting any contrivance, as to be on the contrary a very clumsy one. It will be no very agreeable surprise to persons when they first enter the upper rooms to find that the lofty arched windows, and corresponding loftiness in other respects promised by outside appearances, have quite vanished. The trick must also be betrayed externally, by the absence of window draperies in the heads of the windows; and more strongly still when the rooms are lit-up of an evening—while all is light and brilliant within and below, the upper part of the windows will be all in darkness. If the "Army and Navy" want a motto for their building, let them take

FRONTI NULLA FIDES.

A more appropriate and significant one they cannot possibly find.—It would not at all surprise me to hear that they already begin to damn Sansovino, and one or two other people besides,—Count D'Orsay included, for his cajoling them into a precious bad bargain with his "most beautiful palace in Europe."

III. The windows of the principal floor of the "Army and Navy" have probably been made to appear large arched apertures for no other reason than of rivalry to the Carlton Clubhouse, except it be that such stratagem was resorted to as being the easiest way of getting over some difficulty, and of avoiding the heresy of committing anything like a fresh idea in design. The arches might have been retained as necessary for decorating and filling-up the space above the windows; but had *logical* design been attended to, the apertures would have been made to show themselves as they really are—square-headed; and in the tympanums of the arches semicircular niches might have been introduced, for the reception of busts of military and naval heroes—at some future time, at least, if not at first: and surely such decoration would have been an equally appropriate and striking, as well as honourable, distinction to that clubhouse.

IV. Although I did not intend to say anything further concerning Mr. Ruskin, having already said so much, I am induced to do so in consequence of having just met with a long critique upon 'The Seven Lamps,' which shows very strongly that I am not the only one who thinks that Mr. Ruskin has been prodigiously overrated as a critic on Art—at least, upon Architecture. Even the *Art-Journal*, too, albeit not addicted to censure, and notwithstanding that it gives him credit for "magical language, lofty poetry, warm generosity," and a good deal besides, takes him to task rather severely for the barbarous doctrine involved in the following maxim:—"Not to decorate things belonging to purposes of active and occupied life." To say the truth, such doctrine strikes so directly at the root of all that is now being done with the view of advancing manufactures by means of Art, and thereby giving to Art itself a positive "mercantile value," that it is rather a wonder the book was not laid under interdict in that quarter, and its writer pronounced a tasteless ignoramus, and shallow pretender in matters of art. *Sharpe's Magazine*, too, has called in question many of Mr. Ruskin's peculiar opinions and tastes, and reproaches him pretty *sharply* for ignoring or depreciating such glorious achievements of the present age as steam navigation, railroad communication, &c., and for repudiating the active and intelligent spirit of our own times, and inculcating the duty and wisdom of returning to that of the middle ages. The reviewer quotes his tirade against railways, but has not pointed out—perhaps because he thought that every one must detect it—the notable piece of sophistry and paralogy which assures us that "we have just spent a hundred and fifty millions, with which we have paid men for digging ground from one place and depositing it in another"! He who could write such nonsensical stuff, would say—that is, were he consistent—farmers pay men for walking up and down a field all day long after a plough; and builders pay them for buttering bricks with mortar.

V. It is not, however, from either of the above-named publications, but from a rather recently-established periodical, with the title of the *Rambler*, that, in its number for last July, the author of 'The Seven Lamps' has got what is vulgarly called "a complete set-down." When it is known that the *Rambler* is a "Catholic Journal and Review," the hostile tone of the article is fully accounted for: nevertheless, it says a very great deal which, unpalatable as it must be to Mr. Ruskin's admirers and applauders, as well as to himself, they would find it an exceedingly difficult matter to gainsay. Greatly must those be scandalised who have extolled Mr. Ruskin's eloquence and "magical language," when they find the *Rambler* assuring us that "his ignorance is as egregious as his dogmatism is offensive; and he has adopted a peculiar style of writing, which frequently verges on the unintelligible through the *excessive awkwardness* of its construction, and *his utter want of perception of the true genius of the English language.*" As "set-down" the first, that is a tolerably strong one, for it knocks *down* at a blow what others have cried *up* as a "very remarkable" and distinguishing excellence in 'The Seven Lamps,' and claps an extinguisher upon it. Further on, the writer in the *Rambler* says: "There is something so transcendently ludicrous in the notion that the Church of Rome is *idolatrous*, and yet that the early mediæval architecture was the result of the purest Christian faith and feeling, that we can only suppose that Mr. Ruskin believes that Cranmer, Luther, and Henry VIII., flourished some 700 years ago, and that Salisbury Cathedral was built in the reign of Elizabeth. The simplicity which can identify the creed and practices of the thirteenth century with those of English Protestantism is so delicious, that whatever else be Mr. Ruskin's deserts, he may lay claim to the invention of something unquestionably *new*." That is a palpable hit; and it might have been added, that it is anything but consistent in one who contends for the direct influence of religion in matters of taste and art, to extol the mediæval styles of Papal Italy in preference to our own; to say nothing of his unqualified and wholesale reprobation of "our detestable Perpendicular," notwithstanding that it is—as he ought to be able plainly to perceive—the only mode of Gothic which is at all capable of being applied to general purposes, and which contains within itself the elements of further development for such purposes at the present day. One very just accusation which the reviewer makes against Mr. Ruskin is, that he does not at all expound the *principles* of architecture. Upon them his "Lamps" shed no light at all. In fact, there is no sort of system of the æsthetics of architecture in his book; what is intended to look like system, and may pass for such with readers in general, being no more than a perfectly arbitrary and whimsical division of the subject. The critic in the *Rambler* goes even so far as to hint that Mr. Ruskin is a fool—at least, is one-half a fool, though in the other he may be a genius; and certainly he has uttered some exceedingly gross absurdities. There is also a good deal of sarcastic quizzing—some will say, in lack of argument—fired at Ruskin, in the *Rambler*, especially as regards his abhorrence of railways and railway-travelling; which perhaps has had some share—the only *share* Mr. Ruskin holds in railways—in causing the present depreciation of railway shares and property. "Henceforth," it is said in the *Rambler*, "we shall never see a person on the Great Western, or Birmingham, or any other line, huddled-up in a corner of a carriage, dark, sour, and misanthropic in visage, and resenting the suggestions of any agreeable thoughts as a cruel mockery of an inward and unknown sorrow, without thinking of the author of 'The Seven Lamps' rejoicing in his woes, and oppressed with the mingled consciousness that he is travelling at thirty miles an hour, and that that wicked Papist, the Earl of Arundel and Surrey, is a member of the Commons House of Parliament." Ruskin is also taken-up, or rather set-down, by his reviewer for his extravagantly fanciful, even nonsensical, notions on the subject of beauty in architecture, which must of necessity be altogether different from that of natural objects. According to Mr. Ruskin's reasoning, doors, windows, &c., must be little better than so many unnatural deformities, they being in the unhappy predicament of letters (*i.e.* the characters used in writing or painting), to which he objects that they are like nothing in nature. It would therefore seem that he is incapable of discriminating between what belongs to Nature and what to Art; between the mental pleasure afforded by the contemplation of the one, and that afforded by similar contemplation of the works produced by the other. In a word, Mr. Ruskin is a decided NATURAL; and as such I will now leave him, and also leave those who feel any curiosity to learn what farther is said in the *Rambler* on the subject of 'The Seven Lamps,' to get the publication and read the entire article, which will well repay them for the eighteenpence so bestowed.

VI. In a paper 'On Style in Architecture,' read by him a short time ago at the Institute, Professor Cockerell very properly deprecated pedantic imitation of the antique orders, and the illogical application of them; and as to the former fault, he has endeavoured to correct it in his own practice, by daring, in some of the buildings which he has erected, to deviate considerably from what is considered the standard of the Doric order; elongating his columns, and substituting a fret for the characteristic triglyphs and metopes of the frieze,—with the view, no doubt, of thereby imparting to it greater delicacy, and mitigating its original sternness. But he surely applies it *illogically* and quite contrary to its nature, when he introduces it—as he he has done—as mere decoration in fenestrated fronts, consequently essentially different in their general physiognomy from anything in ancient Greek architecture; and that order is so exceedingly severe and inflexible, so rigid and untractable, as to be fitted for scarcely aught more than a mere portico or colonnade; therefore, to convert it into *en appliqué* decoration is, if not to violate, to do violence to its character,—an indignity which it stubbornly and violently resists. In itself, however, the attempt to break through the frigid formalism established for the treatment of the orders, is a laudable one rather than not, but one which requires in him who makes it more than ordinary artistic skill and power. It is not for every one to make it; *non cuivis adire Corinthum:* yet surely there are, for there ought to be, some capable of making it successfully,—capable of variously modifying according to circumstances, and in accordance with the particular character reqnired by the actual occasion, the types of columnar and trabeated architecture furnished us by the remains of antiquity. If it be asked, what is to guide them in doing so, the reply is: artistic instinct and feeling, some portion of which, it is to be presumed, architects—at least, some of them, are gifted with, unless architecture be now in the unhappy condition of a Fine Art, without artists for its followers,—one which leaves them nothing else to do than to re-combine, or rather merely put together, hackneyed forms and features,—as is not unfrequently done either in utter ignorance or utter disregard of every principle of artistic composition.

VII. Professor Cockerell himself has more than once given us combinations more singular than consistent or tasteful,—studied with regard to aim at novelty, yet anything but carefully considered. His Branch Bank of England, at Liverpool, is a compound of strangely discordant elements and conflicting styles, which, though mixed up together, are not amalgamated, but left to show themselves in harsh contrast to each other. Even were there no other inconsistency in the matter, what he has there done is quite at variance with his own *ex cathedrâ* opinions and advice. "How often," he said in his paper on 'Style,' above referred to, "do we find the young architect, fired with the beauty of the classic column and entablature, of the portico and the pediment, introducing them where their uufitness actually destroys the very beauty he is so anxious to display." Nevertheless, in his building at Liverpool, he himself—"fired," perhaps, "with their beauty,"—has forcedly introduced a Greek-Doric order (considerably modified, it is true), whose columns are mere ornamental expletives in the structure—architectural rhetoric without architectural logic; for being attached to the wall, they not only serve no real purpose, but lose the greater part of the effect that would else attend them, and are reduced to mere embellishment,—for which the character of that particular order most especially unfits it; whereas, the portico, loggia, or other colonnade, carries with it the appearance, at least, of utility, and as far as the order itself which is employed is concerned, exhibits it in conformity with its original intention, and is sure to produce a certain degree of effect, though it may be no more than that of light and shade, and of what arises from perspective appearance, owing to the columns being in a plane considerably advanced before that of the wall behind them. In the building here spoken of, not only are the Doric columns *engaged*, but the intercolumns contain *two* series of windows, which are besides anything but Doric, or rather quite anti-Doric, in design; and, as if for the express purpose of rendering them more so than they else would have been, those of the upper or first-floor have very light metal-work balconies, which have hardly the look of affording sufficient security, the hand-rail being supported only at its extremities. As if for the direct purpose of presenting a strong contrast to those balconies, and also the order itself, the entablature of the latter is surmounted by an *Italian* balustrade—or rather by an uninterrupted line of balusters; for, by way, perhaps, of originality or novelty, the balusters are continued from end to end, without any pedestals between them over the columns, or even at their terminations! I might go on to point out many other eccentricities, but with my characteristic *good nature*, refrain from doing so,—being quite sure that Professor Cockerell, if no one else, will thank me for abridging my criticism.

ON ARCHITECTURAL CRITICISM.

Architects appear to entertain so strong a dislike of criticism, that it amounts almost to antipathy, ill-disguised by professed contempt. If not illiberal, such dislike towards, and deprecation of, criticism is at least impolitic, and inconsistent too. It partakes of illiberality, inasmuch as it seems to say that critics are all alike mere smatterers, very ill-qualified, if not totally unqualified, for the office they assume; it shows impolicy, for to silence criticism would not be the very best way of promoting the study of their art; and it shows inconsistency also,—for if they are of opinion that those who are not professional and practical men, either say nothing to the purpose, or else do actual mischief by misleading others, why then do not they themselves, instead of merely complaining of it, endeavour to remedy the evil by instructing the public better, and by exposing the erroneous opinions or absurdities, and perhaps injustice too, of those who now set themselves up for critics? There are now sufficient facilities for doing so in the promptest and most direct manner, and if architects do not choose to avail themselves of them, so it must be; but then, do not let them complain of a state of things which they themselves encourage by their own silence and supineness. Were they to give the public sound, intelligent, and really artistic criticism, the latter would no longer be duped or misled by that of mere pretenders—of shallow, one-sided, purblind praters and writers,—because they would no longer tolerate it.

Even the profession themselves are not free from error; for they commit a mistake attended with serious ill consequence to the interests of architecture itself, when, though they would have it looked upon as a Fine Art, they in a manner claim for it immunity from criticism, as being one which can be properly appreciated by those alone who actually practise it, and who are acquainted with construction and all its processes.—Strange doctrine, and surely as unfortunate and short-sighted as it is strange. Instead of inviting people to study the artistic branch of architecture, it deters them from even attempting it; telling them, in fact, though not in direct words, that it is one by far too exclusively technical to be mastered by any one who does not apply himself to it professionally; whereas, could the profession themselves see an inch beyond their noses—which they do not appear to do at present, they would perceive how much it would be to the advantage of themselves as a body, and to that of their art also, were they to break down the barriers with which they have hemmed it in, and to popularise the study of it to the utmost of their power. Direct proof is afforded of this, by the great, and we may call it rapid, advance which has of late years been made in one style—namely, the mediæval; and rather in spite of the profession themselves, it urging them on in a direction which else they might never have taken—at least, not to the same extent. The impulse came from without: it was given by antiquaries and archæologists—in other words, by *mere amateurs*, but earnest ones, who, by means of various and numerous publications, have greatly facilitated the study of that style, and created a widely-diffused interest for it. And amateurs of that particular class now form so numerous and also so influential a body, that the profession dare not open their lips against them; on the contrary, are glad to accept them as patrons. That as far as the various styles of Gothic are concerned much good has been effected by the zeal of non-professional students and writers is not to be denied, it being they who have in a manner forced the profession to render themselves practically conversant with those styles. At the same time, it must be confessed that what has so far been done for good, falls greatly short of what it might, and what—let us hope so—it will be. The interest so created at present extends to very little more than a single style of architecture and a single class of buildings; and not only that, but the predilection for Gothic which has been thus fostered, is too overweening and exclusive, and apt to be accompanied with prejudice against, and contempt for, other styles which have at least this in their favour, that they accommodate themselves infinitely better to our purposes and practice generally at the present day; consequently must be retained by us, whatever modifications they may henceforth undergo. Again, the impulse given to the study of mediæval architecture having proceeded chiefly from those addicted to antiquarianism, they have given to the study itself a bias much stronger towards the archæological and historical, than the æsthetic and artistic. It is familiarity with dates, and the distinctions between one style and another, and similar matters, that is displayed, rather than any power of critical investigation and judgment. All is *grist* that comes to the archæologist's mill: everything is treasured-up as a specimen, every specimen venerated as a relique; all the more precious, perhaps, on account of its singularity—namely, its singular ugliness. There is by far too much of the "chronicling small-beer"—and some very flat and stale too—in what emanates from architectural writers and teachers of the historical class; and it very rarely happens that a drop of the wine of genuine and generous criticism is mingled with their "small-beer" stuff.

Generous Criticism! Many readers will, no doubt, here protest that the expression is a downright contradiction in terms,—which it certainly is according to the sense vulgarly attached to the word Criticism. Of criticism, as of most other things, there are two sorts—the bad and the good; and of the former there are again two other sorts, of which it is impossible to say which is the worst—that which consists of rancorous and reckless abuse, or that which deals only in equally reckless and base puff:

"Like him who just to get a dinner,
Would make a saint of any sinner;
Or else in blackest colours paint
The worthiest man or meekest saint."

Such, however, is not criticism, but the prostitution of it. What, then, is true criticism? The answer is not very difficult: it is that which, founded upon a diligent study of Art, is ever loyal to the real interests of Art; which ever remains unbribed and incorrupt; and which

"———— Nobly dares to show
Faults in a friend, or merits in a foe."

Whether it commends or condemns, criticism should show itself to be honest, and that the opinions which it delivers are the results of impartial and discriminating examination. Mere vague general praise or censure may be uttered by any one; and so long as stuff of that sort will pass for criticism, it may truly enough be said that "Critics all are ready-made," and that criticism is very easy work. But the criticism worth having, that which instructs both the public and the followers of Art themselves, must be first learnt by an apprenticeship to it of study and reflection. Of such criticism the praise is worth having, because it is not bestowed indiscriminately upon every one; whereas some are so lavish of that article, that, becoming as common as gold in California, it ceases to be precious. "My good Madam," said Dr. Johnson once to a lady who was complimenting him in very fulsome style, "before you are so prodigal of your praise, do for a moment consider how much it is worth." The same might be said to the dealers in Puff. Still, it may be thought that however proper it may be for criticism to bestow praise with some degree of reserve, and only where it can be shown to be merited, there is no occasion for its administering censure: where it cannot commend, it can at any rate be silent;—yes, and so hold out impunity to Pecksniffs, and allow public taste to be corrupted by Art-brummagem of all sorts.

Were architectural criticism—for we confine ourselves to that—fully exercised in the way which it ought to be, it would be influential for good in more ways than one. While it encouraged talent and merit, it would check mere empty pretension; and, instructed by sound criticism, the public would in time learn to distinguish clearly between the one and the other, instead of trusting, as they now do, to the voice of report, or being guided by the *éclat* attending mere vogue. Professional men would then perceive the necessity of attending to the demands of criticism—as they may, in fact, be said to have done already in the case of Gothic architecture. Criticism—that is, honest and sterling criticism—is a real friend to architects, though it may be a stern one. Were its lessons attended to, it would elevate them to the rank of artists; not the mere nominal rank, as at present, where the term *artist* is but a conventional one, bestowed by courtesy on almost any one who carries on business *comme il faut*, without being guilty of the horrid vulgarity of keeping a shop; but to the real rank of truthful and earnest followers of their art,—faithful and devoted to it, rejoicing in its advance and successes even when they did not participate in them personally.

When criticism is erroneous, let its errors be fairly exposed; when it is unjust, let its injustice be shown and reprimanded with all the severity the case merits;—but to declaim against, or rather sneer at, criticism as something that is uniformly mischievously officious and impertinent—as architects appear to be disposed to do—is both illiberal and unwise. If—as some of them all but directly say—it is themselves alone who can be competent judges of architecture, and that they alone are properly capable of directing public taste in regard to it, they are surely guilty of a very gross dereliction of duty in suffering spurious criticism to be disseminated, while they, indifferent to the ill consequences arising to their art from such pseudo-criticism, withhold the genuine. Their own words condemn those in the profession who represent architectural criticism to be, almost without exception—for they make no exceptions—the reverse of what it ought to be; since they plainly intimate that there is very great need for better criticism—for such as they alone are capable of producing, yet instead of doing so, preserve an obstinate silence; leaving the public to be misled, by various shallow and erroneous opinions, merely because they themselves are too indolent to contradict them,—for to question their ability to do so would be deemed the height of presumption.

It is, perhaps, owing to their antipathy to criticism and everything connected with it, that, when they do chance to take up the pen, professional men very seldom care to display any particular critical power, by speaking of works of architecture as works of art, and by deliberately pausing upon, and intelligently explaining their respective beauties or defects. Hence a certain degree of dogmatism, or the appearance of it, in their writings; for however just they may be in themselves, remarks which amount to no more than the brief and bare enunciation of opinion, or of its verdicts, must almost inevitably partake of dogmatism in their tone. We are in a manner authoritatively commanded to admire or disapprove upon the mere *ipse dixit* of the writer, without argument of any sort being employed for the purpose of convincing us. Far—very far are we from wishing to insinuate that it is professional men alone who deal only in assertion when they should give us something like adequate reasons and proofs. But *they* have surely little right to complain of architectural criticism being for the most part so feeble and unsatisfactory as it is, if they allow it to continue what it is, by not even so much as endeavouring to improve it. If they think that by merely sneering at, and affecting to despise bad criticism—which all the while they leave to corrupt public taste—they can put it down, they are greatly mistaken.

DISCHARGE OF WATER FROM RESERVOIRS.

The Theory of the Contraction of the Movement of Water flowing from Apertures in thin Plates, in a Reservoir in which the Surface of the Water is maintained at a constant altitude. By J. Bayer, Lieutenant. (Translated for this *Journal* from Crelle's '*Journal für die Baukunst.*' Band 25.)

(Concluded from page 293.)

For computing the quantity of discharge for less altitudes of pressure, the sinking of the level, as already mentioned, must be taken into consideration. It can be easily ascertained that in Table I., for $m = 5$, the co-efficient $k' = ·6029$ remains invariable, as the altitude of pressure of the mean value of the water level before and after sinking is assumed, and equation (g) § 11 applies. Take therefore H for the altitude before, H″ after, the sinking. Then for the "less altitudes,"

$$h. \quad Q = ·6029\sqrt{(4g)}\cdot\tfrac{2}{3}l\left\{\left[\tfrac{1}{2}(H+H'')+l\right]^{\frac{3}{2}}-\left[\tfrac{1}{2}(H+H'')\right]^{\frac{3}{2}}\right\}.$$

As for greater altitudes, as soon as the sinking of the level no longer takes place, $H = H''$, and this equation becomes the equation (g, § 11) above; and ensures general accuracy when it is employed for greater altitudes, with the modification that the co-efficient corresponding to the quantity m be taken from Table I.

In order to make a more extended application of the equation (h), there are here given the computations from twenty-four experiments with square orifices (the side of the square being ·2 mtr.) These experiments are given by Poncelet in Table IV. of his work.

Table III.

	No. of Experiment.	Altitudes of Pressure of the level after sinking (H″).	Altitudes of Pressure of the level before sinking (H).	$m = \frac{H}{l}$	The Co-efficient corresponding to m in Table I., k'.	The quantity of Discharge by Experiment.	The quantity of Discharge by Theory.	Error.
		mtr.	mtr.			liter.	liter.	liter.
Greater altitudes	1	1·3718	1·3720	6·860	·6037	129·527	129·736	−·209
	2	1·3321	1·3323	6·661	·6037	127·475	127·974	−·499
	3	—	—	—	—	128·158		+·184
	4	1·2148	1·2150	6·075	·6034	122·659	122·555	+·104
	5	1·1248	1·1250	5·625	·6032	117·906	118·243	−·337
	6	—	—	5·000	·6029	118·249		+·006
Less altitudes.	7	·8522	·8525	—	—	104·542	104·183	+·259
	8	—	—	—	—	104·081		−·102
	9	—	—	—	—	104·879		+·696
	10	·4686	·4690	—	—	80·589	80·456	+·133
	11	—	—	—	—	80·631		+·175
	12	—	—	—	—	80·294		−·162
	13	—	—	—	—	80·170		−·286
	14	—	—	—	—	80·373		−·083
	15	—	—	—	—	81·057		+·601
	16	·2999	·3005	—	—	67·289	67·396	−·107
	17	·1407	·1420	—	—	51·924	52·088	−·164
	18	·1407	·1420	—	—	51·882		−·206
	19	—	—	—	—	51·852		−·236
	20	·0567	·0600	—	—	41·689	41·787	−·098
	21	·0136	·0220	—	—	35·658	35·846	+·312
	22	·0136	·0220	—	—	35·475		+·129
	23	—	—	—	—	35·372		+·026
	24	—	—	—	—	35·878		+·032

The mean error above is ·274 liter. The probable error is ·185 liter.

The measurement of the altitude in relation to the surface of the water before sinking has various difficulties: so that for practical application it is necessary to be able to compute the quantity of discharge by the altitude of pressure for the level after sinking, the measurement being taken immediately above the orifice. When the equation (i), § 11, is applied to this purpose, and the corresponding co-efficient designated by c, we have

$$i. \qquad Q = cl^2\sqrt{\left\{4g(H'' + \tfrac{1}{2}l)\right\}}.$$

The co-efficient c may now be found. This is easily obtained by Table I. by putting $m+1$, instead of m. For instance, when $H'' = ·0136$, $\frac{H''}{l} = ·068 = m$, and $m+1 = 1·068$; and for this ratio Table I. gives the value of $c = ·5950$. To show the agreement of this method with the experiments in Table III., the following table gives, side by side, the co-efficients determined from experiment and calculated by the above method.

Altitude H″.	$m = \frac{H''}{l}$.	Co-efficient c by Experiment.	Co-efficient c by Theory.
·0136	·068	·5941	·5950
·0567	·2835	·5937	·5963
·1407	·7035	·5959	·5981
·2999	1·4995	·6008	·6001
·4686	2·3430	·6027	·6014
·8522	4·2610	·6045	·6030

The greatest discrepancy from experiment does not exceed ½ per cent. For greater altitudes equation (i) is directly applicable. It therefore extends to all practical cases for all altitudes, if for the less altitudes the co-efficients corresponding to $m + 1$, and for greater altitudes that corresponding to m, be taken.

When the quantity of discharge Q has been found in equation (i), it can be substituted in (h) to find H, the altitude of pressure of the water-level before sinking.

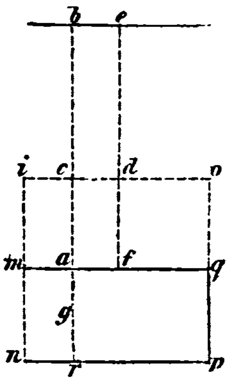
13.

The Co-efficient of Contraction for Rectangular Orifices.

When k'' signifies the co-efficient for rectangular, k as before for square, orifices, we have as in equation (d) of the foregoing paragraph

$$k'' = \frac{k' f_q V_q}{f_r V_r} = \frac{k' f_q}{f_r}\sqrt{\frac{H_q}{H_r}}.$$

As, however, any rectangle of which the base $l = np$, and height $b = pq$, may be considered part of the square $npoi$ described on the same base, the contracting forces in rectangular and square orifices must be equal to one another; so that the co-efficients for rectangular orifices may be computed as the co-efficients for square orifices, merely by the position of the orifice with respect to the surface of the water in the reservoir. From these considerations we have



$$a. \qquad k'' = k' \sqrt{\frac{H_q}{H_r}}.$$

When, first of all, the altitude above the upper edge is equal for both orifices, and equal h_r, we find for the centre of pressure,

$$1. \qquad H_q = h_r + \tfrac{1}{2}l + \frac{l^2}{12\,(h_r + \frac{1}{2}l)}.$$

$$2. \qquad H_r = h + \tfrac{1}{2}b + \frac{b^2}{12\,(h_r + \frac{1}{2}b)}.$$

In the preceding paragraph, however, by comparing the co-efficients, the centre of the orifices at the same depth may be found. We have, therefore, when the altitude of pressure above the square $= h_q = ed$ (in the figure), the following equation between $h_r = ba$ and h_q,

$$ab + pq = ed + op; \quad \text{or, } h_r + b = h_q + l; \quad \therefore h_r = h_q + l - b.$$

Put this value of h_r in the above expressions (1. and 2.), and we have generally for the co-efficients of rectangular orifices,

$$b. \quad k'' = k'\left\{(m+\tfrac{1}{2})n - 1 + \frac{1}{12[(m+\frac{1}{2})n-1]}\right\}^{\frac{1}{2}} \left\{(m+1)n - \tfrac{1}{2} + \frac{1}{12[(m+1)n-\frac{1}{2}]}\right\}^{-\frac{1}{2}}$$

Where $ml = H$, the altitude of pressure above the upper edges of the square and rectangle, and $n = \frac{l}{b}$ expresses the proportion of the base to the height. For $n = 2$ the base is double, for $n = 4$ four times as great, as the height, &c. In the following table the co-efficients for six different rectangular orifices, are given by computation from equation b.

Table IV.

Altitude of Pressure $m = \frac{H}{l}$.	Co-efficient k''.					
	$n = 2.$	$n = 4.$	$n = 6.$	$n = 8.$	$n = 10.$	$n = 20.$
0	·6687	·6964	·7034	·7066	·7083	·7117
1	·6352	·6513	·6560	·6583	·6597	·6623
2	·6255	·6369	·6404	·6421	·6430	·6451
3	·6207	·6294	·6321	·6335	·6343	·6359
4	·6178	·6249	·6272	·6283	·6289	·6303
5	·6159	·6219	·6238	·6247	·6253	·6266
6	·6145	·6197	·6214	·6222	·6227	·6237
7	·6135	·6180	·6196	·6203	·6207	·6216
8	·6127	·6168	·6181	·6187	·6191	·6199
9	·6121	·6157	·6169	·6175	·6179	·6186
10	·6116	·6149	·6160	·6165	·6169	·6175
20	·6091	·6109	·6115	·6117	·6119	·6123
30	·6082	·6094	·6098	·6100	·6102	·6104
40	·6078	·6087	·6090	·6092	·6092	·6094
50	·6075	6082	·6085	·6086	·6087	·6088
60	·6073	·6079	·6082	·6083	·6083	·6084
70	·6072	·6077	·6079	·6080	·6080	·6082
80	·6071	·6076	·6077	·6078	·6078	·6079
90	·6070	·6074	·6076	·6076	·6077	·6078
100	·6070	·6073	·6075	·6075	·6077	·6076
200	·6067	·6069	·6069	·6070	·6070	·6070
1000	·6064	·6065	·6065	·6065	·6065	·6065
⋮	⋮	⋮	⋮	⋮	⋮	⋮
·	·6064	·6064	·6064	·6064	·6064	·6064

It must here be remarked that l signifies the great, and b the small, side of the rectangle. When also the smaller side is horizontal, l will be the greater vertical.

In computing the quantity of discharge from rectangular apertures, distinction must be made between greater and less altitudes of pressure, of which the limits must never be such that the sinking of the level may have considerable influence. For the square, we have designated these limits by a value of $m = 5$, which corresponds to the altitude of pressure $H = 5l$. For rectangular orifices we find the limits by the altitude $H = 4b + l$, which expression for $b = l$ gives the same as before. As $m = \frac{H}{l} = \frac{4b + l}{l}$, when $n = \frac{l}{b}$ and b is the height of the orifice, $m = \frac{4 + n}{n}$. For the corresponding values of m and n, it is seen by the Table IV. that the co-efficients for smaller altitudes are, as in the case of the square orifices, invariable. For greater altitudes the co-efficients vary, and are found by Table IV. for the ratios $m = \frac{H}{l}$ and $n = \frac{l}{b}$.

The general equation for computing the quantity of discharge by rectangular orifices is by (§ 12, h),

$$c. \qquad Q = k'' \tfrac{2}{3} \sqrt{(4g)} \,.\, l\left\{\left[\tfrac{1}{2}(H + H'') + b\right]^{\frac{3}{2}} - \left[\tfrac{1}{2}(H + H'')\right]^{\frac{3}{2}}\right\}.$$

This expression applies for all altitudes of pressure, and requires only the value of the co-efficient, which, as we have just said, varies for greater altitudes, and remains constant between the limits $m = 0$ and $m = \frac{4 + n}{n}$. Put in the last expression for m, $n = 2$; then $m = 3$; for $n = 6\frac{2}{3}$, $m = 1{\cdot}6$; for $n = 10$, $m = 1{\cdot}4$; &c. For these different values Table IV. gives the respective co-efficients $(k'') = {\cdot}6207$; ${\cdot}6369$; ${\cdot}6460$; 6530. By the value of m, we have the altitude $H = ml$ in the measure by which l is measured. For instance, if $l = {\cdot}2$ metr. and $m = 3$, $H = {\cdot}6$ metr.

In the following table the experiments which Poncelet has given in his work (Tables V. VI. VII. VIII. and IX.), are collected and compared with the above equation (c).

Experiments of Poncelet and Lesbros with rectangular orifices of equal horizontal base l, but of different heights b. l was throughout = ·2 metr.

Number of Experiments.	Altitude of Pressure above the upper edges, before sinking of the level, H.	Altitude of Pressure above the upper edges, after sinking of the level, H″.	Ratio $m = \frac{H'}{l}$.	Coefficients computed by Table IV. k''.	Quantity of Discharge, by experiment	Quantity of Discharge, by theory.	Differences.
I. *Orifice of* 10 *centimetr. height* $= b$; $n = \frac{l}{b} = 2$.							
	Metr.	Metr.					
2	1·5054	1·5053	7·527	·6131	67·510	67·730	−·220
2	·9572	·9571	4·786	·6163	54·691	54·784	−·093
8	·4318	·4315	..	·6207	37·951	38·142	−·191
2	·0640	·0622	..	..	18·185	18·335	−·150
2	·0180	·0025	..	..	13·174	12·715	+·359
II. *Orifice of* 5 *centimetr. height*; $n = 4$.							
1	1·6651	1·66506	8·325	·6164	35·596	35·493	+·103
1	1·6650	1·66496	8·325	·6164	35·533	35·491	+·042
1	1·6646	1·66456	8·328	·6164	35·530	35·479	+·051
1	1·6614	1·66136	8·307	·6165	35·536	35·457	+·077
2	1·0558	1·05574	5·279	·6213	28·780	28·608	+·172
6	·4520	·4519	2·260	·6349	19·214	19·418	−·204
6	·1875	·1870	..	·6369	12·867	12·989	−·122
3	·0808	·0788	..	..	9·058	9·110	−·052
3	·0216	·0186	..	..	5·897	5·909	−·012
2	·0113	·0060	..	..	5·138	5·040	+·098
III. *Orifice of* 3 *centimetr. height*: $n = 6\frac{2}{3}$.							
2	1·3660	1·36596	6·830	·6200	19·451	19·363	+·088
2	1·0790	1·07894	5.395	·6230	17·443	17·316	+·127
2	·4615	·4614	2·307	·6379	11·582	11·701	−·119
2	·4501	·4500	2·250	·6385	11·416	11·572	−·156
2	·1925	·1912	..	·6460	7·658	7·815	−·157
4	·0417	·0393	..	..	4·045	4·032	+·013
IV. *Orifice of* 2 *centimetr. height*; $n = 10$.							
1	1·3902	1·3901	6 951	·6208	13·023	13·243	−·210
1	1·3641	1·3640	6·820	·6211	12·985	12·898	+·087
1	1·3425	1·3424	6·712	·6218	12·866	12·789	+·077
3	·9752	·97507	4·875	·6257	11·140	11·003	+·137
2	·3820	·3819	1·910	·6445	7·127	7·148	−·021
2	·1014	·1008	..	·6580	3·871	3·851	+·020
2	·0103	·0060	..	..	1·667	1·538	+·129
V. *Orifice of* 2 *centimetr. height*; $n = 20$.							
1	1·3970	1·39697	6·985	·6216	6·507	6·520	−·013
2	1·3213	1·32126	6·606	·6229	6·316	6·355	−·039
2	·9879	·98785	4·939	·6266	5·562	5·529	+·033
3	·4929	·49280	2·464	·6409	4·017	4·006	+·011
2	·1900	·18975	..	·6589	2·536	2·557	−·021
4	·0540	·05264	..	..	1·454	1·409	+·045
3	·0124	·00961	..	..	·813	·735	+·078

The level in reservoir before sinking was 3·5 metr. above the orifice.

As the measurement of the level before sinking may sometimes be difficult, we may in ordinary cases apply the equation (2) § 11, with sufficient accuracy in such a manner, that the altitude of pressure H" of the level after sinking may appear in the formula. We have then

$$Q = k''bl\sqrt{\left(4g(H''+\tfrac{1}{2}b)\right)}.$$

The co-efficient k'' will be obtained from Table IV. for the ratios $m = \frac{H''}{l}$ and $n = \frac{l}{b}$.

14.

Rectangular Orifices open on their upper Sides.

By equation (d) § 12,

$$a. \qquad k' = \frac{kf_0V_0}{f_qV_q} = \cdot 6064\sqrt{\frac{H_0}{H_q}}.$$

It is found in the same way as for h_0 and h_q; *i.e.* when the altitudes of pressure above the upper edges of circular and square orifices were zero, that for the centre of pressure

$$b. \qquad H_0 = r + \frac{r^2}{4r} = l - r + 2r - l + \frac{r^2}{4(l-r+2r-l)}.$$

$$c. \qquad H_q = \tfrac{1}{2}l + \tfrac{1}{8}l = \tfrac{5}{8}l. \qquad \text{Consequently,}$$

$$d. \qquad H_0 = \frac{3}{2l}\left\{l - r + 2r - l + \frac{r^2}{4(l-r+2r-l)}\right\}.$$

$2r-l$ is the difference of the height of the two orifices, or the difference of the depths of water when it reaches to the upper edges of the orifices. Let, therefore, the upper edges of both orifices be in one plane. Then the difference in respect to the altitude of pressure $= 0$; consequently, $2r - l = 0$, and we have when both orifices are full,

$$e. \qquad \frac{H_0}{H_q} = \frac{3}{2l}\left\{l - r + \frac{r^2}{4(l-r)}\right\}.$$

Let now for the assigned position of the orifices the water depth sink to l in both. The depth of water in the square orifice is then zero; in the circular orifice, on the contrary, it is still $= 2r - l$. Put, therefore, the value of equation (e) in (a), and we have the co-efficient $k''' = k'$ (in Table I. for $m = 0$) when the outlet is full, or for a depth of water l in the square orifice. Put, on the contrary, the value of equation (d) in (a), and we have the co-efficient k''' for a water depth 0 in the orifice. For all remaining depths, consequently, the values of the co-efficients lie between these limits, and their computation is only arrived at by giving the expression $2r-l$ in equation (d) in such a form that for a water-depth l in the orifice it may be zero, and when the water-depth is zero may have its full value. Let the variable water-depth between the limits 0 and l be designated generally by h; then the function $(2r-l)\left(1 - \frac{h}{l}\right)$ satisfies the conditions; h, however, must never exceed l. When $h = l =$ the breadth of the orifice, this expression is zero, as required; and when $h = 0$, the expression $= 2r - l$. Put therefore, as before, $\frac{l}{h} = n$, then $1 - \frac{h}{l} = 1 - \frac{1}{n}$. Multiply, therefore, $2r - l$ in (d) by this factor, and put $\frac{H_0}{H_q}$ in equation (a); and we have, when for r its value $= \frac{l}{\sqrt{\pi}}$ is written, the general expression for rectangular orifices open on their upper sides, for altitudes of pressure equal to or less than the breadth of the orifice, as follows:—

$$f. \qquad k''' = \cdot 6064\sqrt{\tfrac{3}{2}}\left\{1 - \frac{1}{\sqrt{\pi}} + \left(\frac{2}{\sqrt{\pi}} - 1\right)\left(1 - \frac{1}{n}\right) + \left(4\left[1 - \frac{1}{\sqrt{\pi}} + \left(\frac{2}{\sqrt{\pi}} - 1\right)\left(1 - \frac{1}{n}\right)\right]\right)^{-1}\right\}^{\frac{1}{2}}.$$

$$g. \qquad = \cdot 7427\left\{\cdot 43518 + \cdot 12838\left(1 - \frac{1}{n}\right) + \left(4\pi\left[\cdot 43518 + \cdot 12838\left(1 - \frac{1}{n}\right)\right]\right)^{-1}\right\}^{\frac{1}{2}}.$$

The co-efficients k'' are computed by these equations for different values of $\frac{l}{h} = n$, and given in the following table.

Table V.

Ratio n.	Co-efficient k'''.	Ratio n.	Co-efficient k'''.
1	·5836	3	·6096
1·1	·5871	4	·6130
1·2	·5899	5	·6151
1·3	·5923	6	·6163
1·4	·5944	7	·6175
1·5	·5962	8	·6182
1·6	·5979	9	·6188
1·7	·5993	10	·6193
1·8	·6006	12	·6200
1·9	·6018	..	..
2·0	·6028	∞	·6275

[The smallest co-efficient occurs when the water-depth is equal to the breadth of the orifice. When the water-depth is greater than the breadth of the orifice, $\frac{h}{l}$ must be put equal to n.]

The computation of the quantity of discharge by a rectangular orifice, where the base is greater than the height, can be effected by equation (e) § 11, when for b is put the value h here corresponding and the correct co-efficients: we have then

$$h. \qquad Q = \tfrac{2}{3}k'''hl\sqrt{(4gh)}.$$

The co-efficient k''' will be either computed by equation (g), or given by Table V. above for $n = \frac{l}{h}$.

The sinking of the level in the reservoir which takes place in and about the orifice, has not hitherto been considered; h, therefore, always refers to the unsunken level.

On the hypothesis that the sinking of the surface is proportional to the velocities—that is, to the square of the depth of water, we have

$$\sqrt{h'} : \sqrt{h} = h' - h'' : h - h'';$$

and when all the quantities are expressed in parts of the base l,

$$\sqrt{\frac{h'}{l}} : \sqrt{\frac{h}{l}} = \frac{h'-h''}{l} : \frac{h-h''}{l}.$$

Consequently, when the sinking of the level is found by experiment for $h' = l$, it may be computed thus for all other depths.

In the first experiment in the following table $h' = \cdot 2079$; $l = \cdot 2$; $h' - h'' = \cdot 0167$. Put this value in the above proportion, and take $\frac{\cdot 2079}{\cdot 2} = 1$, which is approximately correct, and we have

$$1 : \sqrt{\frac{h}{l}} = \cdot 0835 : \frac{h-h''}{l};$$

and hence it follows that the sinking of the level for the water-depth h is

$$i. \qquad h - h'' = \cdot 0835\sqrt{(hl)}.$$

This expression is valid of course only for the value of h, nearly equal to or less than l, and requires moreover that the water in the reservoir be at rest and have not already acquired a considerable velocity.

Table VI.

Comparison of the experiments of Poncelet with the foregoing Formula.

Water depth above the lower edge		Experiment.			Computation		Value of n.
of the level before sinking, h.	of the level after sinking, h''	Quantity of Discharge	Co-efficient, $\frac{2}{3}k'''$	Sinking of level, $h-h''$.	Co-efficient by equation g $\frac{2}{3}k'''$	Sinking by equation i, $h-h''$.	
Metr.	Metr.	Liter.		Metr.			
·2079	·1912	32·648	·3888	·0167	·3900	·0167	1·0895*
·1631	·1470	22·329	·3930	·0153	·3933	·0150	1·2256
·1029	·0909	11·528	·3943	·0120	·4012	·0120	1·9436
·0605	·0514	5·263	·4003	·0091	·4071	·0092	3·3058
·0446	·0368	3·342	·4053	·0078	·4093	·0079	4·4842
·0235	·0176	1·324	·4149	·0059	·4125	·0057	9·0213

* Here h is greater than l, and therefore by the note to Table V., $\frac{h}{l}$ must be put $= n$.

15.

Different Forms of the Stream of Water.

The contracting force by § 7 is proportional to the diameter of the orifice. Hence it follows that the contraction in a square orifice

(A) is least in the sections *kh* and *fi*, and greatest in the sections *ae* and *db*. As the contraction may be considered as a force acting perpendicularly to the axis of the stream, it follows that the particles of water in *a*, *b*, *e*, *d*, are moved by a greater force, and more nearly approach the centre than the particles *f*, *h*, *i*, *k*, on which smaller force acts; these must therefore be deflected from the centre to a certain point while the others approach the centre. Hence arise by degrees different forms of the column, as Poncelet and others have described, and as the section is represented in fig. (B). When the points *f*, *h*, *i*, *k*, have extended to their maximum, they again approach the centre; and when, finally, these recurring undulations are gradually destroyed, the column approaches the circular form (C), when the acceleration of gravity and the resistance of the air separate the particles of water, and render the precise form indeterminable.

Fig. 1

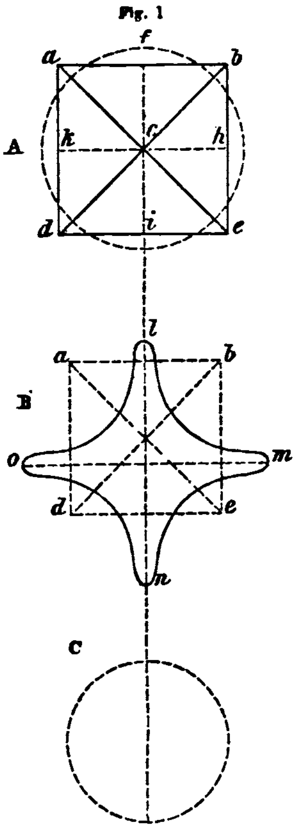
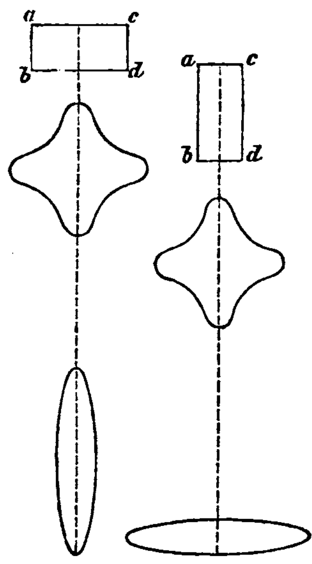


Fig. 2. Fig. 3.



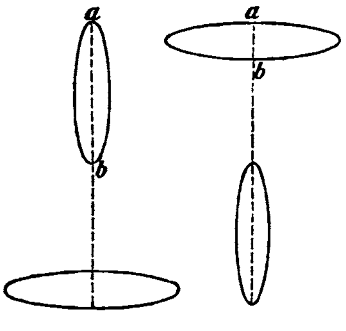


Fig. 4. Fig. 5.

For similar reasons, the column from a rectangular orifice of which the greatest side is horizontal, at different distances from the orifice will have the form of section represented in fig. 2. When the greater side is vertical, the sections are as in fig. 3. The section for an elliptical orifice will also be elliptical, as represented in figs. 4 and 5. These forms are given in the experiments of Weisbach.*

Berlin, August 1846.

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* 'Experiments upon the Discharge of Water,' &c. Versuche über der Aus fluss des Wassers durch Schreber, Hahue, Klappen und Ventile. Leipsig, 1842.

Substitute for the Crank.—Professor Frazer lately exhibited at the Franklin Institute, a model of a contrivance by Mr. G. W. Risdon, intended as a substitute for the crank in converting rectilinear into rotary motion. The model consisted of two cylinders, the pistons of which were connected by a cross-head, to which were attached two vertical racks, passing one on each side of the first axis of the machinery, upon which is placed a toothed semicircle, so adjusted that during the descent of the pistons it is driven by one rack, and during the ascent by the other; the circular motion is thus continually preserved. A shifting catch at one extemity of the toothed segment allows the motion to be reversed with rapidity and ease.

REVIEWS.

The First Three Books of Euclid's 'Elements of Geometry,' from the text of Dr. Robert Simson, together with various useful Theorems and Problems, as Geometrical Exercises on each Book. By Thomas Tate, &c. &c. &c. London: Longmans, 1849. 12mo.

Mr. Tate is a genuine Proteus! It was only *last year* that Mr. Tate most heroically denounced the 'Elements' of Euclid, as altogether unfitted for the purposes of education. He *then* spoke of the work as, the "artificial verbiage of a technical logic"—as, full of the "tedious verbiage of rigorous demonstration"—as, having "defects as an initiatory system too apparent to admit of even an apology." These statements were, of course, believed by Mr. Tate true *then:* but why has one short year made them false *now?* Is scientific truth so mutable as this implies it to be? If it be not, why is it that Mr. Tate comes forward now with an edition of that very book which he last year consigned to the "tomb of the Capulets"? We should at least have expected, were it only for the sake of his reputation, that he would have offered some kind of apology for this strange inconsistency; either by attempting to explain away the harsh language he had applied to Euclid's work; by a candid acknowledgment of having become more enlightened on the merits of that book; or, at least, to show that in his present undertaking nothing of mercantile purpose was the moving cause. Mr. Tate, however, can "blow hot and cold," according as his hands are too cold or his broth too hot, with sufficient *nonchalance* to astonish the Educational satyrs of Battersea and the Committee of Council—to say nothing of those still more plastic satyrs, "the schoolmasters who may be desirous of obtaining a *Government certificate.*"

This last quotation is from Mr. Tate's new preface; but we will give that manifesto entire, as it is but a single sentence:—

> "This edition of Euclid has been published in a cheap form, with the hope that it may tend to advance the mathematical education of this country, and with an especial reference to the instruction of schoolmasters who may be desirous of obtaining a Government certificate."

"Least said—soonest mended." Mr. Tate has left off writing dissertational prefaces, which in a man whose opinions on science vary with the development of the understanding of the Committee of Council, is, to say the least, very prudent. He, however, adopted this "canny" course too late: his preface to the 'Principles of Geometry' should never have been written—or at least never published. His present book would have come before the world with a better grace, did it not always remind us of the menial, time-serving, and purpose-serving spirit in which he so evidently writes. It is utterly impossible that Mr. Tate's *real* opinions on these subjects can have honestly veered round to the opposite point of the compass since last year. He must think, in the main, as he thought then; and we cannot but ask how any man, to serve a temporary purpose, can become accessory to the enforcement of a system of education diametrically opposed to his own honest convictions? The "Sir Archy Mac Sycophants" may enforce constant "boo-ing to the great mon"; but it is very degrading to the man of science to "boo" his scientific convictions to the caprices of an official Board—of a Board, too, which from its composition must be totally incompetent to form a trustworthy opinion upon any subject connected with the *practice* of popular education. Indeed, it appears that the introduction of anything having the name of Euclid attached to it, into the Council's list of books, was rather in compliance with the urgent representations of the press, than from any conviction on the minds of the Committee that Euclid was the only proper work for the purpose. What should we say of the physician or the divine who wrote books on medicine or theology in subservience to the views entertained by a medical or theological Committee of the Privy Council?—condemning a nostrum or a dogma last year with the severest vituperations, and this year coming forward with a patent to vend the self-same nostrum, and to profit by the sole right of preaching the self-same dogma? The physician would be branded as a quack and a charlatan—the divine as a hypocrite and impostor. Will Mr. Tate tell us wherein his case differs from these suppositious ones?

Short as the preface to Mr. Tate's Euclid is, he could not help compromising himself, in stating that the *cause* of his publishing it "in a cheap form" was "the *hope that it may tend to advance the mathematical education of this country.*" The "mathematical education of this country" can be "advanced" by a book which has so recently been described by Mr. Tate as "a highly artificial system, which can only be read, thoroughly, by a person who is already a mathematician, and who can enter into its metaphysical subtilties and operose demonstrations"! Who can fail to see the gross inconsistency of the proposal to "advance the mathematical education of the country" by means of such a book as Mr. Tate describes Euclid to be?—but perhaps the "cheapness" of this edition removed all other defects from it? Whatever be the provocative to this publication, it would be calling Mr. Tate a complete noodle to suppose that the real one is that which he professes in the preface. What it is, he knows himself:—and it is not difficult for others to conjecture.

A word or two here on the principle adopted by the Committee of Council, in respect to their dealings with authors and publishers. Instead of asking Parliament for an adequate sum of money to purchase, at a remunerating price, the works they require for their operations, they (with sham economy) "beat down" the author or publisher in his prices; so as to make every transaction a *certain pecuniary loss* to him with whom they thus "chaffer" about the odd tenth-of-a-farthing per copy. Had Napoleon lived now, and seen the manner in which some of our Public Boards are conducted, he would have improved his description by calling us a "nation of shopkeepers with a government of pedlars."

This is not all. It is well known that books can be sold the cheaper as the sale is more rapid: for then, and only then, can large editions be printed from the same types. Elementary books are always printed in large numbers at once; for if the sale will not be rapid enough to justify this, the publication becomes "a dead loss." The money lying dead in paper, the expenses of warehousing, commission, and other business items, absorb more of the income from the book than is covered by the nominal profit upon the publication. If, then, the Committee of Council would engage to take a certain number of copies, to receive them and pay for them at once upon their being printed, some little *amende* would be made for the hard terms they enforce. But no—they will only take them as they want them: some works it may be (especially such as the Committee really patronise) by the hundred; some others (those they only *permit* to be on their "list" for the sake of public decency) by the dozen, the half-dozen, and we have heard, by the single copy at a time!

This is the way in which a Board of the Privy Council "encourages education"!—namely, by devising every obstacle to its progress, and rigidly *discouraging the production of the books necessary for educating well.* Men of eminence and ability in science and literature are sure to keep aloof from such a Board as that of Whitehall; and, except in very rare cases, the competition must be left to those who are scrambling for a little notoriety, or possibly for bread and existence. As the Committee sow, so they reap: they pay "beggarly prices," and get the articles at their true worth.

The effect of this system of cheapening books and brow-beating authors (as though they were "cheating-hucksters"), is very pernicious as far as education is concerned. The best teacher requires a good text-book, and the want of it increases his labours ten-fold: and even the worst will do something, if he only keep his pupils steadily at work from a good one. The Government, however, by its treatment of authors, and the mode which it adopts of bribing schools and schoolmasters by the cheapness of certain books which it vends to them, has decided that the best books shall not be used. The public money is virtually employed in the arrest, instead of the promotion, of education: it is a scheme worthy of a Rodin, or of the founder of his order, the far-famed Loyola himself.

We would here offer one or two remarks upon the tendency of the "centralising system" of education. It had its origin under the most arbitrary governments of the continent, and is still employed by them in enslaving the popular mind. It has been said that "a people can only be governed by fraud or by force;" and that since an onward tendency has been given to the human mind, the only chance of governing safely and discreetly is for the government to take charge of the general education of the people. A ukase of the Czar has lately limited even the number as well as the quality of the students in his universities; and though this may be somewhat peculiar, yet the subjects of instruction are very rigorously limited in many of the continental states. The professors and teachers, too, are appointed and partly paid by these governments; so that an effective control is kept over the simplest details of popular instruction; whilst it is sufficiently well known what care is taken to prevent the circulation of "improper books." Every state has its "index," as well as the Vatican. Yet the last two years have shown to all the world (kings, emperors, and statesmen excepted) the inefficiency of such contrivances for creating a docile and obedient populace. Russia was not ripe: but in all other states, the convulsions have been more severe and the contests more sanguinary, in the direct ratio of the rigour with which popular education was supervised by the respective governments. This should be a warning; and the comparative non-interference on the part of the government, in the United States, in England, and in Belgium, has been rewarded with internal peace, in proportion to the degree of that non-interference. This, too, should be a warning to us.

We are bound to say that the principles and profession of the English Government on this matter, have our entire concurrence. Indeed, the supervision of education was altogether *forced* upon the Government, by incessant clamour, out of the House and in the House: for if the Minister was compelled to bring in a bill for a money grant in aid of general education, he was obliged as a consequence, to control its dispensation and supervise its use. So far at least the Minister is free from all blame.

However, the task was an ungracious one,—involving responsibilities rather than conferring power, and creating much official trouble without the possibility of giving general satisfaction. Faction and sectarian jealousies are too intimately mixed up with the question of education in this country, to render an Educational Board much unlike a committee of bear-wards or railway directors. It has certainly so proved itself—at least as at present constituted; and this is the more to be regretted from its being the result of religious intolerance and of priestly assumption of an educational monopoly. Thus it ever is *where there is money to be dispensed and power to be exercised.* It is, indeed, with deep pain that we have witnessed the unworthy scenes that have been exhibited in the Broad Sanctuary during the last two or three years. The hold of the Church upon the affections of the people depends so much upon the bearing of its priesthood, that we are sure the clamour and rapacity, and above all the claims of vested *privilege*, which have marked the proceedings of that assembly, are little calculated to serve either the interests of the Church, or even to advance the personal interests of the conclave.

The Government has, in one respect, done well—it has ignored all claims for monopoly, as regards religious profession. The churchman and the dissenter stand alike; and the same conditions are imposed upon all. On the other hand, except the dispensation of money, or the supply of certain books at reduced prices, or (as should be added) the appointment of salaried "Inspectors" of those schools that receive pecuniary assistance, the Government has managed to take as little trouble as could well be taken;—and a to responsibility, their do-nothing system relieves them in a great degree from charges of direct wrong-doing. Of sins committed, few can be laid at the door of the Minister: but of implied duties omitted, alas, how many!

The greater part of the money voted by Parliament is expended in payment of the official persons employed to work the educational machine—the members of the Committee, its clerks, and the School Inspectors. No doubt, too, if the grant were doubled or tripled, these items would expand themselves in a still greater ratio. But even if they did not, it cannot be denied that under its present conditions, this Committee of Education has degenerated into little more than a comfortable snuggery for a few individuals, and a pleasant system of gratuitous locomotion for a few others. We put it under the best view in putting it thus: but even then, does not the educational philanthropist call upon us to "buy too dear a whistle"? The results are incommensurate with the cost of the machinery; and the best interests of the country would be consulted by an entire dissolution of the Committee and the entire cessation of the grant. The whole system is unsuitable to the social relations of parties in this country.

Still, we have no expectation that any attempt of this kind will be made, either by the Government *in esse* or by the Minister *in posse.* Education is the great political stalking-horse of the day; and his paces are such that every charlatan can mount him with perfect security. Twaddle, Rhodomontade, Quackery, and Self-Conceit can always keep their seats, and goad the poor beast at their own will—and to the execution, too, of any and every purpose they may think it their interest to entertain. No dissolution, then, is in the remotest degree, probable.

What then can be done?—and, which is equally important, will what can be done, be *really done?*

In the first place, then, let a committee be appointed to *fix upon the books most suitable for the purposes of education.* This ought not to be composed of any one class of persons exclusively,—except that they should all be men of educational experience, of ten years at least; and that not only should their knowledge, but their professional experience too, include a great deal more elementary subjects than Greek and Latin, Dialectics and Analytical Mathematics; neither wholly University men, nor wholly non-Academic. Let their decision be final, say for five years; and at the same time be confined to a *single work* on each subject. Then, let justice be done to the *authors* of those works, by the Government purchasing the copies it expects to require *at a fair market price*, and *by taking those copies and paying for them at once.* At present, whether in ignorance, or under some more culpable motive, the Council seems to treat an edition of a book like a corfe of coals, or a barrel of train oil, as things to be supplied by contract,—chosen by the lowest tender, and to be supplied at certain stated times, just as they will probably be wanted. They forget, or at least affect not to know, that copies of books are only to be multiplied *at once*, except at enormous additional expense; and that the only ground on which low prices and remuneration can be combined, is by *immediate sale.* Why is the writer of a good book (and good elementary writing is more rare in all ages of the world than any other class of good writing) to be sent into the *Gazette* for his labours—and sent, too, by a Government Board specially appointed for the encouragement and aid of learning? Yet such is the *tendency* of the plans adopted by Dr. Shuttleworth, if it have not already been the actual effect. And this is called "aiding education"! It makes one blush—aye, till the blue asphyxia takes the place of honest red!

Nothing short of such a committee will satisfy the public—nothing, indeed, should. An honest compliance with its decisions should replace the present system of underling influence in the selection of books, and in the special recommendation of particular ones from the list which is issued by the Committee. On this last phrase, which expresses a wide-spread suspicion, we have only to remark that—if an ungarbled report of the prices at which the Committee buys and sells be published, together with liberty granted to the public to inspect all correspondence about the choice and supply of these books; and if we do not find that the suspicion is justified by these documents, we will gladly withdraw the implied censure. We should be amongst the foremost to award the praise of having done well, could we conscientiously believe that such praise was deserved.

If, on the contrary, such a plan be not adopted, let all works be alike thrown open, so that whichever of them be deemed by the local committee of any school the best adapted for their own purpose, be supplied with them by the Government, at a certain but fixed per-centage below the price of publication. The Government might without censure, perhaps, demand the trade-advantage; but not a single sous more than any other dealer is regularly allowed. This, indeed, diminishes the author's and publisher's income sufficiently—as too many of us know too well. What further reduction the Government may make by the aid of the annual grant, should only be made from these wholesale prices; and not upon the sixty per cent. now enforced (upon some books we believe even more) by the Committee, upon authors and publishers.

But why should even this trouble, and its multiplied costs, be incurred? It certainly furnishes a few more opportunities for patronage, by the appointment of *employées* in managing the details of the business. Would it not be more simple, economical, and consistent, to allow upon the book-bill of every school that complied with the conditions for the grant, a certain per centage in part-payment of the bill? The accuracy and honesty of such bills could be easily guarded by sufficient tests; and even if not, as a false attestation is a misdemeanour at law, we apprehend there would be little risk of imposition.

But to return to Mr. Tate's book:—but here we are again forced back upon the Committee of Council. It appears from the sentence quoted as comprising the preface, that any schoolmaster who is master of the *first three books of Euclid, may obtain a "Government certificate" of his competency as a teacher.* What an exalted idea of the present race of schoolmasters her Majesty's Ministers must have formed! However, the evil will work its own cure; and the ridicule attached to a Government diploma, gained on such grounds as these, will be as great amongst the schoolmasters, as that of a Scotch LL.D. is amongst literary and scientific men.

What Mr. Tate calls *his* "edition" comprises only just *the half of all modern editions*—viz. the first three books. The Privy Council in its superlative wisdom has decreed that these are sufficient, and that the next three are merely curious redundancies which ought to be lopped off: and Mr. Tate, like a well-bred spaniel watching its master's eye, is eager to perform the "fetch-and-carry" orders therein expressed. That the fifth book should transcend the comprehension of a minister, or a minister's "managing master," we can well understand; and the sixth has too intimate a relation with the fifth, to be very intelligible without its fellow: but that the fourth, which is the only book that takes a formally *practical* character, should have been excluded, can only be accounted for by the assumption that the question as to the number of books to be required was decided by a throw of the dice, or some equally scientific criterion!

Perhaps some one of the "rising generation" of Pettys may enlighten their grandpapa, the Marquis; or some of Dr. Shuttleworth's Cambridge friends, sorry to see so *great* a man committing such strange blunders, remonstrate with him on the absurdities of his doings. In due time, the fourth book may get amongst the conditions for the "Government certificate;" and to save appearances, even the fifth and sixth may be inserted in the list, *though not enforced as a condition.* In these cases, Mr. Tate's eye will be on Dr. Shuttleworth's; and the signal being understood, Mr. Tate's edition will expand in the indicated ratio.

As Mr. Tate's edition is professedly printed verbatim from Simson's, this is no place for remark upon any of its details. A few pages of problems and theorems, mostly unsolved, constitute the whole of Mr. Tate's labours—with the exception of a treatise on 'Geometrical Analysis,' which occupies, with its illustration, *almost a whole page!* These "various useful theorems and problems" are so familiar to our eye (mere "stock-problems," the property of everybody), and the whole, either in the same or slightly-modified forms, have been so often given, that we wonder what peculiar merit belongs to Mr. Tate for their transfer from Mr. Potts's edition of Euclid into his own. To bring them together for the first time is very meritorious, for it costs an immense amount of disagreeable labour: but to mark a few of an already collected set for the use of the printer, involves so little labour, that if *fame* is to be thus obtained, fame ought to be as cheap as "blackberry tarts." Mr. Tate has earned *this* fame at least. But there yet remains the "analysis."

In a foot-note at p. 88, we find the following:—"Should the student fail in solving any of these problems by the ordinary synthetic method, let him employ the method of analysis given at p. 107." We have to ask whether the words *ordinary* and *synthetic* are to be understood as synonymous, and the phrase itself as a pleonasm? or whether we are to understand that there are more synthetic methods besides the *ordinary* one? We look in vain for an antecedent definition of synthesis, and the student would naturally go to Johnson to be enlightened—with what success we need not say. However, we proceed to the page referred to, viz. p. 107, and we begin by placing Mr. Tate's and Sir John Leslie's definitions of analysis in juxta-position.

TATE.	LESLIE.
Geometrical Analysis.	*Geometrical Analysis.*
In the method of analysis we assume the proposition advanced, and then proceed to trace the consequences which follow from this assumption, till we arrive at some known or admitted relation. The reverse of this process constitutes Synthesis or Composition, which is the method employed in the preceding pages. In the solution of geometrical problems of more than ordinary difficulty, it is necessary that we should adopt the method of analysis, in order to discover the different steps which must be pursued in the construction. "Analysis," observes an eminent geometer, "presents the medium of invention; while synthesis naturally directs the course of instruction."	Analysis is that procedure by which a proposition is traced up, through a chain of necessary dependence, to some known operation, or some admitted principle. It is alike applicable to the investigation of truth contemplated in a *theorem*, or to the discovery of the construction required for a *problem*. Analysis, as its name indeed imports, is thus a sort of inverted form of solution. Assuming the hypothesis advanced, it re-mounts, step by step, till it has reached a source already explored. The reverse of this process constitutes *Synthesis*, or *Composition*, which is the mode usually employed for explaining the elements of science. Analysis, therefore, presents the medium of invention, while synthesis naturally directs the course of instruction.

The wonderful originality of Mr. Tate will now be apparent enough: but the intelligibility of these very general modes of defining analysis, to any but an experienced analyst, will be more doubtful. What is said is not false: yet it is only vaguely true; and no one, we are confident, that attempted to form an idea of geometrical analysis from such definitions, could form a correct and definite, and still less a *working*, idea. In truth, there is no portion of geometry that requires so much careful instruction and amplified illustration to become intelligible, as the doctrine of geometrical analysis—not even the doctrine of ratio or the method of exhaustions. In this nearly all writers have alike failed. Brevity leads to obscurity—as Horace intimated long ago. Mr. Tate was not then very likely to succeed where so many have failed: but most writers (and Leslie amongst them) have made some atonement by furnishing an adequate number of examples, from which the *practice of the method* of analysis and its related synthesis *might be learnt.* Here, however, we are shuffled off with the analysis and synthesis *of one easy* problem; and the analysis of this consists *of a single step only.* Nor is the language and manner of this one analysis and synthesis so very precise as to preclude the possibility of misconception of the analytical principle. At any rate, this example is preposterous as a specimen of the method itself, or even as a *guide* for those wizards who "may be desirous of obtaining a Government certificate." Mr. Tate is insulting the *scientific* public, and hood-winking the *general* public, by such arrant trifling as this.

One word more about this work. The *student* who stops short at the third book might as well not begin Euclid at all, whatever might be the case with the aspirants for a Government diploma. He cannot get the remaining books of Euclid separately from these; and hence he is obliged to buy over again what Mr. Tate had sold him, in order to his getting what Mr. Tate professed to give him—an "edition of Euclid." This mode of imposing upon the poor youth of humble life who is desirous to study, by abstracting from his pocket his hard-earned shillings (all under the pretence of serving him too!) is very much like some of the benevolence which occasionally comes before the metropolitan police magistrates.

Differences of detail, indeed, there are; and, according to the trader's code of ethics, the difference of detail between an ambiguous transaction and a masterly piece of enterprise need not be very great. The Christian moralist may see more to condemn than to admire in such a code; but what matters this, when that code is framed by the great city lawgivers—the magnates who count the day's gains by hundreds, and sometimes by thousands? "Why not then allow Mr. Tate, in his small way of business, the privilege of other traders?" Aye—why, indeed? We do not wish to deprive him of it; but we ask consistency even in trade. We only object to his one day deluging the public mind with a subtle poison at a profit, in order that he may the next make a fortune by its antidote, or perhaps by a semi-antidote. In the case of physical poisons the law would step in; but public opinion can alone arrest a moral or intellectual pestilence. The press is the only tribunal before which such cases as these can be tried: and we believe that we "judge righteous judgment," in an unhesitating condemnation of the same man writing the two works in question; and still more so, of that man putting in any claims to a consistent scientific character. We consider him to have damaged the cause of science itself,—to have held geometry up to ridicule in public estimation, as a thing having one character last year, and another this,—as destroying public confidence, in the earnest enforcement of the value of science by its *sincere* cultivators,—and as placing reason on a par with mere sentiment, variable as the digestion, and uncertain as the megrims of the morrow. We yet hope that the public may be led, on forming its judgment of the sincerity of the convictions of scientific men, to select specimens to judge from, very much contrasted to that which Mr. Tate will afford them.

REPLY TO REVIEW OF 'ALGEBRA OF RATIOS.'

SIR—Having observed in the review of my 'Algebra of Ratios,' in your last number, a very serious misconception on some important points, I will, with your permission, offer a few remarks, principally by way of reference to certain portions of the work which the nature of the objections clearly shows have either escaped perusal, or been greatly misunderstood.

1st. It is said, that "Mr. Browning *assumes as an axiom* that when three terms of a proportion are fixed upon, *a fourth exists.* There is nothing in the details or the spirit of the ancient geometry analogous to this assumption. Still, we will not quarrel with the assumption, though we could wish the author had been able to dispense with it."

That this assumption has been dispensed with, a reference to the index will at once show; and on turning to the pages therein referred to, it will be seen that the mode of proof is as follows:—"If $m'B$ is a variable fraction of B increasing to the limit A, then $m'D$ is a variable fraction of D increasing *to some limit* C."—IX. *Art.* 1.

This limit is proved in I. *Art.* 2, to be "a quantity which has the same ratio to D which A has to B; and therefore when the ratio of A to B is given, and D is any quantity whatever, we thus prove the existence of *another quantity* C which has the same given ratio to D."

By means of these propositions, in the proof of which the whole difficulty lies, it is shown in I. *Art.* 52, that when three terms of a proportion are given, a fourth exists.

2ndly. It is objected "that the cases are very few in which *we can exhibit the arbitrary fractions* of any one of the quantities concerned."

This clearly is not required, and were it possible, would be of little use. It is only necessary that we should be able *to conceive the existence* of such fractions, *not to exhibit them in a numerical form;* and for all purposes of reasoning on the nature of ratio in general, this mental conception, with the use of general symbols to denote what we know to exist but cannot otherwise express, will be found sufficient.

3rdly. It is said, "His definition of proportion is tantamount to this: that if

$$A = \frac{y}{x} . B, \quad \text{then } C = \frac{y}{x} . D;$$

$$A > \frac{y}{x} . B, \quad \text{then } C > \frac{y}{x} . D;$$

$$A \angle \frac{y}{x} . B, \quad \text{then } C \angle \frac{y}{x} . D;$$

for all values of y and x expressible in finite terms. In this, if y and x be not numerical symbols, we apprehend that the term 'fraction' will be deemed inappropriate; and not only so, but that the definition itself is without distinct meaning. We have viewed them, then, as 'numerical symbols.' On the next page, however, they are deprived of their arithmetical character, and are directed to be understood as 'symbols of ratio' only. This seems to us to invalidate the definition itself; and we apprehend that, to render this consistent, a new definition of ratio which does not involve any *numerical considerations* whatever, ought to be given."

Here I am constrained to complain somewhat of unfairness (unintentional I am sure), in exhibiting my definition in a symbolical form very different from my own—which, for the most part, is verbally expressed—and then framing objections from the form which is thus introduced. I have no where said that *fractions and whole numbers* verbally expressed, as in my definition, are to be deprived of arithmetical meanings, and regarded as *ratios*; but that symbols which hitherto have been used to represent fractions and whole numbers, will, *with special exceptions*, be regarded as *symbols of ratio* in the sense previously defined.

The distinction between the arithmetical and the extended meanings of these symbols has, in all cases, been carefully observed. Thus, the symbol m is used in mB to denote an arithmetical multiple or fraction of B; but as a subscript symbol, it is used in B_m to denote the quantity whose ratio to B is m. This notation has been retained until, in the course of investigation, it could be shown that mB and B_m, having the same value, could allowably be interchanged. And in page 55, will be found this remark:—"Consistently with this, mB may in future be used to denote either a concrete number of which B is the unit, or a quantity whose ratio to B is m. The notation of *Art.* 3, which was adopted only *to avoid confusion with arithmetical symbols*, will therefore no longer be required."

The foregoing remarks will, I think, tend to show that the logical niceties which I am represented to have disregarded, were invariably present to my mind during the investigation of the subject, and have in reality been carefully observed in every portion of the work.

I am, &c.

HENRY B. BROWNING.

Stamford, October 20, 1849.

[We have inserted Mr. Browning's letter entire, although a large portion of it is taken up with quotations from our review of his book. Mr. Browning is of opinion that we have misrepresented his meaning; and we deemed it the best way to allow him to explain away, as he best could, the passages and steps of his processes to which we had expressed objections. We make this exception to our general rule (of not allowing our pages to be made the vehicle of reply from authors dissatisfied with our strictures,) entirely on account of the abstract character of the subject under discussion, and the almost insurmountable difficulty of expressing verbally the conceptions of the mind respecting it. We consider that Mr. Browning, under these circumstances, is entitled to that indulgence: but were we to open our pages to replies in general, we should find it necessary to only notice those works upon which we could bestow unqualified praise—for what author, but those fortunate few, would not otherwise deluge us with "reams of reply?"

1. Whether Mr. Browning's proof of the *existence* of the fourth proportional be, as he says it is, legitimately made out from the passages referred to, we shall not here stop to inquire. We apprehend the existence *in posse* of the fourth proportional has not been questioned—only the exhibition of it *in esse.* No one doubts the

possible existence of a line perpendicular to a given line, drawn through a given point; and much ingenious reasoning may be wasted in proving that possibility. Yet to make the mere possibility (nay, the very necessity) of such a line existing, a condition in the hypothesis of a theorem or a datum in a problem, would be contrary to the general practice of geometers. Euclid, at any rate, *actually finds this perpendicular before he makes the least use of it.* Mr. Browning does not even now profess to have placed his fourth proportional in the same category. What we stated is therefore not yet invalidated; and our objection retains all its force—even did we grant, which we are not prepared to do, that his proof of the possible existence of this fourth magnitude is free from paralogism.

2. This obviously stands or falls with the preceding, if viewed under one aspect—that of placing our *conceptions of things absolutely* (the fourth proportional, for instance,) in the same category with our *conceptions of the relations* of actual things to one another. The difference between these classes of "conceptions" is, philosophically, very great.

It would almost seem that Mr. Browning considers that *words are not symbols.* We are really unaware of any "mental conception" which *can be* expressed in "general symbols," and which *cannot be* expressed in a verbal form. We fear Mr Browning is a little confused in his views of the objects, and of mental influences and uses, of symbols.

3. We really cannot see the force of the objection made to the "symbolical form" in which we exhibited Mr. Browning's definition, so long as he is unable to affirm that one form of it is not essentially different from the principle of that definition—mostly "verbal," as he says. We intended no travestie of his views; but it does happen to place the question under an aspect very inconvenient for Mr. Browning to deal with. We still think that whoever reads his verbal definition with our symbolical expression of it, will not only acquit us of "unfairness," but be compelled to admit that a more accurate symbolical exhibition of it could not be devised.

Did we believe Mr. Browning to be capable of intentionally trifling with us, we should be disposed to suspect he intended to do so, in what he here says respecting "symbols of ratio." It is here that the inconvenience of our symbolical version of Mr. Browning's definition is felt by him. He says, in his letter, that "symbols which hitherto have been used to represent fractions and whole numbers, will be regarded as *symbols of ratio in the sense previously defined.*" Of these same symbols he says in his book, "these not being numerical symbols, but symbols of ratio, to which at present *arithmetical rules do not apply.*" If he deny that his definition involves *number*, what can the word "fraction" mean? If it be admitted to involve an arithmetical idea, how does he deprive the symbol of ratio of its arithmetical character? He must disentangle himself from this dilemma before we can proceed another step, and answer the question whether his definition be intended to be arithmetical or not. This was the ground of our former objection; and, for aught that Mr. Browning has shown, that objection still remains in all its force.—ED.]

THE LAWS OF FORM IN ARCHITECTURE AND ARCHITECTURAL DECORATION.

1. *Form and Sound—can their Beauty be dependent on the same Physical Laws? A Critical Inquiry dedicated to the President, Council, and Members of the Royal Scotch Society of Arts.* By THOMAS PURDIE. Edinburgh: A. & C. Black, 1849.
2. *An Impulse to Art; or Ancient Greek Practical Principles for Volutes and Lines of Beauty innumerable.* By JOSEPH JOPLING, Architect. London: Published by the Author, 1849.

Mr. D. R. Hay has praiseworthily devoted himself to the subject of decoration, and more particularly to the finding out and striking out of the great laws which govern it. His industry in the publication of many works, we have had occasion to praise, and likewise his spirit of research; but his latter works, although beginning with the most tempting promise, have been carried to a heighth of idealism and mysticism which has much detracted from their useful character. They have not, however, come before us, and although we were desirous of making some remarks on their obvious tendency to mislead the student, we have not till now had the opportunity. The development of the simple numerical law of colour, following in the steps of Field, was useful; but the ambition of the author has failed to keep him up in soaring higher. We must conclude that Mr. Hay did not adequately appreciate the result of his own labours, or he would not so have miscalculated his powers.

The application of the numbers 3, 5, and 8, to yellow, red, and blue, was good as a formula in mixing and placing colours, but the knowledge of it did not suffice to make a lad a colourist. The determination of three dominant sounds in music will not make a composer. Why, then, should Mr. Hay suppose that the elimination of three simple elements of form would make a designer? The three elementary colours result from light—by their synthesis they make the two modes of white and black. They combine together, and make secondaries and tertiaries. Mr. Hay's elementary forms do not admit of a similar synthesis and combinations. Indeed, no practical result could be expected from an inquiry so conducted.

We take a different ground from the writer of the 'Critical Inquiry,' and we therefore contend *à priori* that there can be no complete comparison between shape and sound, or shape and colour. Points of resemblance there may be, and must be, but identity there cannot be. The objects of sight, hearing, and taste are brought within the appreciation of the same nervous centre, but objects of colour, shape, sound, and taste are of different origin. Things seen have three modifications—shape, light-shade, colour. What have things heard, tasted, or smelt? Things touched have several modifications. Colours, as the elementary constituents of one object—light—have a greater degree of simplicity; but shapes are not the elementary constituents of one object: and even the researches of the crystallographer do not show that circles are generated from squares, or ellipses from triangles—the research is useless. Colour is the limited attribute of one class,—heat is a limited attribute,—sound is a limited attribute: but form is unlimited. Whatever the shades of difference, and they are slight, there is a oneness, a greater sameness, spreading through the works and schools of painting from all time, than there is of those of architecture. To quote loosely,—

> O! nimium fortunati, si sua nôrint bona;

how happy would architects be if they did but avail themselves of the resources of their art. The schools of architecture have great and essential differences,—how unlike are the Parthenon and the Alhambra, York Minster and a Teocalli! To compare the modifications of form with those of colour is truly *magna componere parvis*—a giant is matched with a dwarf, and the former is thereby dishonoured.

Because nature in simple things is simple, and because the capacity of man is limited, so is there a school of philosophy which toils to bring all things down to simplicity,—as if the attributes of nature were to be so limited. The universe is reduced to homogeneous atoms; man is developed from a zoophyte, a cryptogam, or a non-fossiliferous rock; the solar system is traced to circles and spheres; all nature is brought down to one socialist standard. These are various forms of humbug which figure in the garb of philosophy, and by the teaching of which art is more or less hurtfully affected.

To bound the field of artistic exertion is to bound the artist's powers: give him the ambition of a Phidias to reach even to heaven, and he will strive for godlike works; but the strength of a Sampson, while yoked in a mill-track, will only grind the same meal and bran. We therefore earnestly deplore those works which have the tendency of limiting the circumscriptions of art, and feel the greater interest in books, like those of Mr. Jopling, which teach the infinite variety of the resources of art. Mr. Jopling steadfastly contends that circles and ellipses are not the be-all and end-all of art, but that the number of beautiful curves is endless, and the mode of executing them easy.[*] It is evident he is no patron of the pseudo-geometrical decoration of the great hall of the Society of Arts.

Mr. Purdie was not able to listen calmly to Mr. Hay's papers on 'Form and Sound,' read before the Scotch Society of Arts, and he therefore claimed the right to review them at length in other papers before the Society; and this being demurred to, he has rushed into print. The metaphysics of the subject he has treated rather loosely, and left many points unelucidated; but he has contested, with great success, the practical application of Mr. Hay's doctrines.

Of late, strong testimonials have been given by men of high standing and pretensions, to Mr. Hay's scheme for mapping out the human figure; and if we believed what we read, we could hold no doubt of its entire success as a substitute for the study of anatomy. Painters of the present day are lazy enough as it is, and they may not be disinclined to avail themselves of a method which promises to revive Albert Durer's empirical proportions, and Sir

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[*] We learn that the Board of Trade, through the instrumentality of Mr. Stafford Northcote, have ordered several copies of the 'Impulse to Art,' for the Schools of Design.

Joshua's empirical flourishes of the compasses, to find out where a woman's breasts ought to be placed.

This would be a bad look-out enough; but besides applying his system to plum-puddings and the human face divine, Mr Hay has adapted it to the Parthenon and the Pantheon, and opened a royal road to architecture. It is under these circumstances we recommend Mr. Purdie's little work to our readers—first, because we think he ought to be encouraged for writing on architectural art, when so few are inclined to do so; but most because he has taken up a question which architects have very little considered, and are very little in the habit of considering—what is the foundation of beauty in art? Incidentally, Vitruvius comes under discussion, and students may read with some degree of interest Mr. Purdie's commentary on his text.

We should have liked well enough to have followed Mr. Purdie at some length, but our readers are not in the habit of pursuing metaphysical disquisitions, and would thank us little for our pains. We are obliged, therefore, to refer those zealous in these matters to Mr. Purdie himself. We must, however, give one caution—that Mr. Purdie seems to labour under rather warm feelings against Mr. Hay, and with the wish to arm himself with a tomahawk instead of a quill.

In concluding these remarks in deprecation of the "elementation" of form, we cannot help expressing our belief that a study of the laws of proportion, properly conducted, would lead to results very valuable to the practitioners of art.

THE SEWERS COMMISSION.

Our *Journal* is not so considerable, that we can claim for it the power of influencing the opinions of the public at large, or the decisions of a cabinet; but we may safely pride ourselves on possessing the confidence of the leading members of two intelligent professions, and thereby the means of taking some considerable part in the discussion of measures affecting their interests. Of ourselves we could do little, but in stimulating the professions watchfully to uphold their interests, we have set machinery in motion which has worked out a great result. All parties joined in decrying the old Commission of Sewers; its evil working could readily be seen, but all were not agreed as to the want to be set right. The old Commission has been swept away; but in setting-up a new one, the ministry has made a show of remedying that evil on which the professional interest and their organ were most urgent in their denunciations.

The old Commission wanted men of working knowledge and skill: they wasted their time in undertakings beyond their grasp, —and they did nothing, inasmuch as they did not grapple with the crying evils before them. The old Commission is dead,—"*Anno ætatis suæ*" may be written on its tomb: it may be set down how long it lasted, but there can be no words to show what it did. When death was stalking over the land, and the readiest help was wanted to stay it, the Commission, before they did anything, undertook a survey. When engineers and surveyors were to be had in numbers, and were, in good truth, starving for want of work, the Commission gave the Survey away to the soldiers, who ought to have been at work on the Ordnance Survey,—and to this day the corporals and privates have not sent in the survey. For the plans sent in for a general sewage, there was no Sewers Map, and the profession owe the one they had from the Commissioners to the private enterprise of Mr. Wyld, M.P., the geographer, who published his own survey, and compelled the Commissioners of Sewers to give him the levels.

The same mood has swayed throughout. The soaring mind of Mr. Chadwick was to give us lasting springs of health, so that London should never again sicken. What has been done?—The needful works have been stayed, and some paltry cleansing undertaken; and so far from the common health having been bettered, the common health has been hurt by the mistaken doings of the Commission. In the height of the cholera, they flushed sewers and emptied cesspools—thereby blasting the air by night and by day; and they poured into the Thames such a reeking flood of filth, as to make the river hurtful to those who travelled on it for health or for business, or who drank its polluted waters.

The Commissioners talked a great deal upon the subject of the wasted sewage, and of what they meant to do on that head: but all they did was to make trials of sewer-water,—whereas sewer-water is worth so little, that it cannot be borne beyond the neighbourhood of London; is only fit for grass-land; and as it cannot be laid on at all times of the year, must therefore be wasted or long-stored—thereby again raising the outlay.[*] Besides, if it be used for watering and manuring grass-lands in the vicinity of large towns, the evaporation would cause the atmosphere to be tainted, and infect the inhabitants with fever and all the attendant maladies of malaria.

On the old Commission there was no engineer, architect, or surveyor, though there were some royal engineers. Thus, the Commission was without working men, and thus slur was cast on the professions, on the pretence that their members might have an interest in the works. The true meaning was to thrust away men who would not be the followers or tools of Mr. Chadwick, and who might open their minds fairly and freely. Thus was a crying evil made, and it behoved the professions to clear themselves of the stigma which Mr. Chadwick attempted to cast on their value in the business of the Commission, and again on their skill in that of the Survey.

The ministry have sent the old Commissioners adrift, and have named new ones, and in so doing have called in Robert Stephenson, M.P., Philip Hardwick, Rendel, and Peto. So far as this is an acknowledgment of the wrong that has been done, and so far as it is acknowledgment of the rights of the professions, it is to be praised. Men of higher standing and of better feelings than those named, cannot be found; and so far as it rests with them, we have every ground for trust: but we warn the professions not to give way—to be wary and watchful—for the old leaven is still at work. As if for fear of the mischief to jobbing, which a few high-minded men might do if left to themselves, the civilians are muzzled by having several royal engineers set against them. What royal engineers have to do on the Metropolitan Commission of Sewers we cannot understand. Every opening in the Sewers Commission belongs as rightfully to the professions, as the Lunacy Commission does to the medical men, and the Law Commissions to the lawyers. This Commission is among the few public employments which the engineers have, and there can be no right in making it partake of the appearance of a military commission, which it now does by the number of Royal Engineers in the Commission.

We maintain that if eight professional men are to be on the Commission, they ought to be all civilians; and on all hands we think it unfair the civil engineers or architects should be overborne by a greater number of the military engineers, who have less weight and less standing as a profession. If the whole eight were taken from among the civilians, an evil would be stopped which has now arisen. The civilians now named are of that high standing, they cannot readily give their time to the working of the Commission—they are so busy it is not worth their while: they can only give their time to such business as is of greater weight. Not so with the military engineers, they can always be there; and it is, therefore, only a sham to talk of the new Commission being in the hands of working men. It is well enough that the civilians now named are government *employés*, and the fellows of Mr. Chadwick on the Board of Health; but having done the professions the honour of naming some of their head men, the other four may now be taken from men of less standing, but having the time to do the daily and weekly work of the Commission.

It does not seem to us by any means settled that Chadwickism is at an end in the new Commission, although Mr. Chadwick's name is not in it. The civilians cannot very well trouble him, as they are likely to be everywhere but at the Sewers Office; indeed, at St. Stephen's, the Britannia Bridge, Birkenhead, or Great Grimsby, or in any canal in Europe where their skill is wanted. The military engineers will be at their posts. The Woods and Forests and the Board of Health are always at hand to meddle, and Lord Carlisle and Mr. Chadwick will have the sway without bearing the brunt.

Above all things, the professions must not forget that, Commission or no Commission, their work is not at an end. To lay down sewage for the world of London, to heal the blighted streams, to bring in fresh water and fresh air, to supply the husbandman with the needful food of culture,—these are works which must be wrought out by our professional men. It is a new field for work which is opened to them; and they must not lean on the Commissioners, but work hard themselves. Formerly, our path was a straight one; we were going on slowly and steadily in it, but the Sewers Commission has upset everything,—and it is needful to provide not only for the wants of the metropolis, but to remedy the errors they have committed, and the evils they have created.

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[*] 'Native Guano, the best Antidote against the Fatal Effects of Free Trade in Corn.' By GEORGE BURGES, M.A. London: Effingham Wilson, 1848.

'Native Guano versus Sewer Water.' By SCAVENGER. London: Sherwood, 1849.

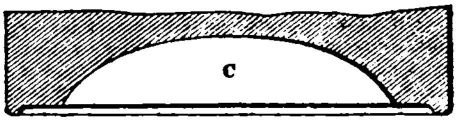
REGISTER OF NEW PATENTS.

RAILWAY WHEELS.

Charles Green, of Birmingham, brass tube manufacturer, and James Newman, of the same place, mannacturer, for "*improvements in the manufacture of railway-wheels.*"—Granted March 28; Enrolled September 28, 1849.

The improvements relate to the construction of wrought or malleable iron wheels for railway-carriages. The wheel is to be made of two pieces of metal only, the boss or nave, and the rim and body of it; and the two to be welded together. The iron is rolled into bars first, as shown at A, in the section fig. 1, and then bent into the form of a hoop, and the ends welded together; the hoop is then placed in the block B, and there subjected to repeated blows from a succession of upper dies or blocks C, the form of which gradually approaches the form of one side of the wheel, until ultimately the metal takes the form shown by the dotted lines. It is then in a state to have the hole made in the centre for the reception of the boss or nave, and for this purpose is placed in another die or block, only differing from the one described in having a hole in the centre, coinciding with the hole to be made. A descending die or cutter then forms the hole of the shape and size required; this hole is not formed even and cylindrical, but is made serrated or jagged, for enabling the boss to take a better hold when manufactured. The hole is now fit for the reception of the boss, which is inserted in the shape of a hollow cylinder of one or two pieces of metal, and a mandril driven in expands the cylinder, and compels the metal forming it to enter the serrations of the hole in the wheel; it is now again subjected to the action of a series of dies or blocks as before described, the mandril still remaining in the hole until the wheel ultimately takes the form shown in fig. 2. In placing and forming the boss in the wheel, it is necessary it should be at a welding heat.

Fig. 1.



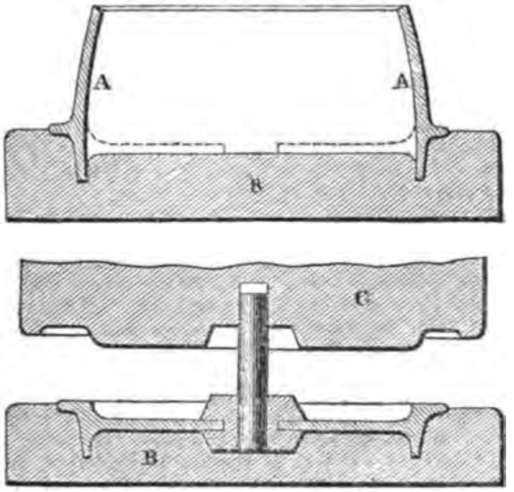


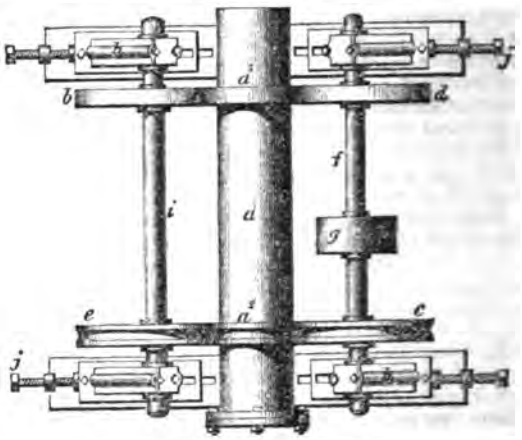
Fig. 2.

METAL CASTINGS.

Andrew Shanks, of Robert-street, Adelphi, engineer, for an "*improved mode of giving form to certain metals when in a fluid or molten state.*"—Granted March 14; Enrolled September 14, 1849.

This invention relates to the employment of centrifugal force for forming metal castings of tubes and cylinders, and other circular-shaped hollow vessels, without the use of cores. The casting is effected by pouring the liquid metal into hollow cylindrical moulds (the internal diameter of which corresponds with the external diameter of the tube or cylinder to be cast), placed in a horizontal position, and caused to rotate rapidly; when the centrifugal force produced will cause the molten metal to spread itself in a uniform manner over the internal surface of the mould, the thickness of the tube or cylinder depending upon the quantity of metal poured into the mould.

Fig. 2.



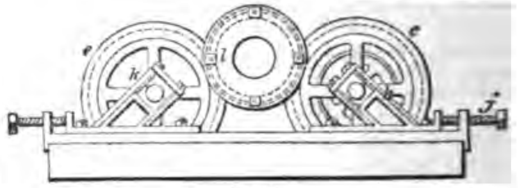


Fig. 1.

The machinery employed in casting tubes and cylinders is represented at figs. 1, and 2. Fig. 1, is a side elevation of the machine; fig. 2, is a plan view thereof; and fig. 3, is a longitudinal section of the mould, showing the pipe z, cast within it. a, is the metal mould, formed with two collars a^1, a^2, which rest upon the wheels b, c, d, e; and the collar a^2, has a rib or bead upon it, that enters into a corresponding groove in the wheels c, e, in order to prevent any movement of the mould in the direction of its length. On the shaft f, of the wheels b, c, is a rigger or pulley g, around which passes an endless band from a steam-engine or other first mover, and causes the shaft f, to revolve; and this motion is communicated to the mould by the wheels b, c. The bearings h, h, of the shafts f, i, can be caused to approach to or recede from each other by turning the screws j, j, for the purpose of adjusting the level of the mould, and [illegible]lating the distance between the wheels b, c, and d, e, [illegible] of different diameters. One end of the mould is [illegible]ernal flange k, to retain the fluid metal within it [illegible] and, to the other end, an annular plate or rin[illegible] purpose. The fluid metal is int[illegible]ed i[illegible]er is rotating, by means [illegible] me sufficiently set, [illegible] th[illegible] off the wheels

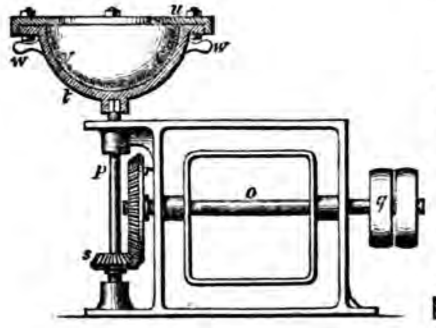


Fig. 3.

Fig. 4.

b, *c*, *d*, *e*, the plate *l*, is taken off, and the pipe or cylinder is removed from the mould.

The apparatus employed for casting circular-shaped hollow vessels is represented, in sectional elevation, at fig. 4. It consists of a framing *n*, in which two shafts *o*, *p*, are mounted: to the shaft *o*, motion is given by a band passing around the pulley *q*; and this motion is transmitted by the bevel-wheel *r*, and pinion *s*, to the upright shaft *p*, which carries the mould *t*. On the upper edge of the mould an annular plate *u*, is bolted, to retain the fluid metal during the revolution of the mould, and to admit of the casting or vessel *v*, being removed when the metal has become sufficiently set. At the bottom of the mould is formed a socket, to fit upon the top of the shaft *p*; so that, when placed thereon, it will accompany the shaft in its revolution; and the mould may be readily removed from the shaft and replaced thereon. *w*, *w*, are the handles by which the mould is lifted.

METAL CASTINGS.

David Henderson, of the London Works, Renfrew, Scotland, engineer, for "*improvements in the manufacture of metal castings.*"—Granted March 20; Enrolled September 20, 1849. [Reported in the *Patent Journal.*]

This invention has reference: First—to the manufacture of pipes, columns, girders, and other similar castings, presenting an uniform section throughout the whole or greater part of their length, by means of a short moveable part pattern, and also in close mould-boxes. Secondly—To the casting of pans, basins, or other like circular figures, by means of part patterns, in moulds formed in close mould-boxes. Thirdly—To the producing a succession of castings, of the uniform section mentioned, from the same mould, without destroying it at each casting, as is usually the case.

In the manufacture of castings of the kind mentioned (having an uniform section throughout) he employs what he terms a close mould-box, instead of the ordinary box used, which is open at the back; the sand or loam being rammed from the back. This mould consists of two parts, as usual, dividing at the centre line, in the case of small pipes, representing two halves of the tube, each having numerous small holes bored through them to allow the air and gases to escape. Each half-mould is furnished with two internal lips or flanges, of the full length of the mould, which project towards the centre, their inner edge being suited to the external form of the casting; or they may be of a breadth that will admit of a slight thickness of sand between the edge and the casting. These lips form a secure hold for the sand constituting the mould, which in the upper half (with the mould in a horizontal position) may be said to represent the abutments of the arch formed by the sand. The lips are carried out thin, or tapered towards the centre, and planed or otherwise rendered true on the face, so that they may fit accurately together to form the entire mould. The pattern employed to form the body-part of the mould consists of a short semi-cylindrical piece, having a plate on the flat side or back of the part pattern, which slides on the dividing surfaces or lips of the mould, retaining it always in the same central position as it is travelled throughout the length of the mould, and may either be held at the different positions required, by bolts at the edges, or by clumps embracing the back part of the half-moulds. In commencing the moulding, the mould to form the socket or lower end is introduced, and the sand rammed round it from the top; the part pattern is then placed in a position immediately above the socket part, and the sand rammed in the space left between the pattern and mould-box, the previously-rammed sand of the socket part closing the bottom of the space. The part pattern is then raised a step higher, and the operation repeated, and continued throughout the whole length of the mould, which is afterwards surmounted by a jet-piece or mould, into which the metal is poured. If the spigot end of the pipe is furnished with a bead, it is produced at the junction of the mould with the sand in the jet-box, one-half being in each; that in the mould being produced by a half-bead on the upper end of the part pattern, and the other formed in the jet part of the mould. Two half-moulds thus formed are placed and bolted together by clumping-rings, or other suitable means, and a core introduced in the ordinary manner, and sustained in a central position at either end. In this manner various other articles may be formed, such as columns, girders, gutters, and other like castings; using the half or single mould-box for such purpose, with the projecting lips, and a plate for the other half, faced with sand, having a core or internal figure of the gutter. Cornices, and other [illegible] figures, are also capable of being moulded in a similar manner; the mould-box in each case being suited to the shape of the article, so that only a thin uniform or nearly uniform coating of sand is required on the interior to form the mould. An example is also given of a grooved roller or pillar, having sharp angular grooves running throughout its length, which in the ordinary mode of casting would require a complicated pattern to produce the mould, whereas it may be formed as readily as a plain casting by this mode of operation. Moulds of this description may be formed in mould-boxes, without lips, to retain the sand, the edges of the box being planed true and out of winding to ensure accuracy in the sliding of the part pattern, which is guided by pieces that embrace the sides of the box, and are carried out to its full length.

In all castings having their interiors formed by cores, the ordinary modes are resorted to for carrying such part into effect. In pipes or cylinders of the larger sizes, it may be advantageous to divide the boxes into three or more parts, in which case, each division is provided with lips, as before explained, which will retain the sand in each individual part. Bend pipes are also represented: in this case the mould-box is divided in the centre line, at the sides of the bend, and suitably faced and lipped at the junction, to admit of the correct working of the part pattern, which is curved to correspond with the curve of the bend. The outer half of the bend is placed on a foot, so that the socket projects in a horizontal direction, suitably furnished with guide-pins, to ensure the parts of the mould meeting correctly.

The second part has reference to the casting of pans and other basin-like shapes. This is effected also in close mould-boxes, somewhat approaching the shape of the pan to be cast, having a number of perforations, as before explained, and also with an internal flange or lip projecting towards the centre, the distance of the said coating. A pin stands up in the centre of the pan at the bottom, on which is placed a part pattern,—that is, the lower end is stepped on it, the part pattern being perhaps 3 or 4 inches broad, and carried up to the edge of the mould-box, where it is secured. This pattern is on the side next the box of the form to be given to the exterior of the pan, and between the pattern and the pan is the space to be filled with sand or loam. When first commencing the operation, one side of the space is closed with a board until the first breadth of the pattern is complete, when it is unbolted at the upper or lip edge of the mould-box, and the pattern moved nearly its breadth in the direction of the circumference, in which it will be guided by the central pin on which it works, and the part bearing upon the lip; the ramming is then continued,—the previously-formed part of the mould forming the stop against which the successive breadths opened are pressed. In this manner, the whole circumference of the interior is lined, when the outer half of the box will be ready to receive the internal part of the mould which is formed on the exterior of a similarly-shaped mould-box, and produced by a part pattern in the same manner as the other; but with this difference in the part pattern—that it is the reverse of that used for the other box. The half-moulds or external and internal parts, so formed, are then placed together and secured in the ordinary manner, when suitable jets are produced in the sand for the introduction of fluid metal.

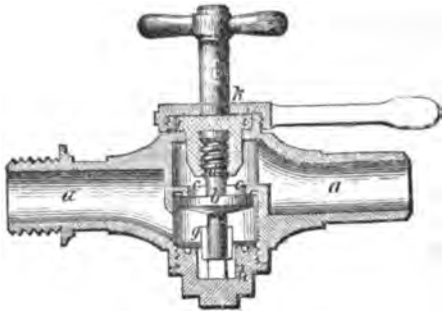
The third part of this invention refers to the production of successive castings from the same mould,—that is, without destroying the form of the sand of which it is composed, but which is only applicable to such articles as pipes or other plain castings easily removed from the mould; in which case he employs close mould-boxes, having lips which retain the sand. If the casting is removed with care, which is to be done immediately the metal has set sufficiently for that purpose, after the black-wash with which moulds are usually coated has been scraped off, the several parts of the mould which have been injured are then to be made good, and the black-wash repeated while the mould yet retains sufficient heat to dry it. Moulds used in this manner should be of dry sand or loam and care taken in the removal of the casting and repairing at each time; thus several castings in succession may be produced from the same mould before its total destruction is necessary.

VALVES AND COCKS.

Peter Llewellin, of Bristol, brass and copper manufacturer, and John Hemmons, of the same place, brass-founder, for "*improvements in the manufacture of cocks or valves for drawing off liquids.*"—Granted November 23, 1848; Enrolled May 23, 1849.

The improvements relate to the introduction of a screw or disc-valve in cocks, to render the same steam and water-tight. The valve is raised for closing the way, or lowered for opening the way, by means of a hollow screw in the rotary stem of the handle; which screw acts upon the disc-spindle. By the turning of this rotary hollow-threaded stem, the spindle of the disc-valve is moved up or down;—it being guided by feathers sliding in the socket. The face of the disc, when raised and brought into contact with the mouth of the aperture, closes it, and stops the flow of the fluid; but when it is lowered the way is opened, and the fluid flows through the cock freely.

In the accompanying engraving, the way *a*, *a*, for the passage of steam or other fluid, is shown as closed by the disc-valve *b*, which is brought up into close contact with the lip or edge *c*, *c*, of the aperture. The disc *b*, is fixed upon a spindle *d*, having a screw or worm at its upper part, acting in a hollow screw in the lower part of the stem of the handle *f*; and from the lower part of the spindle *d*, wings or feathers *g*, extend, and slide in vertical grooves in the socket or plug *h*, which closes the bottom of the cock. The flange or ring *i*, fixed upon the rotary stem of the winch, should be ground very accurately on all its surfaces, in order that it may fit tightly in its socket; and when it is so covered by the winch-cap *k*, it may form a perfectly steam-tight joint. The flange *i*, may be packed with a collar of india rubber, leather, or any fit material, to render it air or water-tight.



GAS AND WATER METERS.

William Parkinson, of Cottage-lane, City-road, gas-meter manufacturer, for "*improvements in gas and water meters.*"—Granted March 20; Enrolled September 20, 1849.

We gave last month an abstract of a paper on this patent meter, read at the British Association; we now have an opportunity of giving additional details from the specification, with the engravings, for which we are indebted to the *Mechanics' Magazine.*

Figure 1 represents a meter of this description attached to the top of a water cistern, and capable of registering a flow of 90 gallons per hour. Fig. 2 is a section of the same, through the centre from front to back. Fig. 3 is a section through the box L; and fig, 4 a section through the centre of the meter at right angles with fig. 2. The wheel, or drum, W, is inclosed in a case M, as in the gas-meter, but it revolves at bottom in a trough of water T, which is freely suspended from the top of the case M, by a semicircular handle V, and adjusting-screw X. The height of water in the trough determines, of course, the measuring capacity of the compartments of the drum; but that height may be varied as may be required, by raising or lowering the trough by means of the adjusting-screw X. The water passes from the trough into the case, and thence into the cistern beneath; and it must never be allowed to rise in the case above the edge of the trough. The apparatus for regulating the inflow of the water into the trough is inclosed in a separate box L, similar to the box which contains the inlet valve in the gas-meter. A view of this apparatus, in two different positions, is given separately in figs. 5, 6, and 6^a. A is a vertical pipe, which is connected at top by a pipe, hose, or otherwise with a head of water, and terminates at bottom in a segmental flange M, in which there is a diagonal slit or opening *n*, for each passage of the water. To the outer sides of this pipe A, there is gimballed a valve D, the top surface of the bottom part *d*, of which is turned truly to correspond with the under face of the flange M. As long as this valve is in the same vertical plane with the pipe A, it completely closes the opening *n*, but on being drawn to one side, as represented in fig. 6, it passes more or less from under the diagonal opening *n*, and allows a proportional outflow of water. It will be obvious, therefore, that by attaching a float to this gimballed valve, as shown in fig. 3, there will be always just as much water supplied as may be wanted. The instrument is in effect very similar to a ball-cock, only that it is much better adapted for accomplishing the end in view, because it is attended with extremely little friction, and the water, however great the head pressure may be, has no tendency either to open or shut it; the only thing affecting it being the actual rise or fall of the float. To obtain a smooth surface for the float to work in, a shield A^a, is inserted athwart the box L, in a direction inclined downwards from a point, immediately above the bottom opening *n*, of the pipe A. But instead of the regulating apparatus just described, another may, if necessary, be adopted, such as is represented in figs. 7, and 8, which will answer equally well. A, is an inlet pipe, as before, which is soldered (sidewise) to, and communicates at bottom with, another pipe D. E, is a conical valve fitted to the bottom of the pipe D, the spindle of which is connected at top to a small piston of equal area with the valve, by which piston any tendency which the pressure of the water might have to open or shut the valve is completely counteracted or neutralised. N, O, are apertures to admit a free ingress or egress of air from the box L, and case M.

Fig. 2.

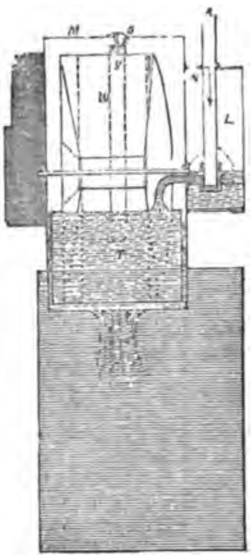


Fig. 5.

Fig. 1.

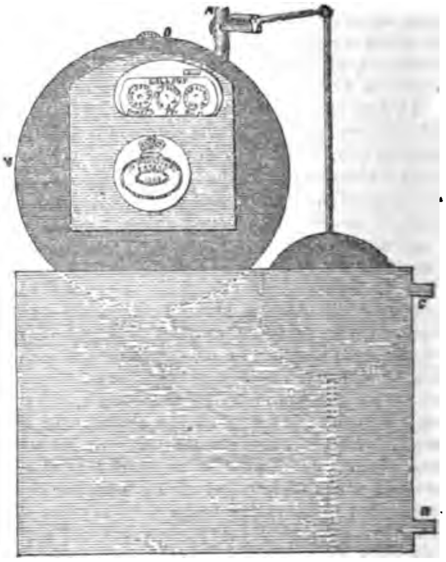


Fig. 6.

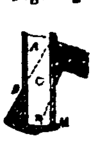


Fig 6^a.

Fig. 4.

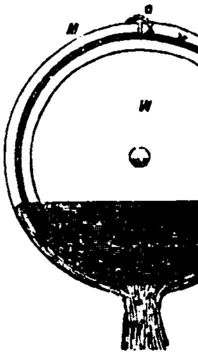


Fig. 7.

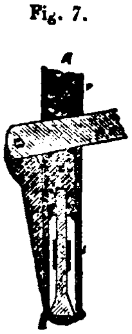
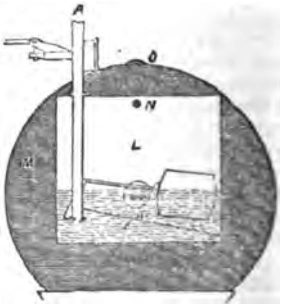


Fig. 8.

Fig 3.



Should it be necessary to provide a compensation for any variation in the level of the water in the trough, this may be readily done by suspending the trough from the short end of a rod or lever (to which the adjusting-screw X, might be attached), and attaching the other or long end by a connecting-rod to the spindle of the float in the regulating-box L.

ON CIVIL ENGINEERING AND ARCHITECTURE.

An Introductory Lecture, given at the Putney College for Practical Science, September, 1849. By Samuel Clegg, jun., Esq.

Civil engineering and architecture, the subjects upon which I am called to lecture, are both essentially practical sciences, and are in some measure so connected as to be synonymous; both engineers and architects must be well versed in the strength of the various materials with which they have to deal, and be so acquainted with their numerous properties as to be enabled to make a choice of them for any peculiar circumstances attending their work. Both must be mathematicians, draughtsmen, carpenters, masons, and be acquainted with the details of all, or nearly all, the mechanical trades; at least they must be learned judges of them, if not skilful operators. They must both be men of business, and should not be ignorant of law.

Both architecture and engineering, therefore, in their most comprehensive meanings, are studies of many and singularly opposite qualities, and are allowed by all whose opinions are worth regarding, to be sciences of the highest importance to the well-being of society: thus far the two professions go side by side. But architecture, as well as being a science, is also essentially a fine art, and here the two professions separate. The path of the architect will, after he has gained his practical knowledge of construction and building, be parallel with that of the painter and the poet in the regions of cultivated taste. The path of the civil engineer is widely different, but if his labours be less in the captivating regions of beauty than the architect's, they are perhaps more among the grand, certainly more among the stern development of massive strength, to resist shocks, inundations, and storms, —which, from the simplicity of the requisite forms and their associations, constitute grandeur. I come amongst you fully sensible of the responsibilities of my office, and with an equally full determination to perform its duties to the utmost of my power; and I shall expect you to go with me, cheerfully, to the tasks which lie before us, and assist me with your diligence. Nothing is more necessary to the due understanding and proper study of engineering and architecture, and to the formation of a proficient in either, than habits of application and industry. Without them even the lowest departments of the professions are not to be mastered. It is not a rapid growth that produces a sound and skilful practitioner, any more than precocity is an emblem of a great statesman. It is not by occasional fits of application, by short starts of preparation, by numerous progenies of little works, performed in a little time, and with less study, sometimes discontinued, and again renewed, that eminence is to be obtained in either of these arts; on the contrary, it is only by regular application—by a constant study of good examples—by able instruction,—by deep and intense study of the elementary principles, with an uninterrupted practice, solely directed to the object, grown up almost into a habit, and ready to be called into use at the shortest notice; it is only by sacrificing every comfort that aims at prevention,—by having resolution to suffer nothing to impede your progress, and by avoiding the Dead Sea of idleness and pleasure, that you can be enabled to shine either as an architect or as an engineer.

Michael Angelo Buonarroti, full of the great and sublime ideas of his art, lived very much alone, and never suffered a day to pass without handling his chisel or his pencil. When some person reproached him with leading so melancholy and solitary a life, he said, "Art is a jealous thing, and requires the whole and entire man." He was also both frugal and temperate, and so persevering in his labour, that he used occasionally at night to throw himself upon his bed without disencumbering himself of the clothes he had worked in.

Inigo, or John, Jones was a native of Llanvrost, in Denbighshire, and by his indefatigable zeal, raised himself from the position of a working mechanic to that of the first architect of the day. Like his father, he followed the occupation of a carpenter and mason in his native town, and built Llanvrost bridge when he was 23 years of age. It was with the money thus obtained that he went to Italy, with letters of introduction from the Duke of Ancaster. When at Rome, finding that he had more talent for designing palaces than adorning cabinets, he turned his study to architecture. By denying himself the common necessaries of life,—by rising early, and retiring late, sometimes not going to his bed at all, he conquered all the difficulties in his path; and after remaining some time in Italy, shackled by poverty, Christian the Fourth of Sweden invited him to Denmark, and appointed him his architect. He afterwards returned to England, and was made surveyor-general of the king's works to James the First, but refused to accept any salary until the heavy debts contracted under his predecessor had been liquidated. Upon the accession of Charles, he was continued in his office, when his salary as surveyor was 8*s*. 4*d*. per day, with an allowance of 46*l*. per year for house rent.

Sir Christopher Wren is an eminent example of a great architect excelling in mathematics, and producing works bearing the evident impress of their author's learning. From the number and diversity of his occupations, may be gathered the fact of his close study and application; and although, unlike Inigo Jones, he had not poverty to fight against, infinite credit is due to him. He was one of the original members of the club which was formed at Oxford in 1648, for philosophical discussion and experiments, and which eventually gave rise to the Royal Society. In 1657 he was chosen professor of Astronomy at Gresham College, and on the Restoration was appointed to the Savilian professorship of astronomy at Oxford. It was very soon after this that he was first called upon to exercise his genius in architecture (a study, however, which had previously engaged a good deal of his attention), by being appointed assistant to the surveyor-general. This led to Wren's employment on the work upon which his popular fame principally rests—the rebuilding of the cathedral of St. Paul's after the great fire. The erection of this noble edifice occupied him for thirty-five years, but did not prevent him during the same period from designing and superintending the completion of many other buildings, nor even interrupted his pursuit of the most abstract branches of science. Wren was created a doctor of law and logic by the University of Oxford in 1661, and was knighted in 1674. In 1680 he was elected to the presidency of the Royal Society, and in 1685 he entered Parliament as the representative of the borough of Plympton. While superintending the erection of St. Paul's, all the salary Wren received was 200*l*. per year. He was also in other respects used by the commissioners with extreme illiberality, and was obliged to yield so far to their ignorant clamour as to alter the design of his building, and to decrease the size of his dome, which he had intended should spring from the outside larger gallery which surrounds it, and give up his magnificent idea of enrichments for embellishing the interior. If he had had the moral courage of Michael Angelo, we should have had yet a nobler monument of his fame. He, like Wren, had obstacles thrown in his way, and we are told the following anecdote:—Under the papacy of Julius III. the faction of Michael Angelo's rival, San Gallo, gave him some trouble respecting the building of St. Peter's, and went so far as to prevail upon that pope to appoint a committee to examine the fabric. Julius told him that a particular part of the church was dark. "Who told you that, holy father?" replied the artist. "I did," said Cardinal Marcello. "Your eminence should consider, then," said Michael Angelo, "that besides the window there is at present, I intend to have three in the ceiling of the church." "You did not tell me so," replied the cardinal. "No, indeed, I did not, Sir; I am not obliged to do it, and I would never consent to be obliged to tell your eminence or any other person whomsoever anything concerning it. Your business is to take care that money is plenty in Rome, that there are no thieves there,—to let me alone, and to permit me to proceed with my plan as I please." Wren's ungrateful employers, in 1718, dismissed him from his place of surveyor of public works; he was at this time in the 86th year of his age. This great and good man died at Hampton Court on the 25th of February, 1723, in the 91st year of his age. His remains were accompanied by a splendid attendance to their appropriate resting-place under the noble edifice which his genius had reared, and over the grave was fixed a tablet, with the following inscription:—"Beneath is laid the builder of this church and city, Christopher Wren, who lived about 90 years, not for himself but for the public good. Reader, if thou seekest for his monument, look around."

Great architects, if uniting with their works any other pursuit or study, have generally fixed upon some branch of science or art connected with architecture: thus, Michael Angelo was a sculptor; Inigo Jones was a painter, and Sir Christopher Wren an astronomer. But Sir John Vanbrugh was a dramatist as well as an architect; he wrote "The Provoked Wife," "Æsop," and other comedies, and built Blenheim and Castle Howard.

Were I to give the character of each and all the eminent architects of this or any other country, they would serve to show how great was the amount of their labour, and with what cheerfulness and perseverance they pursued their tasks at the commencement of their career, and with what determined energy they maintained their name and fame after they had risen to excellence: nor will the characters of civil engineers lose by comparison with the already-named artists.

When the state of civilization and trade in England required more convenient and cheaper modes of transit for its goods than the common roads and wagons of the day afforded, a system of inland navigation was proposed, and Mr. Smeaton was employed in making rivers available for this purpose: afterwards, more direct routes became desirable, and canals were projected, in imitation of those made before by the Dutch and French. The Duke of Bridgewater was the great patron of these schemes, and brought forward James Brindley, who constructed the canal called the Bridgewater Canal, between Liverpool and Manchester. This immense work, which was ridiculed by most of the scientific men of the period as impracticable, Brindley undertook, and completed so as to form a junction with the Mersey. This success caused him to be employed, in 1766, to unite the Trent and Mersey, upon which he commenced the Grand Trunk Navigation Canal. From this main branch Mr. Brindley cut another canal near Heywood, in Staffordshire, uniting it with the Severn in the vicinity of Bewdley, and finished it in 1772. From this period scarcely any work of the kind in the kingdom was entered upon without his superintendence or advice. Among other designs, he prepared one for draining the fens of Lincolnshire, and the Isle of Ely, and another for clearing the Liverpool Docks of mud, which was especially successful. The variety of his inventions, and the fertility of his resources, were only equalled by the simplicity of the means by which he carried his expedients into effect. He seldom used any model or drawing, but when any material difficulty presented itself, he used to seclude himself for days, or until an idea presented itself to him for overcoming it; and so partial was he to inland navigation, that upon a question being put to him by the opposition to one of his schemes, "for what purpose he imagined rivers were created," he at once replied, "undoubtedly to feed navigable canals." The intensity of his application to business brought on a fever, of which he died in 1772, in the fifty-sixth year of his age.

John Smeaton, another engineer who did much to advance his profession in this country, may almost be said to have been born an engineer, his genius appeared at so early an age. His playthings were not those of children, but the tools which men employ. Before he was six years of age, he was discovered on the top of his father's barn, fixing up what he called a windmill, of his own construction; and at another time, while he was about the same age, he attended some men fixing a pump, and observing that they cut off a piece of the bored pipe, he procured it, and actually made a pump with it, which raised water. When he was under 15 years of age, he made an engine for turning, and worked several things in ivory and wood, which he presented to his friends. A part of every day was occupied in forming some ingenious piece of mechanism. In 1751 he began a course of experiments to try a machine of his own invention, to measure a ship's way at sea, and made two voyages to try the effect of it, and also to make experiments upon a compass of his construction. In 1753, he was elected a fellow of the Royal Society, and the number of papers he published in their Transactions will show how highly he deserved the honour of being enrolled a member of that useful and important body: in 1759 he received the gold medal. In 1755, the Eddystone Lighthouse was burned down, and Mr. Smeaton being recommended to the proprietors of that building as an engineer in every way calculated to rebuild it, he undertook the work, which was completed in 1759. To this work I shall allude more particularly when instructing you in the building of lighthouses, as the practice of building then adopted has been continued to this day. But the part of Mr. Smeaton's life I would more particularly draw your attention to is this. During many years he was a frequent attendant upon Parliament, his opinion upon various works begun or projected being continually called for; and in these cases his strength of judgment and perspicuity of expression had the fullest scope. It was his constant custom, when applied to to plan or support any measure, to make himself fully master of the subject, to understand its merits and probable defects, before he would engage in it. By this caution, added to the clearness of his expression, and the integrity of his heart, he seldom failed to obtain for the bill which he supported the sanction of parliament. No one was ever heard with more attention, nor had any one ever more confidence placed in his testimony. In the courts of law he had several compliments paid him from the bench, by Lord Mansfield and other judges, for the new light he always threw on difficult subjects. Mr. Smeaton died in 1792, in the sixty-eighth year of his age.

John Rennie, to whom England is indebted for some of her noblest engineering works, was born on the 7th of June, 1761, at Phairtassie, in the parish of Prestonkirk, in the county of East Lothian. His father, a highly respectable farmer, died in 1766, leaving a widow and nine children, of whom John was the youngest. The first rudiments of his education were acquired at the village school. It so happened that he had to cross a brook on the way, which, when flooded, obliged him to make use of a boat kept in the workshop of Mr. Andrew Meikle, an ingenious mechanic, well known in Scotland as the inventor of the thrashing machine. In passing so frequently through this workshop, young Rennie's attention was directed to the various operations in which the men were engaged; and they, noticing the interest he took in their labours, were in the habit of lending him tools and showing him their use. In the evenings he amused himself with endeavouring to imitate the models he had seen at the shop; and it is related that, at little more than ten years of age, he had completed the models of a windmill, a pile-engine, and a steam-engine. Rennie continued at the Preston school till twelve years of age, when, having had a quarrel with his master, he entreated to be allowed to leave, and, at his own request, was placed for two years with Mr. Meikle. At the end of that time, feeling that a constant application to manual labour was likely to retard his mental improvement, he determined to become a pupil of Mr. Gibson, an able mathematical teacher at Dunbar. Here he soon attained great proficiency, and in less than two years returned to Mr. Meikle with a mind well stored with mathematical and physical science. His first essay in practical mechanics was the repairing of a corn-mill in his native village; and before he was eighteen years of age he had erected several others. During this time he occasionally visited Edinburgh, to pursue his studies in physical science under Professors Robinson and Black. The former of these gentlemen may perhaps have laid the foundation of his future fortune, by introducing him to Messrs. Boulton and Watt, of Soho. Deeming the capital the proper theatre to try the strength of his own powers, Rennie settled in London, after having been a few months only with Boulton and Watt, who had confided to him the superintendence of the mill-work of the Albion Mills then erecting. Mr. Rennie was thus led to study hydraulic engineering, in which he became so celebrated as, after the death of Smeaton, to have no rival. Amongst the most celebrated works of this great engineer must be mentioned—besides numerous mills, bridges, canals, &c.—Waterloo and Southwark bridges, the Lancaster Canal, with the aqueduct over the Lune, the breakwater in Plymouth Sound, and the improvements in the dockyards at Portsmouth, Plymouth, Chatham, and Sheerness. The industry of Mr. Rennie was so great, that he never suffered amusement of any kind to interfere with his business, which frequently occupied him twelve, and sometimes fifteen hours in the day. He was clear in his mode of communicating information to others, and pleased when he found that information was desired. He was never actuated by professional jealousy, or selfish feelings, but was always kind and condescending to the more humble members of his profession. Mr. Rennie died on the 16th of October, 1821, in the sixtieth year of his age, and was buried in St. Paul's, where his remains repose near to those of Sir Christopher Wren.

Thomas Telford was born in 1757, and commenced life as a shepherd boy in Eskdale; but his early and eager love of knowledge led him to seek abroad an occupation more suited to his inclinations. He first repaired to Edinburgh, where he studied architecture with unremitting application, although he must have earned his daily bread by the labour of his hands. In 1782 he was emboldened to try his fortune in London, and was (as he states in his life, written by himself) fortunate enough to employed at the quadrangle at Somerset-place, where he acquired much practical information, both in the useful and ornamental branches of architecture. After a residence of two years in London, he was engaged in superintending the building of a house in the Portsmouth dockyard. "During the three years," he remarks, "that I attended the building of the commissioner's house, and of a new chapel in the dockyard, I had an opportunity of observing the various operations necessary in the foundation and construction of graving docks, wharf-walls, and similar works, which afterwards became my chief occupation." When he left Portsmouth, he was appointed surveyor to the county of Salop, and to this, and the connections formed at this time, he was indebted for a very favourable opening of his career as a civil engineer. His chief attention was devoted to building and repairing bridges and other works, but he also built several churches and other architectural edifices. Telford's progress in his professional career, though not rapid, was steady and certain, and every new opportunity of exercising his talents contributed to extend a reputation which at length became unrivalled—not to his talents alone though, be it said, but by downright hard work united with them. To enumerate all his works would take a long time; but his principal ones are the Holyhead-road, (upon which he himself set higher value than any other), the Pont-y-Casylte aqueduct, and the Menai bridge, the most imperishable monument of Telford's fame. The defects of his early education he had endeavoured to remedy in his maturer years. He taught himself Latin, French, German, and mathematics, in which he was a proficient, but relied more for the dimensions of his works upon practical experiment than upon calculation; but his reason for this preference may have been, and most likely was, his distrust of the data furnished him by mathematical experimenters in those days; but now that we have Barlow and Hodgkinson, calculation from the results of their labours may be safely relied on. Telford was the first President of the Institution of Civil Engineers, and died still holding that office in 1834, aged seventy-seven years.

I shall conclude these sketches with a few remarks upon the life of an engineer not less eminent than those already mentioned—the late George Stephenson. He was born in 1781, at Wylam, a colliery village on Tyneside, near Newcastle. His father was a poor pitman, and he himself commenced his career of labour, when only seven years old, as a "trapper," and advanced in the quality of his employment with his years: became a "picker" at five shillings a-week wages; then, the driver of a "gin;" then, a "breaksman," attending the engine while drawing up coals from the pit—and it was at this time that he thought himself a "made man" for life, because his pay was twelve shillings a-week. When about 23 years of age he began to learn to read, for he had already felt the disadvantages of his early want of elementary education; and in his after years, he never omitted an opportunity of urging young men to avail themselves of every means of education offered to them. While at Killingworth colliery, he perhaps first felt aspirations for higher things rising up within him. He was attentive, assiduous, and active-minded; and he studied the engine at which he worked, so that in time he came to understand it thoroughly. Not contented with merely understanding it—he sought how to improve it, and added so many useful contrivances, that he was at length called upon to do the work of an engineer. He never made a false step, and every year found him higher up upon the ladder of life. He was never idle, either in body or mind. He invented the safety-lamp, and so greatly improved the locomotive engine, that that also may be called his invention.—What George Stephenson did for railways all know.

From these few instances in the lives of men devoted to science and to art, the student will learn the necessity of study, exertion, and self-dependence. An architect or an engineer taking up his work as a task, or merely with the business-like view of earning a livelihood, will never excel. In the days when men of science were comparatively scarce, great perseverance was necessary to get into notice and rise to fame; but double exertions are now necessary; an aspirant to professional honour will find himself jostled and hard set by competitors at every step of his progress. But this must raise up within him a determined spirit of emulation, a spirit not to be daunted or cast down by failures, but one that will become more buoyant by pressure, and he must walk with steady stride and upright head along the steep and difficult path which leads to fortune.

I have said that both architects and engineers must possess a knowledge of the strength and nature of the materials with which they have to work. This I think is self-evident, for the means or money to be expended is always one great element in their calculations; and the quantity of material that can be usefully employed can only be ascertained by calculations based upon an intimate knowledge of the strains and forces they will have to resist, and the capabilities of the timber, the stone, the iron, or other substance that may be employed to resist them. Both Tredgold and Barlow have furnished us with admirable works from which the theoretical knowledge of the properties of all the materials used in building can be learned. There is no excuse, therefore, for failures of work arising from actual want of strength; but failures do sometimes occur, notwithstanding every precaution may have been taken to give the materials, both theoretically and practically, their proper size and form, and proper distribution in the work. In engineering especially, circumstances are occurring every day, features constantly present themselves, of which even the oldest practitioner may have had no example previously; and other means taken to obviate evils that may and do thus arise may be the best that both science and art could point out, and yet fail in their object. I say that these are misfortunes only, not faults; but when they occur with a man unqualified by scientific knowledge to deal with them, they are very serious faults indeed, and should be visited with the utmost censure.

Engineering (says Mr. Hyde Clarke), is of all professions, the military excepted, that in which a new adaptation of expedients to unforeseen occurrences is ever most imperatively required, and in which a mere knowledge of past efforts will be insufficient, unless the mind be competent to invent new processes, as well as to avail itself in the best manner of old ones. No man can go upon a spot and say, I will certainly do such and such things at such an expense: some unexpected variation of nature beneath the surface will often thwart the best-calculated plans, and render all attempts at economy abortive. It is practice, aided by scientific knowledge of the highest kind, that only can properly preside over the just application of material to the ever-occurring variations which spring up in the course of an engineering undertaking. And if science and practice sometimes fail in effecting their object at once, what must be the result when ignorance attempts the work? Failure, certain and disastrous failure, heaping disgrace upon the head of the quack practitioner, and often ruin upon his employers. I use the word quack advisedly, for although neither architect nor engineer unfortunately need diplomas of practice to give them a right to the use of C.A. or C.E. after their names,—they yet have morally, and in common honesty, an obligation which should bind them to certain spheres of work which they feel themselves qualified to undertake; and depend upon it every man knows his own capabilities. If, then, men calling themselves engineers or architects, undertake a work they know they are incapable of performing without the assistance of a *dry-nurse*, in the shape of a good "clerk of the works," they are quacks in every sense of the word,—quacks as much as the charlatan who practices medicine without the sanction of the colleges.

The demand for engineers, caused by the hair-brained railway speculations, has filled the profession with unqualified persons, and has tended to lower it below its proper level: and although the present times are, I am rejoiced to say, weeding them out pretty fast, it will, and must, be some time before it reaches its healthy state again.

It is true, the Institution of Civil Engineers and the Institute of Architects exist, and men to become members of either must present proper qualifications; but there are numerous practitioners who are not members, and who seek and gain employment. But I hope to see, ere long, by legislative enactment, both architect and engineer obliged to take out a diploma before being allowed to take upon themselves the responsibility of any work, when lives, or a sum of money beyond a certain amount, are at stake,—a diploma granted only after a severe examination as to scientific acquirements, and a practice under others of at least seven years.

I here beg permission to quote some passages from a paper written by Sir John Soane, which appeared in the *Artist* of June 13th, 1807,—as quotations from this high authority will give strength to what I have ventured to suggest myself:—

"An architect, strictly so considered, is not sufficiently employed; his profession is too open to the assumption of persons who have no claim by education or ability; and these are admitted to that patronage without which the architect has no chance either of emolument or fame. There are, therefore, very few persons engaged solely in the practice of architecture. The great mass of those whom we here call architects, though many of them respectable in talents as artists, are under the necessity of combining with their study of the science pursuits not strictly analogous, and are, in consequence, and to their great discouragement and mortification, assimilated with another description of professional men called *surveyors*, and that name is again assumed by all sorts and classes of building workmen and others, until it becomes utterly contemptible."

After enlarging somewhat (and in language by no means mild) upon the difficulties which beset an architect when carrying out a design, through the interference of public boards, and complaining, justly, that unqualified persons are allowed to enter into competition with him, by the aid of pilfered plans, Sir John concludes thus:—

"Before the state of architecture can be improved, and the professors excited to that species of emulation which only can make them eminent, strong and marked distinctions must take place. Those who have patronage must consider it a sacred trust and deposit,—the meed only of science and genius. The claims of the untaught, ignorant, and presumptuous, must not only be disallowed, but repelled with indignation and contempt, till at length they are consigned to that obscurity whence they ought never to have been suffered to emerge."

Both engineer and architect must also be men of business; and to the knowledge of the uses and relative advantages of materials must be added the knowledge of their commercial value. The sum to be expended in any undertaking is always a marked feature; and the reputation of an engineer, especially, will be raised by the commercial success of his work. Harbours, roads, canals, and railways, before they are commenced, must show that the traffic or dues from them will amount to such a sum as will insure to their projectors a proper return for their money. The first estimate of the engineer is the document from which the probable amount of returns is calculated. The statistical calculations, or the quantity of trade that will arise, is not, strictly speaking, in the department of the engineer; and he is not answerable if the scheme is not a paying one, from a deficiency in the traffic returns or dues; but if it fail through any excessive expenditure over and above his estimate, he is answerable. His estimate and schedule of prices, fixed through knowledge of local charges and custom of labour—through his close observation and acquaintance with the geological features of the spot, and through his knowledge of the best districts from whence to draw his foreign materials—must be so worked out in detail, and capable of being referred to precedent, if precedent exist, or borne out by the opinion of others, that it will bear the strictest investigation—we will say for the sake of example, that of a Parliamentary Committee; for be it remembered, that estimates are the most vulnerable points in which opponents strike when in the "House;" and if the said estimates do not carry on the face of them the handiwork of a man of business, they will be the first and last work of the scheme—for the session in which they are brought forward at all events.

Perfect knowledge of the business habits of contractors, and of the working habits of artisans, can alone enable him to draw out his specification properly. It is true, the lawyer will be called upon to give to it its legal phrases and finely-drawn pains and penalties for any breach in the performance thereof; but the lawyer will have to work upon a base of the engineer's planning, and, be it sure, the blame will rest with him if any oversight has been committed.

In the specification must be described the exact method by which the various works enumerated therein are to be performed. All the drawings must be enumerated, and more particularly referred to and explained: in short, the specification must be a book of reference, as it were, for the contractor, by which he can settle dimensions and quantities, and appeal to in case of any dispute with his employers as to the proper performance of his duty. There can therefore, I think, be no doubt but that the engineer must be a thorough man of business.

Because I have not alluded in these examples to the architect, it must not be supposed that such documents as estimates and specifications are foreign to his practice, for, equally with the engineer, must he be capable of directing the *modus operandi* of his undertaking,—nay, even probably with still greater minuteness of detail, seeing that his work is generally more minute, and depending more particularly upon exact dimensions for its success.

Both architects and engineers must also understand those branches of law which relate to their profession, and study the science of jurisprudence, so far as to enable them to judge of the legality of their proceedings, to prevent their employers from being involved in law-suits through their means; and to extricate them by the shortest way when so involved, by a cessation or alteration of the offensive operations, if the cause be connected with their pursuits. I mean not that their duties should in any way trench on those of the attorney, or that they should advise in any matter involving a legal or technical question, for "a little law is a dangerous thing;" but they should always understand the particular sections of the law relating to their operations, that they may be able to steer clear of the dangerous rock of litigation.

All the laws of England contain enactments and regulations concerning building, and they consist both of written laws or statutes, and unwritten laws, or laws of common customs. It would be out of place here to describe all the laws which affect the operations of an engineer or architect, but I may be pardoned for making mention of one or two points that have come within my experience, to serve as illustrations of my statement, that they should know "their own law." When the inhabitants of a county are liable for the repairs of a public bridge, they are liable also to repair, to the extent of 100 yards, the highway at each end of the bridge. One instance came under my observation, in which a surveyor neglected not only to take into account the existence of that law in his estimate of the work to be done, but even through his ignorance suffered an action to be brought against himself, as the official representative of the county authorities. He lost the action, and the magistrates refused to bear him harmless, "because he ought to have known the law."

I may mention another instance in the case of a bridge. An engineer was employed by a private gentleman to build a bridge for a public road upon his estate: two years after its completion it was washed away by a flood. It had become so useful to the public that it was necessary to have it rebuilt, and the owner then thought that it might be erected at the expense of the county. But the county refused, because his engineer had not submitted his plans to, and obtained the approval of, the county surveyor,—this neglect freeing them from the legal obligation.

Again, an architect designed and erected for a gentleman a very expensive conservatory, and it was made portable, for as this gentleman was only a yearly tenant, he intended to remove it should he change his residence. But his architect erected the conservatory on a brick foundation; it thus became a fixture, and the property of the landlord.

Examples of such cases might be repeated until the relation of them might fill a considerable volume, but those mentioned will serve to show that the artist employed to execute any works should inquire concerning the laws relating to them.

I have now said as much as the limits of a lecture will allow, upon the duties required of architects and engineers, but I will add a few words upon the duties of the general community with regard to architecture more especially.

If we refer to history we shall find that exactly in proportion as civilisation advanced, *civil* architecture flourished—had its rise, its progress, and decay. It took its styles, its varieties, and its general tone, from the nation who invented or introduced it; and what may with great propriety be called a national style always existed.

Greece, during her independence, invented that architecture which, even at the present day, is our model. Her princes and rulers esteemed it the highest honour to be ranked with artists, and her buildings were looked upon by all as types of her glory.

Republican Rome, although she borrowed her designs from Greece, and built by the hands of Grecian artists, cherished architecture, because, through it, the Eternal City might be embellished, and the dignity of its citizens be enlarged; and although this did not, perhaps, proceed from pure love and veneration of the art, it had its effects, and buildings were produced that have been handed down to us as forms worthy to be imitated even to the present day.

The architecture of England also had its rise, progress, and decay: its rise during the Anglo-Normans,—its progress during the reigns of the Plantagenets and Tudors, when it arrived at its greatest excellence,—and its decline may date from James I., almost up to our own times. I say *almost*, for latterly, under the fostering patronage of royalty, and men of taste and genius, it has struggled into a new existence: let us hope that it is the dawn of a new era for architecture and the fine arts in England. That this germ may bud and grow into healthy beauty, it will require the steady co-operation of all Englishmen connected in any way with architecture. Genuine professors of the art will gladly give their best energies to the task of regeneration, and we have already examples which tell in glorious language (language engraven in stone) what will be the result of those energies. Nothing is wanted but men of influence and and taste to add weight to the balance already inclining so decidedly in favour of purity and fitness of style. I am an advocate for *fitness* in the style of architecture of every building, civil, military, and ecclesiastic; and would those through whose patronage the fine arts flourish study, equally with its professors, the true meaning and intent of fitness, there would speedily be an end to incongruity, and English buildings would stand prominently out as types of English architecture.

Both Grecian and Palladian architecture have taken so firm a root in the soil of England, that any attempt to dismiss the styles at once would be useless, and perhaps fatal to the regeneration of a national one. But will not a little consideration show that these styles are unfitted for the English climate throughout the year? The windows, few and far between, obstruct the light. The low pitched roofs retain the snow and rain, and the projecting porticoes throw shadows where there is already too much shade. An Italian villa, appropriately situate, may fitly serve as a summer residence; but we must seek in another style that comfort and homeliness so loved by all Englishmen: for this style we need not become imitators or pilferers from a foreign nation.

The high-pitched roof, the clustering chimney shafts, the ornamented gable, the oriel window, the irregular plan, suitable as well for internal convenience as for external beauty, are all characteristic of our English style; and each feature has, besides, fitness to our climate to further recommend it. I wish particularly to be understood that I now speak of domestic architecture,—for that of public edifices we may still be indebted to Greece or Rome. Our palaces, institutions, and prisons may still be in the decorated Corinthian, the chaste Palladian, or the stern and sombre Doric. But let our residences, our *country* residences, serve to keep us in mind of our former genius, while they add to our comfort and enjoyment.

One word more before we leave this subject, upon a point which every man has power to forward. I allude to internal decoration. In this branch of art, the house-painter, the paper hanger, and the joiner, are too often allowed to usurp the place of artists, and suffered to bedaub the walls with incongruous colours or tasteless wood-work. Joiners, in particular, have a kind of systematised patent to work evil things; custom to one set of forms and method of work, has so fixed itself upon us, that the same set of moulding planes, the same kind of paneling, serves for all styles of houses. The architect himself is probably somewhat to blame in this, but I believe only to a small extent, for builders, not architects, are generally employed to run up the brick-and-stucco boxes called houses,—and these, building either per contract, or for themselves, to save money and trouble, are little inclined to study propriety in internal finish. It is not that artists consider it beneath them to be the decorators, for Raffaelle painted the walls of the Vatican, Ruben's hand embellished the ceiling of Whitehall, Sir James Thornhill decorated the walls of the chapel and hall of Greenwich, and we have Owen Jones in our day.

It cannot, therefore, be through any false notion of the architect that these internal finishings are left to artisans; but whether it be or not, every gentleman, every man of cultivated mind, is to blame who suffers his house to be coloured up to suit the taste of the sign-painter, who, without any feeling of art in his composition, daubs away in any shade of any pigment he may fancy to be in fashion.

Many patrons of the arts would fire up and say indignantly, "I do not suffer this outrage upon taste to be committed in my house." And I am only happy to admit that there are some glorious exceptions to my rule; but that they are exceptions I will uphold, and say confidently that eight men out of ten have houses painted, fitted, and furnished, with designs that have issued from the shop, and not from the studio. Poor men in the present state of things cannot, perhaps, help this; and the poor man with refined feelings for art must submit, for he cannot alter. But rich men are those to whom I point, and say,—"Study art, and be judges yourselves where art is employed; or consult those whose whole life has been devoted to the cultivation of it,—and who will work for you, not for money alone, but for the love of art: *architects are such men.*"

I shall now beg to conclude with a brief outline of the system I intend to follow in my instructions. The heads of this lecture will show what points I consider the most essential: I shall not confine myself to these alone, but often dwell upon studies which will naturally arise during their development.

The students in both civil engineering and architecture will be divided into three classes. The *junior classes of each* will be united, because I consider that their first studies are identical; and the lectures will be arranged thus:—The history of architecture and engineering, commencing from the earliest state of man in which either science existed; carrying it on through the several epochs which have left us any marked signs from which to date, up to the present time. From this subject I shall go on to the theory and practice of building, explaining the principles which are to guide us; give practical rules and data for determining dimensions; and lay down, as far as possible, a firm foundation upon which the student may build up his own reputation. This junior class will be confined entirely to the study of first principles and detail, that each division of students when they join their respective second classes, may be prepared for general principles and more practical inquiries, and learn the arts as well as the sciences connected with their professions.

The subjects brought before the *2nd class of Architecture* will be divided into three sections. The first will consist of an inquiry into the principles which constitute beauty in architecture,—fitness of construction, propriety of form, and dimensions being brought more prominently forward than the abstruser doctrines which must form the study of maturer years. The orders of classic architecture, their general character and application; intercolumniations, pediments, profiles of doors and windows, proportions of rooms, and matters of this nature, will form the studies of the second section; and the third section will consist of inquiries into the practical detail of old English domestic architecture.

The studies of the *senior class of Architecture* will be almost entirely practical. Proper data will be supplied to the students, and they will design from them simple edifices in the first instance, and proceed gradually to more complicated buildings; examining also into the requisites for barracks, hospitals, prisons, and other public buildings,—the necessary working drawings, specifications, and modes of measurement being particularly attended to in all.

The *2nd class of Engineering* will be engaged in learning the art of using the pile-engine and driving piles for foundations; timber bridges and coffer-dams; of preparing foundations under various circumstances of locality and material; of erecting bridges of timber, masonry, and cast-iron; of draining; of laying out and constructing ordinary roads and railways; of sewering and draining towns, and supplying them with light and water.

The studies of the *senior class of Engineering* will be directed to hydraulic engineering—which consists of canals and their detail, docks, harbours, breakwaters, sea defenses, and lighthouses. Great attention will be paid to drawing and designing from given data, and the making of estimates and specifications;—but these subjects will not be confined to the senior, but be equally attended to by the 2nd class.

It is likewise my wish to make all the students familiar with the use of tools, and that they should become practical as well as scientific workmen; that this is essential, I have the high authority of the late Mr. Telford, who has said,—"Youths of respectability and competent education, who contemplate civil engineering as a profession, are seldom aware how far they ought to descend in order to found the basis of future elevation. It has happened to me more than once, when taking opportunities of being useful to a young man of merit, that I have experienced opposition in taking him from his books and drawings, and placing a mallet and chisel or a trowel in his hands, till, rendered confident by the solid knowledge which only experience can bestow, he was qualified to insist on the due performance of workmanship, and to judge of merit as well in the lower as in the higher departments of a profession in which no kind or degree of practical knowledge is superfluous. For this reason, I ever congratulate myself upon the circumstances which compelled me to begin by working with my own hands."

Many, indeed I may say *most*, of the young men of the present time have no idea at all of working themselves; they learn in the office, from drawings, how work ought to be done,—perhaps I shall be even more correct when I say they know how it ought to look when done; but how to do it they don't know, and are thus obliged to trust much to artificers: and I have known young engineers hesitate to find fault with bad work—such work as common-sense would pronounce to be imperfect—because they could not point out to the workmen the way in which it should be executed.

It perhaps would be too much to expect that every architect and engineer should be absolutely skilful operatives, because, to become so, the artificer's tools must be constantly in the hand; whereas their time, of course, would be occupied more in head than in hand labour. They must, however, as I have remarked, be learned judges of work; and no man can be this unless he himself knows how to work.

Having mentioned the numerous subjects which will form studies for the aspirants to professional qualification, I wish it to be distinctly understood that we do not profess to perfect young men, either as engineers or architects, any more than the Woolwich cadet is perfected by the academy to command when he has received his commission: he may possess the scientific knowledge theoretically, but it will be readily admitted that he will lack the cool head and ready resources in danger which practice and confidence, the result of practice, alone can give. A naval cadet may learn navigation, —may know how to steer, to reef and furl, and even to rig a ship, by instructions on shore; but he would make a sorry seaman without he gained his experience amongst the rough realities of his profession. So, also, a civil engineer or an architect may learn how to excavate, to build, and to design at college; but he must not be entrusted to expend money for others upon his designs, without being qualified by steady, hard practice.

But we *do* profess to give the architectural and engineering student that scientific knowledge, that theoretical acquaintance with their business, that when they enter the office of a practical man, they may understand what they see—and understanding, profit by the experience they will gain on works entrusted to their charge. From my experience with young beginners, it is my decided and serious opinion that they should, before entering an office, learn well all the theoretical branches of their profession, because when in the office they will be left principally to their own resources; and, unless they learn themselves from opportunities offering (not pointed out to them), they may leave the office at the end of their term with probably some knowledge of simple business routine—with some vague and undigested ideas of the conduct of works; but further than that, as little qualified to practice as when they left school.

In this respect, then, as offering a sound mathematical and scientific education to young professional men, this College ought to be encouraged by the older societies of Civil Engineers and Architects,—for by doing so, they would receive into their ranks far different, far better, men than they have been in the habit of receiving.

I earnestly hope, having the dignity of my profession at heart, I may be enabled to unite my strength with that of the other professors of this establishment, so effectually, that it may become all that its most ardent supporters can desire.

BRITISH ASSOCIATION.

Nineteenth Meeting,—held at Birmingham, September, 1849.

(*Continued from page* 314.)

Chemical Section.—Dr. Percy in the Chair.

1. *On the Decomposition and Partial Solution of Minerals, Rocks, &c., by Pure Water, and Water charged with Carbonic Acid.* By Prof. W. B. Rogers and Prof. R. E. Rogers, of the University of Virginia, U.S.

In opening this communication, Prof. W. B. Rogers adverted to its important bearings upon the Chemistry of Geology and the theories of the formation of soils and of the nutrition of plants. He referred to the experiments of Struve, Forchhammer and others, as being of too restricted a scope to permit a basis for reasoning *generally* on the disintegration of rocks, the formation of chalcedonic, zeolitic and other minerals by solution, and the conveyance of inorganic materials into the structure of plants. It therefore becomes a question of importance whether water, pure or charged with carbonic acid, possesses that general decomposing and dissolving power which some chemists have vaguely and without sufficient evidence ascribed to it, or whether this action applies only to the few materials hitherto tried, and which all contain an alkali.

The experiments of the Professors Rogers were of two kinds: first, by an extemporaneous method with the *tache*, and second, by *prolonged digestion*, at the ordinary temperature. In the former a small quantity of the mineral in very fine powder is digested for a few moments on a small filter of purified paper, and a single clear drop of the liquid received on a platinum slip is dried and examined by appropriate tests before and after ignition. In the second process a quantity of the finely-powdered mineral is placed with the liquid in a green glass bottle, and agitated from time to time for a prescribed period. The liquid separated by filtration is evaporated to dryness in a platinum capsule. The residuum is then critically examined, and, if in sufficient amount, is submitted to quantitative analysis. In both processes two parallel experiments were made, the one with pure aërated water, the other with water charged to saturation at 60° with carbonic acid. In the second process correction was made for the alkali, lime, &c., dissolved from the containing glass, by making separate experiments in similar vessels without the mineral powders.

1. When the substance is very minutely powdered before mingling it with the liquid, even the first drops that pass the filter will commonly give a *tache* containing some of the alkali or alkaline earth that has been dissolved. In this way proof of the action of the carbonated water may generally be obtained in a few minutes after adding it to the powder. In the case of pure water the action is feebler and requires a longer time; but with nearly all the substances enumerated it is distinct, and with some of them quite intense.

2. By an independent series of experiments, to determine the effect of heat, which were made upon the *taches* of potassa and soda, and their carbonates, and upon those of carbonate of lime and magnesia, as well as upon considerable quantities of these substances successively exposed in a crucible to the heat of a table blow-pipe, it was found that the order of volatility was as follows: potassa, soda, magnesia, lime. The *tache* of potassa disappeared almost at once, that of soda lingered some time, that of magnesia wasted more slowly, while that of lime remained with little alteration for a long time. Before heat was applied the *tache* of the alkalies or their carbonates would of course be strongly alkaline. That of the carbonate of magnesia also presented a decided and sometimes strong reaction with the test paper, while that of carbonate of lime gave a merely appreciable effect. But on raising the *tache* to a red heat, the carbonate of lime, by escape of carbonic acid, would acquire intense alkalinity, the reaction of the magnesia *tache* would be but little altered, and that of the alkaline *taches* would be almost or entirely destroyed. As examples of this *distinctive* testing and of the mode of proceeding in these *tache* experiments, Prof. Rogers gave some details extracted from the large mass of unpublished results, and called attention particularly to the contrasting phenomena in the cases of Leucite, Olivine, and Epidote: the first characterised by potassa, the second by magnesia; and the last by lime. Thus, in the case of *Leucite*, the water *tache* and carbonic acid water *tache* were both alkaline, the latter very strongly so. But even gentle ignition for a few seconds, or strong ignition for a moment, was found *entirely to dissipate* the alkali. In the case of *Olivine*, the water *tache* was decidedly alkaline; and that from carbonic acid water greatly more so. Ignition produced for the first second or two but little change; but its continuance caused a gradual diminution of the alkaline reaction, which at the end of ten seconds was reduced to about *one-twelfth of what it was at first*. With *Epidote*, the *tache* presented an extremely feeble reaction before heating. Ignited for a moment, the alkalinity was intense; and after ten seconds of ignition, but *little abatement* of the alkaline reaction was discerned.

3. Referring to the second method of experimenting used by the Professors Rogers—viz., that of *prolonged digestion* in water or carbonic acid water, Prof. Rogers exhibited results obtained with hornblende, epidote, chlorite, mesotype, &c., showing that the amount of solid matter dissipated by the carbonated water in many of these cases is quite sufficient for a *qualitative analysis* even when the digestion has only been continued for forty-eight hours. When farther prolonged, they have procured from the liquid a quantity of lime, magnesia, oxide of iron, alumina, silica, and alkali, the dissolved ingredients of these minerals severally amounting sometimes to nearly one per cent. of the whole mass.

4. In connection with the preceding investigations, Profs. Rogers were led to an examination of the *comparative solubility of carbonate of lime and carbonate of magnesia in carbonated water*. In the standard chemical and geological works, the carbonate of lime is stated to be the more soluble; and on this supposed fact is founded a common theory of the origin of the large quantities of carbonate of magnesia in the magnesian limestones. It was conceived that in a mixed limestone containing both the carbonates, the *relative amount* of carbonate of magnesia would be augmented through the more rapid removal of the carbonate of lime by the percolating waters, and that thus the mass would approach more and more to the composition of a dolomite. The experiments of the Profs. Rogers demonstrate that in water impregnated with carbonic acid, carbonate of magnesia is much more soluble than carbonate of lime. Thus by allowing the slightly-carbonated water to filter through a mass of magnesian limestone in fine powder, and collecting the clear liquid, analysis detected a much larger proportion of carbonate of magnesia in the solution in comparison with the carbonate of lime than corresponded with the amount of those substances relatively in the powdered rock. Again, by agitating briskly a quantity of the powder with the carbonated water in a glass vessel, and then separating the liquid by filtration, it was found that a larger relative amount of the carbonate of magnesia had been taken up by the solvent, than of carbonate of lime. From these experiments, the Profs. Rogers infer that the unfiltering rain-water, with its slight charge of carbonic acid, in passing through or between strata of magnesian limestone will remove the carbonate of magnesia more rapidly than the carbonate of lime; and that thus the rock will gradually become relatively less magnesian, instead of being made to approach the condition of a dolomite, as is commonly maintained. Prof. Rogers called attention to the fact that the stalactites in caverns of magnesian lime-

stone contain only minute quantities of carbonate of magnesia. An examination of those in Weyer's cave in Virginia had proved that while the milky white opaque stalactites contain a small but measurable amount, the sparry and more transparent kinds are almost destitute of a trace of this ingredient. It is evident that in such cases the carbonate of magnesia is carried off by the liquid below, and that such is the case seems to be confirmed by the fact of the large amount of carbonate of magnesia found in the springs in the immediate neighbourhood of the cave just named.

5. A fact of much interest noticed in these experiments, is the comparative readiness with which the magnesian and calcareo-magnesian silicates yield to the decomposing and dissolving action of carbonated water and even simple water. This explains the rapid decomposition of most rocks composed of hornblende, epidote, &c., without calling in the agency of an alkali; and it enables us to trace the simple process by which plants are furnished with the lime and magnesia they require from soils containing these silicates without our having recourse to any mysterious decomposing power of the roots of the growing vegetable.

6. In their *tache* experiments, the Profs. Rogers ascertained that the powder of anthracite, bituminous coal, and lignite, all yielded a discernable amount of alkali to the carbonated water, while the ashes of these materials similarly treated gave no alkaline trace on the test paper. This, they think, is at once explained by the high temperature at which the ash is formed, which by experiments already noticed is quite sufficient to dissipate any portion of alkali or carbonate originally present in the material.

Remarks.—Mr. Pattinson stated that he had patented a process for separating magnesia from the magnesian limestone. The process consists in forcing carbonic acid to dissolve the magnesia, whereas it will not dissolve the lime.

2. *Report on the Oxidation of Rails in and out of use, determining the Loss by Abrasion.* By Mr. R. Mallet.

The top surface of a railway-bar in use is constantly preserved in a state of perfect cleanliness, freedom from oxidation, and polish; while the remainder of the bar is rough-coated originally with black oxide, and soon after with red rust (peroxide and basic salts). Not only is every metal electro-positive to its own oxides, but, as established in the second Report on the Action of Air and Water on Iron, the polished portion of a mass of metal partially polished and partially rough is primarily corroded on the rough portion. Hence a railway-bar while in use is constantly preserved from rusting by the presence of its polished top surface. Such polished surface has no existence on the rail out of use. The upper surface of the rail in use is rapidly condensed and hardened by the rolling of the traffic over it; and it is also shown in the above Report that, all other circumstances being the same, the rate of corrosion of any iron depends upon its density, and is less in proportion as this is rendered greater by mechanical means. As every metal is positive to its own oxides, the adherent coat of rust upon iron, while it remains, powerfully promotes the corrosion of the metal beneath, and this in a greater degree in proportion as the rust adherent is of greater antiquity. It has been shown that the rust produced by air and water, which at first contains but little per-oxide, continues to change slowly, and becoming more and more per-oxidised, becomes more and electro-negative to its own base. Now, the rust upon a railway-bar out of use continues always to adhere to it, and thus to promote and accelerate its corrosion; while the rust formed upon a railway-bar in use is perpetually shaken off by vibration, and thus this source of increased chemical action removed.

To recapitulate, railway-bars forming part of a long line, whether in or out of use, corrode less for equal surfaces than a short piece of the same iron similarly exposed. Rails in use corrode less than those out of use. This difference is constantly decreasing with the lapse of time. The absolute amount of corrosion is a source of destruction of the rail greatly inferior to that due to traffic. It is highly probable that the electrical and magnetic forces developed in the rails by terrestrial magnetism and by rolling traffic re-act in some way upon the chemical forces concerned in their corrosion; and that, therefore, the direction of lines of railway in azimuth is not wholly indifferent as respects the question of the durability of rails.

The author concludes with two practical suggestions, deducible from the information obtained:—1st. Of whatever quality iron rails are rolled, that they should be subjected prior to use to an uniform course of hammer-hardening all over the top surface and sides of the rails; and, 2ndly, that all railway-bars before being laid down should, after having been gauged and straightened, be heated to about 400° Fahrenheit, and then coated with boiled coal-tar. This has been proved to last more than four years, as a coating perfectly impervious to corrosive action, while constantly exposed to traffic.

3. *Analytical Investigations of Cast-Iron.* By Mr. Wrightson.

The analyses showed the influence of the hot blast in producing the so-called "Cold Short Iron," by occasioning an increased reduction of phosphoric acid, and the consequent increase of phosphorus in the "hot-blast" iron. The respective per centages were—

	1	2	3	4	5	6	7
Cold Blast ..	0·47	0·41	0·31	0·20	0·21	0·03	0·36
Hot Blast ..	0·51	0·55	0·50	0·71	0·54	0·07	0·40

The irons differed also considerably as to the state in which the carbon was contained in the hard white iron, resembling impure steel, containing nearly all its carbon in a state of chemical combination, whilst the carbon contained in the grey and mottled varieties of iron was principally contained only as a mechanical mixture. The presence of sodium and potassium in all the specimens examined was also noticed for the first time, and it was thought probable that these might materially affect the qualities of the metal.

Remarks.—Mr. Phillips pointed out the loss of carbon, which, in the method described, would arise from the use of hydrochloric acid, giving rise to an oily product; to which Mr. Wrightson replied that he had determined the carbon by an independent method.—The President inquired if Mr. Wrightson had sought arsenic in all his analyses?—Mr. Wrightson replied that he had not found it in some, and did not, in consequence, look for it in the others.—The President objected that it was as important to determine the absence as the presence of so important an element as arsenic. In reply to an inquiry, he said that in examining the slags of furnaces in many countries, he had only discovered phosphoric acid in one from Belgium.

4. *On Copper containing Phosphorus, with details of Experiments on the Corrosive Action of Sea-Water on some varieties of Copper.* By Dr. Percy.

Upon analysing a specimen of copper, to which when in a state of fusion some phosphorus had been added, it was found that it contained a considerable quantity of phosphorus, and also a large portion of iron derived from an iron rod employed in stirring the mixture at each addition of the phosphorus. The copper employed was of the "best selected"—it appeared to be harder than copper treated with arsenic. The details of the analysis of 116·76 grains were given, the result of which was—

Phosphorus	0·93
Iron	1·99

A second analysis gave—

Copper	95·72
Iron	2·41
Phosphorus	2·41
	100·54

It has long been stated that a very small quantity of phosphorus renders copper extremely hard, and adapts it for cutting-instruments—but such an alloy as that formed by Dr. Percy has not previously been formed. It is a remarkable fact that the presence of so large a quantity of phosphorus and iron should so little affect the tenacity and malleability of the copper. The effect also of phosphorus in causing soundness in the casting of copper is interesting, and may be of practical importance.

Remarks.—Captain James, superintending engineer at the Woolwich dockyard, said that the rapidity with which copper sheathing sometimes decays was surprising; in five months it sometimes decays completely. Some of the old copper had lasted forty years; and for the purpose of determining the cause of this difference, he made a series of experiments on all the copper which had been used in her Majesty's dockyard. By steeping these different coppers in salt water for nine months, a series of actions set in, which, by subsequent weighing, were accurately determined. The following table exhibits the results of these experiments:—

		Grains.
Electrotype copper, loss per square inch		1·4
Selected copper		1·1
Copper containing phosphorus		·0
Copper from the "Floric"		1·12
Dockyard copper,	No. 1	1·66
Ditto	No. 2	3·
Ditto	No. 3	2·48
Ditto	No. 4	3·33
Munts's metal		·95

Mr. Phillips inquired if the specimens were wholly exposed to the water, or were only partially exposed, so as to allow the action of air; as in the latter case the chloride of magnesium in sea-water would give rise to the formation of an oxichloride, but which would not be formed if air were absent.—Captain James said they had been wholly immersed.

5. *On the Formation of Dolomite.* By Professor Forchhammer.

The white chalk of Denmark is covered by a bed only a few feet thick, containing corals of the genera Caryophyllia and Oculina, and a number of fossils different from those of the white chalk;

that this bed, which may be seen over a great part of Denmark always in the same position, the same fossiliological character, and the same thickness in the hill of Faxöe, is enlarged to a thickness which cannot be much less than 150 feet. Here the Faxöe limestone is covered by a bed of dolomite, which again is covered by a bed of limestone, consisting almost entirely of fragments of Bryozoa, and belonging likewise to the chalk formation. The limestone of Faxöe contains about 1 per cent. of carbonate of magnesia, arising from the shells and corals which always contain it in a small quantity, but which in some instances, as in the Isis and some Serpulæ, amount to 6 or 7 per cent. The bryozoan limestone which covers the dolomite does not contain more than 1 per cent. of carbonate of magnesia, while the dolomite contains 16 or 17 per cent. of carbonate of magnesia. The dolomite occurs generally in round globular masses; very similar to those of Humbledon Hill, and are evidently (like most of the globular masses of limestone, such as confetti di Tivoli, and the peastone from Carlsbad) the produce of springs,—an opinion which is still more confirmed by a number of large vertical tube-like cavities, which pass through the compact limestone, and are completely similar to those described by several English geologists as passing through the chalk, which have been recognised as the natural pipes of springs. Thus the Faxöe dolomite is the produce of springs; but then these springs have deposited stalagmitical limestone wherever they have passed through the crevices of the limestone rock, which as a more or less thick coating covers all the fossils. Now, this produce of the springs contains only a very small quantity of magnesia, but besides lime, a great quantity of oxide of iron. It appears thus, that the springs do not deposit carbonate of magnesia, if no other reaction takes place than the escape of carbonic acid; but that the dolomite is formed where the carbonic acid springs come in contact with sea-water. The author has made a great number of experiments on the decomposition which takes place when water containing carbonates dissolved by carbonic acid acts upon sea-water, and found that always a more or less great quantity of carbonate of magnesia was precipitated with the carbonate of lime. When using water containing only carbonate of lime, the quantity of carbonate of magnesia thrown down at a boiling heat amounted to 12½ per cent., the rest being carbonate of lime. The results of this decomposition vary, however, very much, and according to conditions not yet well known. So much, however, may be stated, that the quantity of carbonate of magnesia precipitated increases with the increasing temperature. Water which, besides carbonate of lime, contains carbonate of soda, throws down a much larger quantity of carbonate of magnesia, amounting in one experiment to 27·93 per cent. of the precipitate. At last, the author tried what kind of precipitate some of the most famous mineral springs of Germany would form, if they at the boiling point acted upon sea-water. Thus, he obtained:—

From the water of Selters.

Carbonate of lime	86·55
„ magnesia	13·45
	100·00

From the water of Pyrmont.

Carbonate of lime	84·38
„ magnesia	5·12
Protoxide of iron	10·50
	100·00

The oxide of iron in the experiment was of course precipitated as peroxide of iron, and from that the carbonate was calculated—

From the water of Wildengen.

Carbonate of lime	92·12
„ magnesia	7·88
	100·00

Remarks.—Professor Ansted agreed with the view of Professor Forchhammer relative to the formation of dolomite, at the same time observing that there were undoubtedly several other ways in which it may be produced, but that suggested by M. Forchhammer was undoubtedly one.—Dr. Daubeny was glad to see that such subjects were enjoying the attention of chemists. Had Von Bucks had a small amount of chemical knowledge, he would have avoided the elaborate but untenable theory relative to the formation of dolomite which he had advanced.

6. *On the Colouring of Glass by Metallic Oxides.* By M. Bontemps.

Oxide of iron gives usually a green colour, but by various methods of treatment the author obtained by its use all the colours of the spectrum. In the manufacture of earthenware a red was obtained by iron, and at some degrees of heat it gave a yellow colour. Manganese gives a purple or pink colour. The light pink colour given by manganese is liable to change by exposure to a low heat; it passes first to brownish red, then to yellow, and lastly to green. Flint-glass, in which small quantities of manganese are used, is liable to become of a light yellow by exposure to light. Copper produces a fine red colour, and also a green; the former being produced by the lowest degree of oxidation, and the latter by the highest. Silver produces a yellow colour, which may vary from lemon yellow to deep orange. Gold, in the form of the purple precipitate of cassius, gives a ruby colour to glass, but it requires careful treatment; the mixture when first melted is colourless, but becomes red on re-heating. The various colours which at different temperatures the same oxide produces, are attributable to some molecular change in the glass.

M. Bontemps has found that similar changes take place in the annealing oven. He has determined, by experiments made by him on polyzonal lenses for M. Fresnel, that light is the agent producing the change mentioned; and the author expresses a doubt whether any change in the oxidization of the metal will explain the photogenic effect. A series of chromatic changes of a similar character were observed with the oxides of copper; the colours being in like manner regulated by the heat to which the glass was exposed. It was found that silver, although with less intensity, exhibited the same phenomena; and gold, although usually employed for the purpose of imparting varieties of red, was found by various degrees of heating at a high temperature and re-casting several times to give a great many tints, varying from blue to pink, red, opaque yellow, and green. Charcoal in excess in a mixture of silica alkaline glass gives a yellow colour, which is not so bright as the yellow from silver, and this yellow colour may be turned to a dark red by a second fire. The author is disposed to refer these chromatic changes to some modifications of the composing particles rather than to any chemical changes in the materials employed.

Remarks.—Dr. Faraday said, in the beautiful facts brought forward by M. Bontemps, it appeared that many of the changes of colour mentioned are purely physical. The phenomena of the change of manganese from white to pink in glass appeared to him inexplicable as a chemical effect.

Mr. Dilke inquired upon what peculiarity depended the differences discovered to exist in the coloured glass of the windows of old churches and that of modern manufacture.

M. Bontemps stated that the observed differences were entirely due to age and imperfections in manufacture.

Dr. Faraday remarked that any irregularities tended to produce the diffusion of the rays which permeate the glass; and that the opacity of ancient church windows was probably due to a superficial change of the external surface.

M. Bontemps stated that old glass was by repolishing rendered as transparent as any modern glass.

Dr. Faraday concurred with M. Bontemps in regarding the phenomena of coloured glasses not as purely chemical nor purely physical, and believed that it is only by considering them conjointly as physical and chemical that they can be successfully studied.

7. *On the cause of the Colouration of Porcelain by Oxide of Iron, and the general theory of Kilns.* By M. Leon Arnoux.

This communication, which was read by the author in the French language, entered very extensively into the general detail of the process of forming porcelain, and particularly adverted to many defects to which it was liable in the process of manufacture. Particular attention had, however, been directed to discover the cause giving rise to a disagreeable yellow tint which frequently presented itself. The author comes to the conclusion that this yellow colour is due to the presence of oxide of iron. It had been thought by M. Ebelman that infinitely small quantities of carbon produced this defect, but all the experiments of M. Arnoux went to prove the presence of iron whenever the porcelain presented this peculiar tint.

A short discussion followed between the author and M. Bontemps, the latter contending that carbon was far more likely to produce this yellow than iron, and instanced the effects of carbon on glass. He was disposed to think that at the high temperature of firing, the presence of iron would give rise to a blue rather than a yellow colour.

8. *On an improvement in the Preparation of Photographic Paper, for the purpose of Automatic Registration, in which a long-continued action was necessary.* By Mr. Charles Brooke.

The preparation of the paper described may be thus briefly stated:—The paper is washed over by a brush with a solution of 12 grains of bromide of potassium, 8 grains of iodide of potassium, and 4 grains of isinglass in 1 fluid ounce of distilled water, and dried quickly. When about to be used it is washed over by a brush with a solution of 50 grains of nitrate of silver to 1 fluid ounce of water, and placed on the cylinder of the registering apparatus, on which it remains in action for twenty-four hours.

When removed the impression is developed by brushing over a warm solution of gallic acid, containing 20 grains in the fluid ounce, to which a little strong acetic acid is added, and is then fixed with a solution of hyposulphite of soda in the usual manner. The present improvement consists in rinsing the paper in water after the application of the solution of nitrate of silver, pressing out the superfluous moisture in folds of blotting-paper, and then adding a little more of the solution of nitrate of silver to the surface of the paper. This is most conveniently effected by pouring a small quantity on the paper, and then pressing a glass-rod or tube lightly over the paper, by which the solution is evenly distributed over the surface, and the contact of organic matter avoided. The increased sensibility and improved cleanliness of the paper consequent on this addition to the process are presumed to depend on the removal by washing of the nitrate of potash formed by the mutual decomposition of the salts on the surface of the paper.

Remarks.—Mr. **Shaw** remarked that the difficulty Mr. Brooke had experienced could only have arisen from some defect in the preparation of his paper, and that had the difficulty a real existence, the means proposed to remedy it were very doubtful. He spoke confidently on the subject, as by hundreds of experiments he knew that the paper in question, when carefully prepared, preserved all its properties unimpaired for a much longer period than that named by Mr. Brooke, and the failure of the paper in his hands must have arisen from want of care in its preparation. Mr. Brooke's proposed remedy was, he believed, defective in the following respect:—Mr. Brooke assumed, that by adding bromide of potassium to the iodide, a mixture of the bromide and iodide of silver would be obtained on the paper; but such was not the case. If paper prepared with bromide of silver be drawn through a solution of iodide of potassium, the whole of the bromide is converted into iodide. The same took place with chloride of silver when treated with iodide of potassium, so that Mr. Brooke was in error in supposing that he had formed any bromide of silver by the method he described. This new paper was exactly the same as the old which he condemned.

9. *On the Heat of the Vaporisation of Water.* By J. P. Joule.

The object was to point out the complex nature of the heat hitherto taken from the latent heat of steam. In the exact experiments of Regnault 965° was found to be the quantity of heat evolved in the condensation of steam saturated at 212°; of this quantity 75° is the heat due to the *vis viva* communicated by the pressure of the steam, leaving 890° as the true heat of vaporization of water. In a perfect steam-engine supplied with water at 212°, and worked at atmospheric pressure without expansion, 965° will be the heat communicated from the fire to the boiler, 75° will be the heat utilised by conversion into force, and the remainder 890° will be the heat given out in the condenser.

10. *On a new Galvanic Battery.* By Mr. W. H. Wallenn.

The battery consists of zinc and cast-iron, the plates of the latter being brought very near to the former. The zinc plate was coated with lead, by being first immersed in acetate of lead, and afterwards treated with mercury, the mercury being subsequently volatilised by heat. The cast-iron was also prepared with carbon in a way which was not easily gathered from the description, and carbon was also described as diffused in some way through the dilute sulphuric acid which was used to excite it. The battery was said to be very active and very constant, and from the protecting action of the lead the zinc was economised. The author exhibited a plate of zinc which he described to have been used for a considerable time, but which was nevertheless little acted on.

Remarks—Mr. **Shaw** stated that the only novelty in the battery, excepting the use of carbon, which he did not comprehend, was the coating of the zinc with lead, the effect of which, as he understood the author, was to protect the zinc not merely from what is called local action, but to defend it in a great measure from the solvent power of the acid without impairing the action of the battery. In the present state of electrical science, it was impossible to receive such a view without a mass of evidence much more exact than that which had been brought forward. The elaborate researches of Faraday had determined that the amount of electricity evolved in a voltaic pair was in direct relation to the quantity of zinc oxidised and dissolved; that is to say, the solution of an atom of zinc was accompanied by the circulation of a definite amount of the electric force, and that whatever impeded the oxidation and solution of the zinc, diminished in the same ratio the evolution of electricity. The electricity concerned in the decomposition or formation of a compound was as definite a quantity as the material elements entering into its composition, and could be measured as accurately as they could. This was established by a mass of evidence so overwhelming as to be wholly unaffected by the general experiments brought forward.

Mr. **Wallenn** replied that he was still of opinion that his battery was superior, and that the deflection of the galvanometer and the deposition of copper, supported his opinion.

Mr. **Robert Hunt** insisted on the importance of exact experiments; nothing which he had stated could be put in competition with the principles explained by Mr. Shaw, and he believed that by a more minute examination of the subject he would find himself in error. Some of the parts of his battery which he regarded as new were not new; and those that were, were not improvements.

Report on recent Applications of the Wave Principle to the Practical Construction of Steam Vessels. By Mr. J. Scott Russell.—(Read in the Section of Mathematical and Physical Science.)

During the last year I have had more than one opportunity of applying the wave principle to the construction of steam vessels. There is one case, however, in which I have been able to apply it to practice under circumstances of greater complexity and difficulty than have ever occurred to me, and where it has been successful in overcoming difficulties to a greater extent and in a more decided manner than heretofore.

During the last year a very difficult problem was proposed to me. It was this:—To build a steam vessel that should be fast without great length, a good sea-boat without drawing much water, and to carry a great top weight and yet swim very light. Besides, this vessel was to be able to go backwards as well as forwards equally well; and, though a small boat, was to contain great accommodation. The problem is one to which the wave principle is far from seeming peculiarly applicable. In the first place, it is well known that the wave principle prescribes a different form of the bow from that of the stern, in order to obtain most speed with least cost of power. In the second place, it is known that a high speed requires on the wave system a very considerably greater length than was here allowed for the entrance of the vessel or the lines of the bow. It would therefore seem at first to be a case that would prove too difficult for the successful application of the wave system. There is one more feature in the case which gives it interest. At the same time the same problem was worked out by another party on another plan of construction, *not* on the wave principle. Another vessel was built under similar conditions, with engines of the best construction, made by one of the most eminent engineers in England. Both of these vessels were built at the same time and tried under similar circumstances: therefore, here was a case in which the practical value of the wave principle has been brought to a test more direct and less questionable than any that was likely to have occurred—and, therefore, more important to be placed on the records of the British Association. The first question which will naturally occur to a member of this Association who recollects this principle will be this: How could you apply the wave principle in a vessel made to go equally well both ways? The first answer is ready—it is this, that the vessel cannot be made to go only one way—seeing that in one case she would have a best possible bow and a best possible stern, and in the other case could have neither. The next point is this; that in both cases of bow and stern it was necessary to have a compromise. Each required to be in turn bow and stern,—this was accomplished in the following manner:—If there be any point which has more forcibly struck me in the application of the wave principle than another, it is the flexibility of the wave principle,—the extent to which it admits of deviations from its strict rules without losing the benefit of its assistance. If it had unluckily been true of this system that it prescribed an exact mathematical solid in its three dimensions (like Newton's Solid of least Resistance), to which implicit adherence was imperative on pain of losing all the benefit proffered, then, indeed, the system would have been (like Newton's) of little use, from the fact that, from causes independent of resistance, ships cannot be solids of revolution, consistently with other qualities. The wave principle, on the contrary, possesses wonderful flexibility; first, from the circumstance of its prescribing lines *in one plane* only, and so leaving the other two dimensions in the hands of the practical constructor,—so that the sections of the vessel in one plane being given by the system, the sections in two others are at the service of the constructor. I had in this case to lay down for both ends of the vessel, that which is best for a bow and that which is best for a stern, at the given velocity. I had next to place relative values on bow resistance and stern resistance. I had next to single out from between those two lines one which, taken either as bow or stern, would deviate least from either, and so have least resistance on a mean of both directions. This, therefore, the wave principle did;—it gave the limits, and gave also the choice of a series of means all more or less suited to the purpose intended. I have now shortly to state the practical details by which this process was carried into effect and the results arrived at in consequence.

The engines of the vessel, as well as the vessel, had to be constructed by my partner, Mr. A. Robinson, and myself, and we were enabled to adapt the one to the other with greater ease and certainty than in all likelihood we could have done had the engineer been separate from the ship-builder. In our case the engine was considered and made an actual portion of the ship, and the ship of the engine. It will be fair, therefore, to deduct from the good effects attributed to the wave form of the ship such advantages as we possessed in building both engines and boilers and ship as one whole;—still it is fair to remember, on the other side, that the builders of the engines with which ours had to compete have been celebrated for their efficiency and for the large actual power they have developed, when compared with their nominal power. It should also be remembered that the builders opposed to us had previously built the fastest boats of their district. The results obtained are as follows:—Both vessels were about 150-55 feet long; 22-22½ feet beam; 4 feet draft of water; 240 tons displacement; 150-horse power, nominal; propelled by oscillating cylinders of 48 inches diameter, with the same proportion of stroke to paddle-wheel in both cases; and with only such differences as the engineers and ship-builders in each case considered likely to be most successful in carrying out the execution of their work to the best advantage. The terms prescribed to both builders by the engineer of the proprietors being identical, and with only such latitude as should not form an obstacle to whatever might seem best suited for obtaining greatest efficiency.

Results of Experiments on Velocity with equal Power.

	Wave vessel.	Competing vessel.	
Speed	16·18	15·03	miles per hour.
Power	20·3	19·9	velocity of wheel.
Loss	4·17	4·87	slip of wheel.

These are the results of accurate trials, at the measured mile, made both with the tide and against it. It is important to observe the amount of slip, as it serves to show that it was no deficiency of the engine power which caused the difference, both engines having gone at, as nearly as possible, the same speed. In order that the statement just given may not lead to false conclusions, it is necessary to state what were those minor differences in vessel and engine which each constructor adopted as tending to greater efficiency. The wave vessel had a flatter floor, and considerably squarer on the midship section, which was done for diminishing the depth of water as wanted for her use. In the other vessel, the consideration of draft of water was rejected or overlooked, and a finer midship section taken, although with a larger draft of water. In one case, also, the rudders were considered as part of the length of the vessel, and treated accordingly, and in the other case rejected from it. In the engines also, although the diameters of the cylinders were identical, the stroke of the wave vessel was somewhat longer than the other, but the diminished effective diameter in the shorter stroke reduced them to nearly the same proportion. Thus far the experiments given only serve to prove that, practically, a considerably better result has been obtained by a steam-vessel built on the wave principle than a competitor built under conditions that are perfectly identical, in so far as the public and the owners are concerned. But as regards the purely scientific question, I shall add two other experiments with the wave vessel, which furnish data of a more permanent and precise nature—one at a higher, the other at a lower velocity:—

Experiments on the Wave Vessel.

I.			II.		
Velocity of vessel	15·14	miles an hour.	Velocity of vessel	16·50	miles an hour
„ of wheel	18·17	„	„ of wheel	21·20	„
Slip	3·03		Slip	4·70	

The area of midship section immersed was 89·4 feet.
The surface of vessel immersed was 3080·0 feet.
The area of paddle-floats was 26·8 feet.

The conclusion which I deduce from these last experiments is this, that by means of the wave form one may obtain a form of which the resistance shall be represented by $R = \frac{1}{20} A H S$, instead of $R = \frac{1}{8} A H S$, which is the lowest number given in any previous system of construction;—A, being the area of midship section, H, the height due to the velocity of the vessel, and S, the weight of a cubic foot of water.

Comparative Statement of Prices and Wages during the Years from 1842 to 1849. By Mr. G. R. Porter.

We extract the following tables from Mr. Porter's very interesting paper, read in the Statistical Section.

To begin with what is emphatically called "the staff of life," and the price of which is a thing of the very first importance to those who depend upon daily or weekly wages. The 4lb. *loaf of bread* sold in the bakers' shops in London, has been, in the month of July of each year, from 1842 to 1849 as follows:—

1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.
9½d.	7½d.	8½d.	7½d.	8½d.	11½d.	7½d.	7d.

Meat.—The following prices, per stone, are those given for the primest beef (Scots) and Southdown mutton, at Smithfield, in the month of June in each year:—

	Beef.	Mutton.
1842	4s. 8d.	4s. 3d.
1843	3s. 10½d.	4s. 1½d.
1844	3s. 8½d.	3s. 10d.
1845	4s. 4d.	4s. 9d.
1846	3s. 9d.	4s. 8d.
1847	5s. 6d.	5s. 7d.
1848	3s. 10d.	4s. 11d.
1849	3s. 5d.	4s. 2d.

The retail prices paid by the working classes for other articles of food, and for groceries, in a populous district of London, were as under:—

	1844. s. d. s. d.	1845. s. d. s. d.	1847. s. d. s. d.	1848. s. d. s. d.
Tea, per lb.	5 0 to 7 0	5 0 to 7 0	4 0 to 6 0	4 0 to 6 0
Raw Sugar	0 6 to 0 7	0 5 to 0 6	0 4 to 0 5	0 4½ to 0 5
Refined Sugar	0 7½ to 0 8½	0 6½ to 0 7½	0 5½ to 0 6½	0 5 to 0 6
Coffee	1 8 to 2 6	1 8 to 2 6	1 4 to 2 0	1 4 to 2 0
Cocoa	0 6 to 0 8	0 6 to 0 7	0 6 to 0 7	0 6 to 0 7
Rice	0 2 to 0 3	0 2 to 0 4	0 3 to 0 4	0 2 to 0 3
Currants	0 5 to 0 7	0 5 to 0 7	0 5 to 0 7	0 4 to 0 6
Raisins	0 5 to 0 7	0 5 to 0 7	0 4 to 0 6	0 4 to 0 6
Butter	———	0 8 to 0 10	0 9 to 0 10	0 9
Cheshire cheese	———	0 9	0 9	0 9
Derby cheese	———	0 8	0 8	0 8
Dutch cheese	———	0 6	0 6	0 6
Lard	———	0 9	0 10	0 10
Bacon, per cwt.	———	62 0 to 68 0	82 0 to 88 0	75 0 to 81 0
Eggs, per 120	———	7 6	7 6	7 6

The prices for 1846 are not given, as they vary very little from those of 1845.

The consumption in each year, from 1842 to 1848, of such of the articles of which retail prices have been given, as are imported, have been—

	1842	1843	1844	1845	1846	1847	1848
Sugar.. cwts.	3868466	4028307	4129443	4856404	5220248	5779508	6208872
Tea...... lbs.	37355911	40293393	41363770	44193433	46740344	46314821	48735971
Coffee	28519646	29979404	31352382	34293190	36754578	37441372	37106292
Cocoa	2249569	2547934	2369977	2579497	2951206	3079198	2985479
Rice.... cwts.	396972	315359	432480	872274	545843	971494	925731
Currants	196379	254480	284594	309485	358761	331236	380500
Raisins	186240	236826	204230	204960	238255	212024	228542

It appears thus, that a reduction in the retail price of sugar from 7*d.* to 4½*d.* for raw, and from 9*d.* to 6*d.* for refined sugar, has increased the consumption, since 1844, by 2,079,429 cwt., or 50 per cent. The reduction of 1s. per lb. on tea, viz., from 5*s.* to 4*s.*, has caused an additional consumption of 7,372,201 lb. or 18 per cent.; the retail price of coffee has fallen from 1*s.* 8*d.* to 1*s.* 4*d.*, and the consumption has been augmented by 5,753,910 lb. or 18 per cent.; thus adding very materially to the comforts of the working classes, and chiefly the artisan class, among whom the increased quantities here noticed have principally been used.

Strong cotton cloths, the wholesale price of which in 1810 was 10*d.* per yard, sold in 1820 for 9*d.*; had fallen in 1833 to 4d., and may now be bought at from 2*d.* to 2½*d.* per yard. Printed calico, which sold in 1810 at 2*s.* 2*d.*, in 1820 at 1*s.* 4*d.*, in 1833, the Excise duty having been removed, at 6*d.* to 8*d.*, may now be bought at from 3*s.* 6*d.* to 8*s.* per piece of 28½ yds., or from 1½*d.* to 3½*d.* per yard.

Average weekly earnings at an ironwork in South Wales, from 1844 to 1849:—

	1844 s. d.	1845 s. d.	1846 s. d.	1847 s. d.	1848 s. d.	1849 s. d.
Colliers	13 0	16 2	20 4	20 2	18 1	14 3
Miners	10 7	12 4	15 7	15 9	12 1	10 9
Labourers	11 0	11 0	12 8	13 9	11 10	11 0
Founders	23 9	26 11	33 8	33 5	35 0	30 4
Fillers	22 0	25 10	29 10	31 8	32 7	30 4
Cinder fillers	21 0	19 0	21 8	23 6	22 11	21 1
Refiners	37 8	39 3	51 2	40 7	48 9	39 6
Puddlers	22 7	30 6	35 8	32 4	30 11	25 7
Ballers	22 2	32 7	46 1	38 8	31 7	23 0
Rollers	33 7	58 10	72 0	80 0	60 9	35 6
Rail straighteners	20 2	35 5	49 7	47 8	36 8	18 2

Statement of the workmen's earnings at an ironwork in North Wales in each year, from 1844 to 1849:—

	1844 s. d.	1845 s. d.	1846 s. d.	1847 s. d.	1848 s. d.	1849 s. d.
Colliers, per stent, or under 8 hours	1 6	2 0	2 6	2 6	2 0	1 9½
Miners earn 1½d. to 2d. per stent less than colliers.						
Labourers, per week	8 6	9 6	12 0	12 0	11 0	10 0
Furnace Fillers	14 6	15 6	19 0	18 6	18 6	17 6
Cinder Fillers	14 6	15 6	19 0	18 6	18 6	17 6
Furnace Keepers	19 6	23 0	28 0	27 0	23 0	22 0
Refiners	16 0	25 6	32 0	30 0	24 0	21 0
Puddlers	22 0	32 0	32 0	32 0	26 0	24 0
Heaters or Ballers	17 0	22 0	27 0	29 0	22 6	21 0
Rollers	30 0	47 0	76 0	77 0	46 0	46 6
Rail straighteners	30 0	24 0	30 0	30 0	24 0	16 0

The following are the average weekly earnings of 230 han employed in one mill in cotton-spinning, for each year from 1846 to 1849:—

1846, the earnings averaged 10s. per head, of all ages and both sexes, of 8 years age and upwards, working 12 hours a day.
1847 „ „ 8s. 4½d. ⎧ During these years trade was bad, and the work-
1848 „ „ 8s. 2d. ⎩ ing of the mill averaged about 4 days a week.
1849 „ „ 9s. 4d. only 11 hours a day.

[We have purposely avoided reporting Professor Willis's lecture at the Town Hall, on the 'Deflection of Railway Bridges under the passage of heavy Bodies;' and also Professor Hodgkinson's paper on the 'Strength and Elasticity of Stone and Timber,' read in the Mechanical Section, as they were both merely explanatory statements of some of the experiments that were performed for the "Iron Commission," and which we hope to be able shortly to present to our readers in a more complete form than was given at Birmingham.]

THE BRITANNIA TUBULAR BRIDGE.

The final lift of the Britannia tube took place on Monday the 15th ult., the permanent level of 150 feet above high-water mark having been successfully attained on Saturday the 13th. This additional hoist of 3 feet had to be made, and was indispensably important to enable the great tube to be joined on to the end, or land tube, in the centre of the great tower on the Anglesea side of the Straits, and so completing one-half of the passage across. In effecting this it is found necessary to provide for the expansion and contraction of so great a mass of metal, which from changes of temperature are very considerable: the extreme variation in the length of one of the tubes between summer and winter is stated to be nearly 12 inches. To make provision, therefore, for this constant alteration in length, which would otherwise endanger the stability of the whole structure, the great tubes are fixed in the central Britannia tower in such a manner that they cannot move; but on either side where the tube unites with those in the land towers and abutments on shore, they travel on moveable rollers of cast-iron 6 inches in diameter, a portion of the weight being also supported at the top on balls of hard gun-metal of the same size, working in channeled beams and acting in the same way as the rollers. Besides these rollers, which are now being placed, and on which the tube has to be let down, at the extreme ends, where the rails intended for the trains in the tube are joined to those on land, contrivances are used to prevent a gap being formed by the contraction of the tube, which might otherwise interfere with the passage of the trains. Some uncertainty has occurred with reference to the floating of the second tube. Should the tides, &c., be favourable, it will take place before the close of the present month; but if not, at the beginning of December. The hydraulic apparatus will be brought into action for the lifting of the second tube as soon as it is floated to the foot of the piers.

THE PATENT FIRE ANNIHILATOR.

In the *Journal* for March last (page 127), we gave the substance of a paper read by the Rev. J. Barlow at the Royal Institution, on Phillips's 'Patent Fire Annihilator.' Some interesting experiments have lately been conducted by the patentee, at the establishment of the London Gas Company, Vauxhall, and which were reported at the time in the *Mining Journal*, from which we copy the following very sensible remarks.

"These experiments afford convincing proof that, while water is useless when a fire in a building has obtained a hold, except in saturating surrounding materials, and thus preventing its spread, the vapours generated by this apparatus are perfect non-supporters of combustion, and that no fire can exist for one minute after the atmosphere surrounding it has been charged by their application. The outbreak of several alarming fires in the metropolis of late, and the approach of winter, when calamities of this kind are of more frequent occurrence, has again called our attention to the subject; and, convinced as we are of the soundness of the principle, and the perfect success which must attend its use, we shall be most happy if our remarks tend, in the smallest degree, to promote its general adoption. As regards many of these destructive fires, had one of the largest Annihilators been in requisition in the neighbourhood at the first outbreak, the destructive element would have been subdued immediately, and the large amount of property in many instances destroyed would have been saved; while even when the building was in one mass of flame, had the firemen been supplied with some of the Annihilators of the more powerful sizes, the fire would have been got under in a few minutes, instead of requiring the exertions of a number of men for perhaps 30 or 40 hours in deluging the remains of the property with water, and thus utterly spoiling what probably had escaped burning. It is a remarkable, and one of the most advantageous features of the invention next to its annihilating powers, that as instantaneously as it extinguishes fire, so immediately does it create a perfectly wholesome atmosphere for inhalation, and the most delicate fabrics which might escape the flames are uninjured by the vapours generated. We would therefore suggest to the board of directors of insurance companies managing the fire-brigade department, to Mr. Braidwood, the superintendent, and to country insurance companies, whether it would not be advisable to give the new extinguishing apparatus a fair trial. We know how prone human nature is to hang to old associations, and how difficult it is to introduce new modes of action to the exclusion of the old; but in this age of improvement and scientific advancement, the public look to public men to carry out new discoveries, which promise to be productive of general benefit; and in this instance nothing could be more easy, or devoid of any inconvenience, and, at the same time, without involving an expense worth naming when the prospective benefit is considered, than for the firemen, when called out with their engines, to be provided with some of the largest of the hand Annihilators, and thus give them a fair trial. Should they not prove of the advantage represented, the operators would be provided with the element usually employed—water; but should they turn out to be generally effective, as we expect they will be, it must, on consideration, be perceived what a vast amount of annual loss would be prevented to the companies and to the public; while the safety to human life would, doubtless, form a large item connected with their introduction. During Mr. Phillips's lectures, he described to the audience the natural phenomena which first suggested to his mind the idea of applying vapours to the extinguishing of fire in buildings. It appears that, many years since, he was on board an English man-of-war, cruising in the Mediterranean, when an extraordinary phenomena occurred, which few have had an opportunity of witnessing—the formation of an island from the depths of the ocean by volcanic agency. After the consolidation of land above the water, where the sea was 80 fathoms deep, to an extent of six miles in diameter, the volcanic action continued with extraordinary impetus, notwithstanding an enormous chasm was open on one side the island, into which the waters flowed in foaming torrents, and were as instantly ejected, in combination with red-hot cinders and flames of fire, to a perpendicular height of probably three miles. At this awful moment the vessel, about two miles distant, was gradually drifting, at a slow but certain rate, with the current, directly into this vast fiery opening, and the consternation and despair of all on board may be better fancied than described. All was given up for lost, when suddenly the eruption ceased, a vast body of vapour escaped from the crater, and a current of wind springing up from the island, bore the apparently doomed vessel away in safety. From this perilous adventure, Mr. Phillips was struck with the idea which formed the basis of his present invention. He considered that water, *per se*, had evidently no extinguishing effect on the flame, or even on the source from whence it arose; but as soon as a sufficient quanity of vapour had formed in the fiery depths to cut off all connection with the atmosphere, and thus prevent access of oxygen to support combustion, instantly the flames were checked, the very foundation of the fire annihilated, and the mere island alone remained to show the extraordinary outbreak to which Nature had been subjected. Having thus embodied the idea, the next difficulty was the construction of an apparatus which should instantaneously be available, and which should be certain in operation, and this has been most completely effected. The charge in the machine is a chemical compound of a highly-combustible nature, but only when fired by chemical means. It then gives out a most intense heat, sufficient instantly to vapourise the water contained in the case, and which, mixing with its own vapours, forms the gaseous compound, in which no fire can exist. Although thus a strictly chemical operation, it is so arranged that the most unenlightened, or even a mere child, can perform the action required with ease and safety, it being merely pressing down a peg in the top of the outer case. This peg breaks a capsule containing sulphuric acid, which, dropping into a tube containing chlorate of potash and lump sugar, mixed in the form of a powder, the charge above-noticed is instantly put in a state of combustion, and the effects mentioned are the result. We understand that the public generally are becoming alive to the safety of having one of the Annihilators in their houses, as offering such simple yet certain means of stopping the ravages of fire when in embryo; and no theatre, bank, or other public establishment, gentlemen's country mansions, where, from their isolated position, fires are generally so fatal, nor ships at sea, should be without one or more of these life and property saving machines. Preparations are now being made, by the erection of a much larger building than the one on which experiments were lately made, for proving its capabilities on a more magnificent and practical scale; and on such exposition being made, we shall again return to the subject."

PAUPER INDUSTRIAL SCHOOLS.

"It is an ill wind that blows no one good:" so the melancholy event that took place in the late Mr. Drouet's establishment, Lower Tooting, at the early part of the present year, is likely to blow good to the rising generation of pauper children, by having attracted the attention of the public, in an extraordinary degree, to the manner in which those establishments were conducted, and excited a very general and just prejudice against the whole system of what has been termed the "farming-out" of pauper children; and in consequence, an act of parliament was passed to enable boards of guardians to form district unions, for the erection of schools, away from workhouses, for the education of pauper children.

Although prejudice may exist against the congregating a large number of children together, still, unless this is done to a certain extent, proper masters cannot be obtained and paid to educate the children. By education is meant, not only what is known as ordinary school tuition, but also such industrial tuition as will make valuable servants, and induce respectable masters to take the children when of proper age, or to fit them for emigration.

The education in most pauper schools is not at all of an industrial or agricultural character, as it should be with reference to the probable destination of the children in after-life, to whom the utility of garden or field-labour is obvious, as the greater proportion of pauper children have to gain a livelihood as agricultural labourers; and even when they are engaged in other occupations, the now general practice of annexing allotments to cottages, renders a knowledge of garden cultivation of importance to them. Also, from a want of this knowledge, farmers are very unwilling to engage boys from workhouses; and, in consequence, the children remain a burthen to their parishes long after they ought to be supporting themselves by independent work.

There can be no doubt of the fact that, so long as the present system of education in workhouses prevails, responsible people will not take into their service either boys or girls who have been brought up therein, from their want of industrial knowledge, or dread of contaminated morals (the result of contact with adult paupers); and until the whole system is thoroughly reformed, children so brought up will be taken, as now, by people who are little better than paupers themselves, and so become perpetual paupers and burthens to the parishes to which they respectively belong, with perhaps the addition of wives and families; and, therefore, the conviction is forced upon us, that pauper children must have industrial education, and be removed from workhouses into district schools, as early as possible, to avoid contamination.

It is now generally admitted by all persons whose opinions are entitled to any consideration, that no money returns so good an interest as that which is expended in improving the morals of the labouring classes. This is making it a matter of pocket; but of course higher and better considerations should influence our actions.

The guardians of the Wandsworth and Clapham, Croydon, Kingston, Richmond, and Lewisham Unions, are the first to set a good example to the rest of the country, by the formation of a district school, under the said act (for which they deserve great commendation); and for efficiently carrying out their object, they have purchased 50 acres of land by the Annerley Station of the Croydon Railway, at Penge, in the county of Surrey, and they have had prepared by their architect, Mr. Charles Lee, of Golden-square, designs for the proper accommodation of 600 children—viz., 250 boys, 210 girls, and 140 infants; and a contract has been entered into for a portion of the buildings, which are now commenced.

This establishment is to be strictly industrial, and no pauper officers or servants will be allowed on the premises; it will have three large school and class rooms, with apartments for school-masters, school-mistresses, and trade-masters; for steward, matron, other officers, and domestics; with dining-room, chapel, chaplain's room for examining and instructing the children; board-room; wardrobes, cutting-out, work, and store-rooms; two receiving wards, with clothes-rooms and baths attached; three kitchens, scullery, servants' hall and private rooms; bakery, larders, dairy, lavatories; plunging and other baths; a separate laundry-building, with drying, ironing, mangling, and mending rooms; likewise a detached infirmary-building, containing eight distinct boys' and girls' wards, nurses' day and night rooms, surgery, kitchen, wash-house, and laundry. There are to be also bailiff's house and offices; dairy, cow-houses, and other farm buildings; likewise large gardens, so that the boys will be instructed, not only in trades, but in farming and gardening; and the girls in dairy-work. The buildings are to be heated throughout by warm water, applied in a new manner, and thoroughly ventilated by flues and shafts.

The boys', girls', and infants' departments are quite distinct; and all the servants in the bakery, kitchens, and offices are to be women, so that the girls will be taught baking, cooking, household and needlework; and the whole, when finished, will be a model for the guidance of other districts.

THE NATIONAL EXHIBITION OF ARTS.

Since we last wrote, the scheme for a National Exhibition of Arts and Manufactures has made further progress. A private meeting of friends of the Lord Mayor has been held at the Mansion-house, at which a deputation from the Society of Arts attended, and before which the plan was laid, under the name of Prince Albert's Plan. Mr. Cole appeared as the representative of Prince Albert on the occasion, but we could not ascertain from his statements that H.R.H. has any plan at all, the only one put forward being that long since propounded by Mr. Carter Hall, in the *Art-Union;* by ourselves in this *Journal;* and by Mr. Francis Whishaw before the Society of Arts; and by others whose names we do not now remember.

If an object which is desirable should be carried out, there need be no squabbling as to who was the originator, or as to who was the first in the field; but we are sorry for the miserable sycophancy which can attribute to the Prince a projection to which he has no claim, and fearful of the spirit of intrigue and jobbery which can use the Prince's name to cover its own operations.

This is a blemish on the beginning of the undertaking which, it is to be wished, will be got rid of; and there is every hope that it will, for the plan has now attained great publicity, and is likely to receive the support of many leading men. Prince Albert will be fully satisfied with the share of merit which really belongs to him, of having given his powerful influence and patronage for the advancement of this enterprise; and it will be a title to public respect and esteem, of which it is to be hoped he will earn many more in the course of his abode in our country. If the Prince has not hitherto been able to do much, he has nevertheless shown the disposition to be useful; and by presiding at the meetings of the Society of Arts, the Fine Arts Commission, and Agricultural meetings, and many charitable societies, he has greatly contributed to the cause of progress. It is because the Prince is so well worthy of esteem, we should be sorry to see his fame tarnished: it is because the object to which he has devoted himself is truly worthy, we should be sorry it should fail or fall short in its results.

It has been remarked with truth in the *Times* lately, and in our *Journal* of last month, that one reason why such an exhibition has not heretofore been established in this country is, because we feel the need of it much less than our continental neighbours; for to walk from the East India House to Regent's Circus, is to walk through a grand exhibition of national arts and manufactures. There are the windows full of glass, porcelain, and earthenware; the artistically-arranged shows of silks, cottons, woollens, ribbons, shawls, and laces, of England and Paris, the scarce-born novelty of yesterday; the art manufactures, wood-carvings, bookbinding, papier-maché ornaments, picture-frames, plate-glass; fowling-pieces; musical instruments; cutlery from the first workshops of the world; choice tools; saddlery unsurpassed; a rich display of gold, silver, and jewellery; watchwork; optical, philosophical, and surgical instruments; also many new manufactures—cocoa nut fibre, gutta percha, caoutchouc, parianware; the last process in machine-carving, daguerreotyping, electro-plating; the newest application of science or art. Here, too, we see many historical establishments—those of the Arnolds, Dollonds, and Troughtons.

The wide footways, the careful cleansing, the good police, the plate-glass, the gas at night, no less than the walking habits of the population, tend to promote the display in the shop windows, in the arrangement of which practised hands are employed, and in which the glass-worker, the gas-fitter, and the ticket-writer find well-paid occupation. Thus, not even in the covered galleries of Paris, or bazaars of the East, is there a more open exhibition. Everything is made to minister to this show, and instead of the upper floors of the houses, as in other great cities, being occupied by large establishments, all the ground-floors in the trade streets are thrown into the long line of glass-cases—the walls of the grand museum.

It is precisely this state of affairs which makes the influence of Prince Albert more valuable in giving any impulse to the exhibition, for there is a *vis inertiæ* to be overcome. Thus, even our provincial capitals have had shows before ourselves; and the

Mechanics' Fairs of the United States give them precedency of us. The provincial flocks to the exhibition of machinery, or the bazaar for the mechanics' institution, as he does to the great metropolis: but hitherto there has been no sufficient temptation to open such exhibition. The gallery formed in the King's Mews by Mr. Charles Payne, and the Polytechnic Institution, were both projected on a scale too inconsiderable to form a complete national exhibition; and the reliance was rather on the publication of novelties than in the formation of a full collection of everything old and new. Indeed, the call on the Polytechnic Institution is for novelty; and the metropolitan population support it to a much smaller extent than is supposed. To them the shops are open—Woolwich, Chatham, the Mint, the shipyards, breweries, gasworks, marbleworks, saw-mills, docks, railway stations, telegraph stations. It must be something very new to raise wonder in a population so trained. The exhibitions of the Society of Arts begin to pall, and the prosecution of the great undertaking will alone preserve their reputation.

The results to be expected from an exhibition here must be very different from those on the continent. We do not want to glorify manufacturers, to teach governments or people the value of the manufacturing arts; we cannot do much in saimulating the enterprise of our population, for they are fighting against the world. Much of the result will be owing to claptrap. The exhibition, in the Queen's name, in Hyde Park will be a show and a holiday, and tens of thousands in London and throughout England will pay their shillings, regardless of anything but getting pastime for it. Still, some good may be done. Our progress in many branches of manufacture may be made visible, and this will be an encouragement for future exertion; our shortcomings in some may be made known, and English enterprise may be drawn into fresh channels. We must not, however, be unmindful of the inherent vices of such exhibitions,—the prominence given to exceptional skill,—the want of relation between the artistical and mechanical results. On such occasions, we see knives with a hundred blades, which are of no possible use, and a whole table-service within a walnut-shell; castings to rival those of Prussia; silks those of Lyons;—but, after all, a better criterion of national skill than any Exposition, is the *£. s. d.* return of the Board of Trade. From the first Exposition in Paris, there perhaps has not been one in which the wares of "perfidious Albion" have not been beaten; there has never been an exhibition in a colony, but the prizeholder has produced goods equal to those of the mother country: but the commercial results remain unaltered. To make a good article is one essential, but to make a cheap one is another; and the most successful manufacturer is he who does the latter, and as much enterprise must be exerted to effect this,—so after all the cheapest manufacturer is commonly the best. He who can substitute a machine for handiwork, not only obtains greater economy, but greater precision.

At this present time it is not possible to predict results. The organization of local committees does not require any special supervision, but hereafter it will become of the greatest importance to provide properly for the suitable working of the undertaking; and unless it be chiefly by the manufacturers themselves, we are convinced it will fail. If, too, there is to be a centre of toadyism, flunkeyism, and jobbery, the fate of the plan will be sealed. Prince Albert has done his part in launching the undertaking,—he may use his influence with the government in obtaining grants of money and land: but interference in the details must be fatal. When the Prince is present, the freedom of discussion will be swamped by conventionality; when absent, his delegate will rule for him, and he will be compromised unwittingly. The Prince's name will be used in every kind of way, as it has been freely used in giving his name to the plan; and instead of Mr. Whishaw, Mr. Cole, or Mr. Scott Russell being responsible for his own suggestions, he will arm himself with the authority of the Prince. Therefore we say, let the committees at once take upon themselves the necessary authority and responsibility: do not let them fear to displease the Prince by meddling with his plan or his arrangements; but rather to strive for what will truly please the Prince—that is, to carry out the great enterprise in which he has embarked with them.

Let there be no want of zeal on this occasion, but, as it is determined to have an exhibition, let it be one of which England need not be ashamed, and which shall surpass all which has been before. This we can do, and therefore we ought to do it; and the only way is to go heart and hand to the work,—not caring whether a prize fund be raised or not, or whether the prizes are or are not fairly dealt out to each branch of manufacturing industry.

EXPANSION OF LIQUIDS.

On a Formula for Calculating the Expansion of Liquids by Heat. By W. J. MACQUORN RANKINE, C.E.—[From the *Edinburgh New Philosophical Journal* for October, 1849.]

Having been lately much engaged in researches involving the comparative volumes of liquids at various temperatures, I have found the following formula very useful:—

$$\text{Log V} = \text{B}t + \frac{\text{C}}{t} - \text{A}.$$

Log V represents the common logarithm of the volume of a given mass of liquid, as compared with its volume at a certain standard temperature, which, for water, is the temperature of its maximum density, or 4°·1 centigrade, and for other liquids 0° centigrade.

t is the temperature measured from the absolute zero mentioned in my paper on the 'Elasticity of Vapours,' in the *Edinburgh New Philosophical Journal* for July 1849, and is found by adding 274°·6 to the temperature according to the centrigrade scale.

A, B, and C, are three constants, depending on the nature of the liquid, whose values for the centigrade scale, corresponding to water, mercury, alcohol, and sulphuret of carbon, are given below.

	A.	Log B.	Log C.
Water	0·4414907	$\bar{4}$·8987546	1·7890286
Mercury	0·0229130	$\bar{5}$·9048766	$\bar{1}$·2702297
Alcohol......................	0·2615238	$\bar{4}$·6414462	1·2883856
Sulphuret of Carbon	0·2540674	$\bar{4}$·6483572	1·2192054

The data from which the constants have been computed have been taken from the following authorities:—for water, from the experiments of Hallström; for mercury, from those of Regnault; and for alcohol and sulphuret of carbon, from those of Gay-Lussac. As the experiments of M. Gay-Lussac give only the apparent expansion of the liquids in glass, I have assumed, in order to calculate the true expansion, that the dilatation of the glass used by him was ·0000258 of its volume for each centigrade degree. This is very nearly the mean dilatation of the different kinds of glass. M. Regnault has shown that, according to the composition and treatment of glass, the coefficient varies between the limits ·000022 and ·000028.

Annexed are given tables of comparison between the results of the formula and those of experiment. The data from which the constants were calculated are marked with asterisks.

The table for water shows, that between 0° and 30° centigrade, the formula agrees very closely with the experiments of Hallström, and that from 30° to 100° its results lie between those of the experiments of Gay-Lussac and Deluc.

The experiments of Gay-Lussac originally gave the apparent volume of water in glass, as compared with that at 100°. They have been reduced to the unit of minimum volume by means of Hallström's value of the expansion between 4°·1 and 30°, and the coefficient of expansion of glass already mentioned.

In the fifth column of the table of comparison for mercury it is stated which of the experimental results were taken from M. Regnault's own measurements on the curve, representing the mean results of his experiments, and which from his tables of actual experiments, distinguishing the series.

In the experimental results for alcohol and sulphuret of carbon, the respective units of volume are the volumes of those liquids at their boiling points, and the volumes given by the formula have been reduced to the same units.

Expansion of Water.

Temperature on the Centigrade Scale.	Volume as compared with that at 4°·1 C. according to		Difference between Calculation and Experiment.	Authorities for the Experiments.
	the Formula.	the Experiments.		
0°	1·0001120	1·0001082	+·0000038	Hallström
* 4·1	1·0000000	1·0000000	·0000000	Do.
10	1·0002234	1·0002200	+·0000034	Do.
20	1·0016668	1·0016490	+·0000178	Do.
*30	1·0040245	1·0040245	·0000000	Do.
..	..	1·0041489	−·0001244	Deluc.
40	1·00750	1·00748	+·00002	Gay-Lussac.
..	..	1·00774	−·00024	Deluc.
60	1·01718	1·01670	+·00048	Gay-Lussac.
..	..	1·01778	−·00055	Deluc.
80	1·03007	1·02865	+·00142	Gay-Lussac.
..	..	1·03092	−·00085	Deluc.
100	1·04579	1·04290	+·00289	Gay-Lussac.
..	..	1·04664	−·00085	Deluc.

Expansion of Mercury.

Temperature on the Centigrade Scale.	Volume as compared with that at 0° C. according to the Formula.	Volume as compared with that at 0° C. according to M. Regnault's Experiments.	Difference between Calculation and Experiment.	Remarks.
*0°	1·000000	1·000000	·000000	Curve.
90·22	1·016333	1·016361	−·000028	Series I.
100·00	1·018134	1·018153	−·000019	Curve.
100·52	1·018230	1·018267	−·000037	Series I.
*150·00	1·027419	1·027419	·000000	Curve.
198·79	1·036597	1·036468	+·000129	Series II.
205·07	1·037786	1·037805	−·000019	Series IV.
205·57	1·037905	1·037910	−·000005	Series III.
*300·00	1·055973	1·055973	·000000	Curve.

Expansion of Alcohol.

Temperature on the Centigrade Scale.	Volume as compared with that at 78°·41 C. according to the Formula.	Volume as compared with that at 78°·41 C. according to M. Gay-Lussac's Experiments.	Difference between Calculation and Experiment.
8°·41	·91795	·91796	−·00001
*18·41	·93269	·93269	·00000
33·41	·94403	·94399	+·00004
*48·41	·96449	·96449	·00000
63·41	·98183	·98210	−·00027
*78·41	1·00000	1·00000	·00000

Expansion of Sulphuret of Carbon.

Temperature on the Centigrade Scale.	Volume as compared with that at 46°·60 C. according to the Formula.	Volume as compared with that at 46°·60 C. according to M. Gay-Lussac's Experiments.	Difference between Calculation and Experiment.
*−13°·40	·93224	·93224	·00000
+ 1·60	·94768	·94776	−·00008
* 16·60	·96417	·96417	·00000
31·60	·98168	·98168	·00000
* 46·60	1·00000	1·00000	·00000

THE WATER FROM THE CHALK FORMATION.

Analysis of the Water from the Chalk Formation. By Messrs. Abel and Rowney, Assistants at the Royal College of Chemistry.

The deep well water of the London basin has been analysed by Professor Graham. The striking feature of this analysis is, the discovery of the presence of sulphuric acid, and the absence of salts of potash. The water which he analysed, was taken from the deep well in the brewery of Messrs. Combe and Delafield, Longacre. This well not descending so deep into the chalk as the Artesian wells in Trafalgar-square, induced Messrs. Abel and Rowney to subject the water of the latter to an analysis, in order to compare the results with those obtained by Professor Graham. The water on which they operated was taken in the beginning of October, 1847, from the shaft at the back of the National Gallery. At a depth of about 109 feet, the water enters the shaft through a borehole, which passes the London clay and penetrates into the chalk. Thus the water rises from a depth of nearly 400 feet.

The temperature of the water is 58° Fahrenheit, its specific gravity is 1000·95, the specific gravity of distilled water being 1000. The water is very soft and very delicate; test-papers show that it has an alkaline reaction.

The subjoined analysis shows that the constituents of the water of the Artesian wells in Trafalgar-square, are essentially the same as those of the water from the well in Messrs. Combe and Delafield's brewery. There is only one point in which the two waters materially differ in composition. The water which Professor Graham analysed, and which, as already mentioned, comes from a higher stratum, was found to contain no potash salts, whilst these were invariably present in the water of Trafalgar-square. In order to preclude the possibility of error, the water employed for testing was collected at different periods.

M. Payen found that the water of the Artesian Well at Grenelle contained a considerable amount of sulphate of potash and chloride of potassium, so that it would appear that potash salts are characteristic of the waters from the deeper strata.

The water analysed by Messrs. Abel and Rowney did not contain a trace of iron.

Annexed is a tabular view for the comparison of the water analysed by Professor Graham, and the Trafalgar-square water, to which is annexed the results obtained by M. Payen from the analysis of the water of Grenelle, each showing the number of grains in an imperial gallon.

	Wells at Messrs. Combe and Delafield.	Trafalgar-square Wells.	Grenelle.
Carbonate of lime	6·18	3·255000	4·7600
Phosphate of lime	0·19	0·034041	..
Perphosphate of iron........	0·24	..	..
Carbonate of magnesia......	1·08	2·254000	0·9940
Sulphate of potassa	..	13·671000	0·8600
Chloride of potassium	..	..	0·7630
Bicarbonate of potassa......	..	..	2·0720
Sulphate of soda...........	24·25	8·749300	..
Chloride of sodium	12·74	20·058500	..
Phosphate of soda	..	0·291000	..
Carbonate of soda	11·68	18·048800	..
Silicic acid................	0·44	0·971000	0·8990
Apocrenic acid..............	..	0·098700	..
Crenic acid	..	0·137200	..
Extractive matter	..	0·672000	..
Yellow substance	..	..	0·0014
Organic matter (nitrogenous)	..	..	0·0138
	56·80	63·240541	9·8632

The presence of phosphoric acid, first pointed out by Professor Graham in deep well water, could be easily ascertained in the Trafalgar-square water, by the method indicated by that chemist; in fact, on evaporating the water to dryness, and gently igniting the residue, the phosphoric acid, existing partly in combination with lime and partly with soda, is obtained altogether in the form of a soda salt, the solution of which deposits the yellow tribasic silver salt on the addition of nitrate of silver.

The large amount of organic matter contained in deep well water is very remarkable, while the quantity observed in the water of a higher stratum seems to have been very trifling. It evidently arises from the remains of organised beings which have invariably been found in the chalk.

With reference to the quantities in which the different constituents are present, it will be observed, on comparison, that the total amount of fixed constituents is somewhat different (56·80 and 69·40), whilst very considerable deviations are perceptible in the quantities of the various constituents.

The most striking difference is observed in the quantities of sulphate of soda contained in the two waters.

ROYAL SCOTTISH SOCIETY OF ARTS.

The following communications were made:—

1. "*Improvements in Fixed and Revolving Lights, being a New Dia-Catoptric Instrument for increasing the intensity of the light.*" By Thomas Stevenson, Esq., F.R.S.E., C.E.

The author stated that this instrument is composed of three parts—a paraboloidal mirror, having the conoidal portion behind the parameter cut off, and its place supplied by a hemispherical reflector, whose centre thus coincides with the focus of the paraboloid, while in front of the flame is placed an annular lens subtending at the focus of the paraboloid, the same angle as that which is subtended at that point by the greatest double ordinate of the reflector, and having its principal focus coincident with that of the paraboloid. This instrument should theoretically produce the most intense light yet derived from any given flame, as it incloses and parallelizes each ray of the whole sphere of light, so that none are lost by divergence between the lips of the reflector, where, in the present arrangement, not very much short of one-half of the light is lost.

In this instrument the hemispherical reflector throws the light which it receives (viz., the posterior half of the sphere of light) through the focus of the paraboloid, and while the outer ring of this light is received by the paraboloid, and parallelized by it, the central cone is received by the annular lens, and is also parallelized. The outer ring of the anterior half of the sphere of light is received directly by the paraboloid, and is parallelized by it; while the central cone of rays, which, in the present arrangement, is lost by natural divergence, is received by the annular lens, and is parallelized by it. Thus the whole sphere of light is economised. This combination may also be applied *mutatis mutandis* to the illumination of half of the horizon of a fixed light, by means of a single light: the only difference being the substitution of two truncated parabolic conoids for the paraboloid, and a refracting belt for the lens. Two of these instruments directed to opposite points of the compass would light up the whole horizon.

Another new form of lighthouse apparatus was also described, by which the whole sphere of rays can be parallelized by means of a hemispherical reflector placed behind the light, and an annular lens, and a series of concentric totally-reflecting glass zones also placed in front, and receding from the lens back to the reflector. These zones are also new in themselves, as they have the property of parallelizing divergent rays, not only in a vertical plane like the zones in Fresnel's fixed lights, but also in every plane whatever.

2. "*Remarks on Workmen's Houses in Town Districts, with Plans, Elevations, and Descriptions of the 'Lumsden Model Dwellings for the Working-Classes,' erected in Glasgow.*" By James Wilson, Esq. architect, Glasgow.

The author stated that these model dwellings have been especially calculated for towns, where ground is too expensive to admit of the separate-cottage plan being available; yet, from the concentration of conveniences contained in them, and the economical arrangement of these in regard to space, presenting the elements of improvement and economy applicable to cottages. The particulars are as follows:—The building is four stories high; the ground story contains a sub-factor's house, and six others; the three upper stories contains eight houses each, arranged on each side of a central passage. The latter is lit at each end; also, the floor of it is grated for about 6 feet at each end to admit of free ventilation to the roof, where there are two corresponding lowered openings. At the back, on the ground-story, is a wash-house, with three pair of tubs, three boilers, and a centrifugal drying-machine; affording each tenant an opportunity of washing clothes once in about every ten days. There is also a bath-house, for plunge and shower bathing. Each house is contained in a clear space of 18 by 15¼ feet. There is an entrance-lobby to each, 4 by 3½ feet, with watercloset, of good size, and ventilated; the apparatus is simple and strong. The main apartment (which is more room than kitchen) contains a clear space of not less than 132 square feet, by 9 feet high; besides—

1. Two bed-closets, in corners diagonally opposite to each other, and containing each a bed-bottom, 6 feet by 4 feet, being a frame of angle-iron, filled-in with iron-hooping, webbed, with dressing-space in front of same, averaging 11¾ square feet. One closet is enclosed with a partition 7 feet high only; the other is enclosed to the ceiling, but with an opening over the door from door-frame to ceiling, both thus admitting the free circulation of the air of the main apartment over them; each has a shelf for band-boxes, &c.—2. A scullery, containing a dresser with two drawers, shelves above for dishes, &c., and rack below for cooking utensils; a press with three tier of shelves; a coal-box to contain 12 cwt. of coal; a sink with water laid on; and a clear working space 5½ by 3½ feet.—3. A larder in outside wall, with window-frame filled with perforated zinc, and door on inner side.—4. A cooking-range in 3-feet fire-place, with oven, open fire, and boiler.—5. The hearth to fire-place of cast-iron, with low segmental fender cast with it; and in the bottom an ash-box covered by a grating—for the economy of fuel.—6. The lower sash only of main window hung, but a transom and louvre board for ventilation above the upper sash: the lower one easily brought inside to facilitate the cleaning of both.

The rent (which is payable quarterly, in advance) is 6*l.* 10*s.*, including gas, water, and all other rates, excepting the poor's rate. The gas is supplied in the evenings till eleven o'clock, throughout the year. Notice is given by turning it half-off five minutes before eleven, the meter being in the sub-factor's house. A jet is burned all night in the central passage on each floor.

3. "*An Improvement in the Expansive Steam-Engine.*" By Mr. J. C. Pearce, of Manchester.

The improvement contemplated by the author is stated to consist in the application of two self-acting valves, in addition to the expansive regulator, one to each end of the steam cylinder—fixed in suitable passages, which communicate with the waste steam or exhaust-pipe. He states that the use of these valves is to prevent the pressure upon the working side of the piston from falling below the resistance or back pressure upon the opposite side—a very common occurrence in carrying out the expansive principle, although attended with very considerable loss of power; and that the proposed improvement is chiefly adapted to locomotives and other non-condensing expansive engines where the power is extremely variable.

4. "*An Air-Trap, or Stink-Trap, for preventing noxious effluvia proceeding from Drains and Common Sewers.*" By Mr. James Robb, Gas-works, Haddington.

The model is a box, wider at the top than at the bottom, and having a strip of leather fixed round the lower edge, to assist in making an air-tight joint with the valve. The valve is a flat piece of iron, made large enough to cover the bottom of the box, to which it is attached by a hinge on one side, which also forms a lever, on which is hung a balance-weight, for the purpose of bringing it into close contact with the bottom of the box. When fitted into the mouth of the drain or common sewer, and covered with an iron grating, the author stated that it becomes an efficient protector in all weathers, especially as it does not depend on water for preventing the foul air from blowing through.

5. "*A Self-Acting Water-Meter.*" By A. Carrick, Esq., of Glasgow.

The author stated that this meter is a close vessel of any size: that the water is introduced through a valve, and when it reaches up to the bend of a fixed syphon, it is discharged into a receiver below; that the valve is closed while the discharge continues by means of a beam on a fulcrum inside the meter; to the ends of this beam a chain connection is made, so that the valve is drawn up by the superior weight of water flowing through the syphon into a perforated bucket. The number of discharges is indicated by wheel-work similar to a gas meter, the movement being obtained from the arbor that carries the beam. The end of this arbor comes out through the meter, and works a ratchet-wheel, with a pinion of ten leaves on its axis.

6. "*On a New Valve Nose-Cock.*" By Mr. Daniel Erskine, plumber.

The author stated that this valve cock is superior to the common cocks either for steam or hot water. It is fitted with a valve that neatly fits the case; the spindle is fitted with a spiral spring, which makes it self-shutting, and the spindle passes through a stuffing-box.

7. "*Time Piece moved by a Spring of Vulcanised Caoutchouc.*" By Mr. William Smith, clockmaker.

The author stated that he conceives the superiority of this spring to consist in its perfect invariability, from the absence of friction, and the simplicity of its application, being in the form of a ring, one end of which is passed through a piece of steel with an eye, to which is attached a hook connecting it with a pulley, both ends being fixed at the bottom of the column by a steel pin passed over them.

8. "*Description and Drawing of a Glass-Blowing Apparatus.*" "*Description and Drawing of a New Furnace for Melting Glass.*" By Mr. William Cooper, glass manufacturer, Aberdeen.

The author remarks, that owing to the manufacture of glass having been so long chiefly in the hands of monopolists, and coupled with stringent excise restrictions, the principle of the crown and plate glass melting furnaces have undergone little alteration or improvement for the last half century. During the decomposition of the ingredients used in the manufacture of crown, sheet, and plate glass, the application of heat to the crucibles or pots, by the present system, is defective and objectionable. The present mode of melting is in a square furnace, with the pots placed at each side, and the fire in the middle of the furnace: the flame and heat acting on one side of the pots, and passing over the top of the pots to the working holes, the furnace being fed at each end. By this method there is a great waste of fuel and heat, and the heat being more immediately on the side of the pots, the decomposition and fusing of the materials begin at the centre or middle of the pot, and is not carried on regularly, which is the means of causing seed and other defects in the glass metal.

1. By the new method the heat is brought to act on the bottom of the pots, where the decomposition and fusing of the materials ought to commence, uniform and regular in its progress towards the top of the crucible, and by this means expelling more effectually the various gases during the process of melting, which, if they be retained, are injurious to the metal.—2. The construction of the tease hole is such, that the carbonaceous matter contained in the fuel is consumed in passing through the grate room, leaving a solid pure body of heat in the furnace, under and around the pots, and thereby preventing the carbonaceous matter from acting upon and discolouring the metal.—3. From the subdivision of the tease holes, and the retention of the heat, the metal is fused in a shorter space of time.

9. "*On the Manufacture of Kelp-Glass, and on the best kinds of Glass for Staining and Enamelling.*" By Mr. William Cooper, glass manufacturer, Aberdeen.

The author in his communication remarks, that the glass stainer and enameller is subject to frequent disappointments and losses, owing to the variety and different proportions of ingredients used in the manufacture of glass since the use of kelp was abandoned; each kind requiring a different degree of heat, and producing different results, when passed through the enamelling and staining kilns. English crown glass stands a greater heat than sheet glass, even although of the same composition; and this is owing to the peculiar method of manufacturing it. Glass made from Orkney kelp produces the most brilliant red colour, and which has a remarkable property of transmitting red rays of light at a great distance, and on that account it is preferred for lighthouses. The French ruby glass, though of a rich and beautiful colour, has not the same reflecting power. The author gives the following recipe for making kelp glass for staining purposes, as successfully practised by him for a number of years:—Good Orkney kelp well-ground and sifted, 308; Lynn sand, 224 = 532 pounds, well fritted together in the calcar arch; a due mixture of cullet to be added while founding. If it is required to improve the colour, reduce the 532 pounds to powder, and add maganese 2 to 4, nitre 8, and arsenic 4 pounds. The whole to be intimately mixed before founding. Cullet may be added or not, at the discretion of the founder. If properly treated, either mixture will be found to produce an excellent red colour in crown or sheet glass, by means of the oxides of silver and antimony, in the usual way of applying them. The author states that kelp is now almost entirely out of use in making glass; and that a spurious article is now made to resemble kelp glass in appearance, called 'dark sheet glass,' and sold at double price, as kelp glass. It is made from sand, chalk, common sea salt, and broken glass, and sometimes the usual sheet glass metal is tinged with the oxides of iron and maganese, or smithy coals, to counterfeit kelp glass. This "dark sheet glass," when the staining magma is applied to it, gives a 'dingy red colour' with a slow heat, but when fired with other colours, with a smart heat, it produces an 'opaque brown colour,' instead of the brilliant transparent red expected, and the artist's work is spoiled beyond all remedy. The author states that Orkney kelp glass is the best for ornamental work and picture subjects, where a brilliant red colour is required, and that the market sheet glass, made with soda, ash, or barytes, &c., and selected as colourless as possible, is the best for enamelling purposes, or for light orange, yellow, and lemon stain colours.

NOTES OF THE MONTH.

Gurney's High-Pressure Steam-Jet for Sewage Ventilation.—Some account appeared in the morning papers a few weeks since, of an explosion of sewer-gas in the Friar-street sewer, Blackfriars-road, in consequence of the sewer being connected with the furnace-chimney of Messrs. Anderson and Cattley. A most interesting and perfectly successful experiment with the steam-jet of Mr. Goldsworthy Gurney has since been tried, for ascertaining its capabilities, in the yard of these gentlemen, who thus describe the operation and its effects:—"A communication was made from our yard to the sewer by a stone piping, 12 inches diameter, and a steam-jet three-eighths of an inch diameter (about the size of a large goose quill), taken from a small boiler, was, by a proper arrangement of connected cylinders, made to act as an exhausting power, and thus draw the foul air from the sewer. This jet produced a most powerful current, and in five minutes after it was set in action the whole of the pestilential vapour was drawn out, and the flushing men were able to go into the sewer, which, for nearly two years past it had been impossible to enter. At the Blackfriars-road entry, they found most foul and putrid deposit, to the depth of four feet eight inches, exhaling sulphuretted hydrogen, and other poisonous gases in large quantities, samples of which have been taken by Mr. A. Anderson, which he intends, in conjunction with Dr. Ure and Mr. Scanlan, to analyse carefully. This filth is so thick that the shovels stand upright in it, and the men found it so difficult to wade through that they could not proceed further than 200 yards up the sewer. This morning all the man-holes in Friar-street have been opened, and the men have gone into the sewer at every point. It is in the same state of accumulated filth from end to end, with an inclination running towards our factory, originally intended to go to the Thames, through Union-street. We tested the down-cast draft of fresh air at every man-hole, and found it to be of considerable velocity when the jet was on, drawing in rapidly the vapour from smoking paper, and almost instantaneously re-producing flame by the force of the current. At the opening of the large sewer in Blackfriars-road, the draft was so strong as to oblige the workman to surround the light with his hands. The officers of the commission have set men to work to clear out the sewer, and they can remove the deposit through Blackfriars sewer, instead of drawing it up into the street and carting away. In an experiment made on the 20th ult., the action of the jet was stopped for five minutes; the down-cast air was also stopped at every opening, when the stench over the man-hole in Blackfriars-road was insupportable; but within 80 seconds after the jet was again put on, the currents were reversed, as if by magical command, and all effluvia to the street ceased. Every one acquainted with the power of the steam-jet, as now applied to the ventilation of coal mines, would expect this result in its application to the ventilation of sewers; but the most interesting and valuable point to the public in this operation is, that it not only draws off all offensive effluvia, but by a simple process decomposes, and, in popular language, destroys it on the spot. The withdrawal of the whole mass of gaseous sewage from Friar-street has neither tainted the air, nor can it be detected at any distance from the apparatus by the most delicate tests. These remarkable results have been effected in a few hours, at a very trifling cost, and it is quite evident that we have now at command the means of effectually and safely purifying the sewers of all London."

Timber Preserver.—M. Louis Vernet, of Buenos Ayres, has obtained a patent for preserving from destruction by worms, insects, decay, and fire, certain vegetable and animal substances. This invention consists chiefly in impregnating, saturating, or coating the substance to be preserved with a weak solution of arsenic, alone or combined with other materials. The solution is obtained by boiling an arsenious acid in water until it is dissolved, and the fluid becomes clear and transparent. The proportion of arsenic to water is 1 lb. to 40 gallons, and care should be taken not to allow the fire to touch the sides of the boiler above the water, which would cause the arsenic to sublimate, and act injuriously on the health of the workmen. The quantity of water evaporated should be replaced by the same quantity of fresh water, in order that the relative proportions above-mentioned may be maintained. Or, a concentrated solution may be formed by dissolving 1 lb. of arsenic in 5 gallons of water, which can be preserved for any length of time in wooden vessels until required for use, when every five gallons must be diluted with 35 gallons of water. The article may either be immersed in or washed over with the solution, and then dried, whereby it will acquire a thin coating of arsenic, which will be imperceptible to the senses, but a sufficient preservative against the ravages of insects, &c. Or, it may be impregnated with the solution by exhaustion or pressure. When the solution is required to dry quickly, 6 lb. of alum to 1 lb. of arsenic are dissolved in it. To preserve timber from fire, it is to be impregnated with a solution of 1 lb. of arsenic, 6 lb. of alum, and 10 lb. of potass, in 40 gallons of water. To preserve timber immersed in water from decay, and the ravages of the worm, it is to be painted over with the solution mixed with oil or any suitable tarry matters.

Lancefield Forge.—This extensive and interesting workshop of industry, the property of Messrs. Fulton and Neilson, situated in Lancefield-street, Anderston, near the foot of the North-quay, is celebrated for the production of the hugest and finest pieces of forged iron work to be found in the three kingdoms. When in full operation there are about 100 persons employed on the premises, several steam-engines constantly at work, and the various processes for the conversion of common worthless-looking scraps into ponderous bars and shafts, fitted to drive the paddles of the largest steamers, or the wheels of the most extensive manufactories, are carried on with steadiness and vigour. In one part of the work we are shown a cutting machine driven by steam, which slices iron plates, an inch in thickness, into small pieces, as easily as a housewife could cut a piece of cheese with a table knife. In another department, these scraps or shingles are built into heaps, about the size of quartern loaves, preparatory to being put into a furnace, from which they are drawn out in lumps or masses blazing red, and then subjected to the "tilt hammer," by which they are beaten into a solid state, and shaped into bars of a certain length and thickness. From this part of the work comes the material for the construction of all the immense shafts, columns, and heavy engine gearing which daily issues from the forge, sometimes requiring 10 or 12 horses to convey them to the place of their destination. After leaving the tilt hammer, these iron bars are conveyed to Nasmyth's patented hammers—two of the most interesting machines in the place—by which they are beaten into larger pieces, and made to assume the form and design for which they are required. These machines can be made to give a pressure of five to seven tons at a stroke, and are easily managed by two or three workmen, who can make the huge mass come down at one moment so softly as scarcely to bruise a blade of grass, and at another with a force that would sink a ship of war. Here, by the help of lever power, two or three men can raise, and turn, and manage the formation of a mass of iron weighing 12 or 14 tons as readily and as simply as a common blacksmith would forge a horse's shoe, and here these immense masses are formed so accurately as not to be the sixteenth part of an inch from their pattern. At present we may mention the Lancefield Forge Company are in course of constructing four shafts, each of them 14 tons weight, for the Halifax vessels, and the process of their formation is both ingenious and surprising. Another article in the work that attracts much attention is what is called the slotting machine, a huge iron structure, about 65 tons weight, by which blocks of cold iron are cut, and grooved, and paired, as easily as pieces of wood in the hands of a carpenter.—*Glasgow Chronicle.*

Morticing Machine for Joiners' Work.—We inspected, at Messrs. E. T. Bellhouse and Co.'s Eagle Foundry, a new machine for morticing wood. This machine, though recently introduced into this country, where it has been patented by Mr. William Furness, of Liverpool, has been used for the last fifteen years in the United States of America, where it was invented by a Mr. J. A. Fay. It is on the principle of the slotting machine for iron, but with a power of adjustment of the point of the tool which enables a great variety of work to be done by it. The chisels employed are peculiar in shape, not being solid like the ordinary mortice chisels, but flat, like the common joiner's chisels, with the edges turned up at right angles, so that the chips are drawn out of the mortice, after the hole has been cut. The machine can be used with any size of chisel from ¼-inch up to 2 inches; it will also set out and mortice naves for wheels not exceeding 10 by 15 inches. Pins and dowels are made by it in a quick and perfect manner. It can be made to operate either by foot or steam-power, and one machine will perform the work of eight men. The cost of the machine is about 20*l.* —*Manchester Guardian.*

Biscuits made by Machinery.—At the extensive ship-bread bakery of Mr. Thomas Harrison, Mersey-street, is a patent machine, which differs from those hitherto in use, in size, in utility, and in adaptation for the firing of the bread, on the hot-air principle, now the property of the Patent Desiccating Company. The flour and water in proper proportions are placed in a cylinder, and the first operation of thoroughly mixing is performed by arms inside. On leaving the cylinder, the dough is kneaded by means of a large iron cylinder, under which it is passed several times. The required thickness is attained on passing beneath a smaller cylinder. The dough, spread like a large sheet, passes along an endless cloth, the machinery moving at each stroke the precise width of a biscuit. As the dough passes along, by the rising and falling of a nicely-adjusted piece of mechanism, the biscuits are cut into shape and receive the stamp of the patentee. The biscuits are not circular, but have six sides, and, therefore, there is not, in cutting out, any waste of dough, except a small portion at each end. Passing along the endless cloth, the biscuits are conducted to the mouth of the oven, where they are received on what may be called, for familiar illustration, an endless gridiron, which, as the machine moves, draws in the biscuits in a few seconds. Each oven is 4½ feet in width, and 26½ feet in length. There are four ovens, one above another, and all fed from the same furnace with hot water. The mixing of the flour and water occupies about twelve minutes, the kneading five or six, and the firing half an hour. As each oven contains 650 biscuits, and may be filled within a few minutes of each other, there is no difficulty in producing from flour and water no fewer than 2,600 biscuits in an hour, or nearly a ton of ship biscuits every two hours. The biscuits, too, are of excellent quality—beautifully crisp and sweet. It is difficult to convey to the reader a correct idea of the operation of so ingenious and useful a piece of machinery, but it is so exceedingly clever that we would advise the curious to visit the establishment. Messrs. W. and M. Scott, of the Tranmere Foundry, are the manufacturers.—*Liverpool Mail.*

Railways.—The railway system in England has nearly reached 5000 miles in length, and the average cost of construction has been very much reduced, therefore a diminished traffic per mile may be expected. It appears on a comparison of results that the mileage traffic has not fallen below the estimate rate, and that there is not the least ground for doubting the traffic resources of the country, or despairing of the extension of the railway system.

Locomotion v. *Stationary Engine power.*—We understand that the alteration in the working of the London and Blackwall Railway, by the substitution of locomotives for the rope, has resulted in a saving of 50 per cent. in the working expenses, the cost of the rope having been 1s. 10d. per mile, and the locomotives about 11d. On the Bow branch, which, as our readers are aware, is being worked by one of Messrs. England's new engines, the working expenses amount only to about fourpence per mile.

Proposed Great Railway Bridge at Cologne.—We have much pleasure, says the 'Manchester Guardian,' in noticing, as one of the fruits of the recent visit of his excellency the Prussian ambassador to this town and neighbourhood, that our distinguished townsman, Mr. William Fairbairn, C.E., has been invited by the Prussian Government to offer his advice and assistance in connection with a most important work, which is about to be undertaken in Rhenish Prussia. It has been determined that the Rhine is no longer to be a barrier to an uninterrupted railway communication between the shores of the German Ocean and the great cities of central Germany; and the neighbourhood of Cologne has been selected as the fittest site for effecting this junction. On the invitation of his excellency Chevalier Bunsen, Mr. Fairbairn has prepared plans and calculations for this important bridge, and has been called to Berlin to submit his design to his Majesty the King of Prussia and the authorities. The Rhine is at present, as is well known, crossed only by floating bridges, and it has, indeed, hitherto been considered an impossibility to erect permanent structures, which should be able to withstand the destructive powers of the enormous masses of ice which are brought down from the region of the Alps by this mighty stream. It is known that the Romans had two passages across the river, constructed, however, of wood, and consequently liable to great damage and deterioration; but since their age all attempts to erect massive bridges have failed.

Fall of a Railway Viaduct at Preston.—During the last nine or ten months some hundreds of men have been employed in the construction of a viaduct in the Ribble Valley, forming part of the Preston extension of the East Lancashire Railway—a branch by which it is intended to form a connection with the main line at Lostock junction (some two or three miles from Preston), so as to render the company independent of the North Union. The viaduct is intended to consist of 52 arches, altogether about 600 yards in length. The arches (which are built upon piles) are constructed of brick, with stone springers. In consequence of the wetness of the weather, the bricklayers were not at work at the time of the occurrence. The only men engaged at the time of the fall were some half dozen, who were making preparations for the resumption of work by the bricklayers. The whole of the centres, with the exception of three sets, had been removed, for the erection of other arches. Of the three remaining in, two sets had been "slackened," preparatory to removal.

Telegraphs.—England is now one of the worst provided countries in the world for electric telegraphs. Although in this country so much genius has been devoted to the establishment of the telegraph system, as much is charged to convey a message 80 miles here as to convey one 1600 miles in the United States; yet such is the state of legislation, no new company can be started here to afford efficient telegraphic communication. If this state of affairs be long allowed, the commercial interests of the country will suffer.

Telegraph Posts.—Mr. H. G. Hall, of Kirkersville, Ohio, has patented in America an improvement in posts for telegraphs, which consists in "preventing the posts supporting magnetic telegraph wires from rotting at the surface of the ground, by forming on their lower ends shanks or tenons, and inserting the same into sockets, formed in cast-iron shoes, made flaring and sharp on their upper or concave ends, to allow them to be driven into shoulders on the posts, which are of greater diameter than the shoes, in order to overhang and protect them, and prevent the water getting into the shoes at the joints, said sockets or cavities being made of greater depth than the length of the tenons, in order to leave spaces between their bottoms and the ends of the tenons, after the shoes are driven on the same, and thus allow them to be driven farther on when required."

The French Navy.—The Minister of France has made his report on the present state of the French Navy, and very great improvements are to be made in the steamers, the machinery of many of them being of a description that would be of very little service in case of being called suddenly to sea. It appears that several English engineers have received orders, and entered into contracts for supplying new boilers, and the requisite machinery, to be constructed in France, but the material to be allowed being imported from England. A great alteration is likewise about to be made in the import duty of English coals in France—to be the same impost as those from Belgium.

Hydraulic Machines.—Monsieur A. de Caligny has applied to hydraulic engines, worked by a small fall of water at a low speed, the cylindrical valves used in the Cornish engine. We are not able to speak as to the originality or utility of this application.

Chain Links for Cables, &c.—Some experiments have been tried on the premises of Messrs. Brown and Lennox, Mill-wall, Stepney, to test the power of links for mooring chains, cables, and other purposes, formed on the principle of Mr. Price, of Lower Islington, a gentleman already known among scientific men as the inventor of improvements in anchors. The object of the inventor is to lessen the expense and weight of chains as at present constructed, by doing away with the stud or cross-bar of the link, and making the link with straight or parallel sides, and not of the present oval shape; his principle being that the fibre of the iron being kept straight, it will sustain or resist a much greater weight or strain than when force is exerted against it transversely. The test was completely satisfactory; a link of iron, ¾ inch in diameter, with parallel sides 3 inches in length, and 2½ inches in breadth, without a stud, not breaking till a strain of 18 tons was put on it, being 8½ tons beyond the government proof. This invention is worthy the notice of nautical men, and those who require chains for other purposes.

Newall's Patent India-Rubber Springs for Rigging.—A patent has been secured by Mr. Newall, the wire-rope manufacturer, for a new description of spring, intended for the purpose of forming an elastic support from the ship's side, for setting up the rigging. It consists of a long box, formed of iron plates, being square in the inside, into which are inserted square blocks of India-rubber, having between them thin plates of sheet-iron. There is a regulating screw by which the rigging can be strained to any degree of tightness, and whatever strain is imposed on the rigging afterwards from winds, lurching of the vessel, or other cause, the India rubber spring, by its reaction pulls the rope in its place when the strain is removed.

Asphalte of Seyssel.—The results of the experiments, made by direction of the Hon. Board of Ordnance on the embrasures of Plymouth citadel, for testing the strength of buildings cemented with asphalte, have been highly satisfactory. In the course of last year several experiments were made on the old batteries, and on new ones constructed in brickwork, bedded and jointed in fluid asphalte. The old embrasure of rubble masonry was considerably shattered by the firing six times of a 32-pounder gun, with charges of 10lb. of powder each. The experiment was repeated on the asphalte battery, and no effect was observable. By the aid of this valuable material, the bomb-proof buildings on the southern ramparts, which were uninhabitable for a century, have, since June, 1846, been converted, under the orders of the engineers, into barracks, where about 400 men are now lodged in dry quarters.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM SEPTEMBER 20, TO OCTOBER 18, 1849.

Six Months allowed for Enrolment, unless otherwise expressed.

James Higgins, of Salford, Lancaster, machine maker, and Thomas Schofield Whitworth, of Salford aforesaid, mechanic, for certain improvements in machinery for preparing, spinning, and doubling cotton, wool, flax, silk, and similar fibrous materials.—September 24.

The above patent being opposed by caveat at the Great Seal, was not sealed till October 2nd, but bears date the 24th September, the day it would have been sealed had no opposition been entered.

John Meadows, of Princes-street, Coventry-street, Middlesex, carver and gilder, for improvements in veneering.—September 27.

John Marriott Blashfield, of Millwall, Poplar, Middlesex, roman cement manufacturer, for improvements in the manufacture of manure.—September 27.

William Browne, of St. Austell, Cornwall, mine agent, and Richard Rowe Veale, of St. Columb Major, Cornwall, for improvements in preparing for pulverisation flint-stone, china-stone, ores, minerals, spas, sands, earths, and other substances.—September 27.

Nicholas Doran Maillard, of Edward street, Portland-place, engineer, for improvments in obtaining motive power for giving motion to machinery, and in propelling vessels.—September 27.

William Boggett, of St. Martin's-lane, Middlesex, gentleman, for improvements in heating and evaporating fluids.—September 27.

William Edward Newton, of Chancery-lane, civil engineer, for improvements in the manufacture of knobs for doors, articles of furniture, or other purposes; and in connecting metallic attachments to articles made of glass or other analogous materials. (A communication.)—September 27.

William Jamieson, of Ashton-under-Lyne, Lancaster, machine maker, for certain improvements in looms for weaving.—October 4.

Charles Atwood, of Tow-lane Iron Works, near Darlington, Durham, esq., for an improvement or improvements in the manufacture of iron. (A communication.)—October 5.

William Edward Newton, of Chancery-lane, civil engineer, for improvements in machinery for planing, tongueing, and grooving boards or planks. (A communication.)—October 5.

Alfred Vincent Newton, of Chancery-lane, mechanical draughtsman, for improvements in the manufacture of pipes or tubes. (A communication.)—October 5.

Henry Watson, of Newcastle-upon-Tyne, brassfounder, for improvements in valves or cocks.—October 12.

Robert Larkin, of Ardwick, Lancaster, machinist, and William Henry Rhodes, of Openshaw, Lancaster, mechanic, for certain improvements in machinery for preparing, spinning, doubling, and weaving cotton and other fibrous substances.—October 12.

Peter Armand le Comte de Fontainemoreau, of South-street, Finsbury, for improvements in spinning fibrous substances. (A communication.)—October 12.

Joseph Lowe, of Salford, Lancaster, surveyor, for certain improvements in grates or grids applicable to sewers, drains, and other similar purposes.—October 12.

Michael Titch, of Chelmsford, Essex, patent salt manufacturer, for improvements in baking bread, biscuits, and other matters, which improvements are applicable for drying goods.—October 12.

Cornelius Bonell, of Kempsey, Worcester, engineer, for certain improvements in rotary engines, to be worked by steam or other means, and also in the construction of carriages, vessels, or other vehicles to be worked or propelled by the said improvements in rotary engines or other motive power, and for the machinery to be connected therewith.—October 12.

James Banister, of Birmingham, manufacturer, for a certain improvement or certain improvements in tubes for locomotive and other boilers.—October 12.

George Alois Kingelson, of Essex-street, Strand, Middlesex, chemist, for a composition or preparation for destroying vermin.—October 12.

Charles Rowley, of Newhall-stret, Birmingham, button manufacturer, for certain improvements in apparatus for weaving, and in articles to be attached to dresses.—October 12.

John Torkington, of Bury, Lancaster, railway contractor, for certain improvements in the construction of chairs for railways.—October 12.

John Christophers, of Heavitree, Devon, formerly merchant and ship owner, for improvements in naval architecture.—October 12.

Thomas Lightfoot, of Broad Oak, Lancaster, chemist, for improvements in printing cotton fabrics.—October 12.

William Stedman Gillett, of Wilton-street, Grosvenor-place, Esq., for improvements in packing pistons, stuffing-boxes, slides, and other parts of machinery, and in forming bearings, and in making cylinders and other forms of metal.—October 12.

Conrad William Tinsel, of Bristol, sugar refiner, for improvements in the processes and machinery employed in, and applicable to, the manufacture of sugar.—October 12.

John Mercer, of Oakenham, Lancaster, gentleman, and William Blythe, of Holland Bank, Lancaster, manufacturing chemist, for improvements in certain materials to be used in the process of dyeing and printing.—October 12.

Jules le Bastier, of Paris, gentleman, for certain improvements in machinery or apparatus for printing.—October 12.

Joseph Johnson, of Huddersfield, York, bricklayer, and Joel Cliffe, of the same place, ironfounder, for improvements in furnaces or in the means of consuming smoke.—October 12.

John Debell Tuckett, of Plymouth, Devon, merchant, for a new and improved method of preparing a manure called "superphosphate of lime," without using any acids in the decomposition of the various substances of which the manures now in use, and for which patents have been obtained, called "superphosphate of lime," by the application of artificial agency, by which more than double the quantity of a true superphosphate of lime can be produced beyond that for which any patent has hitherto been granted; that the same may be applied in the production of all kinds of crops, more particularly wheat, barley, oats, turnips, and other vegetables.—October 18.

Thomas Dawson, of Melton-street, Euston-square, machinist, for improvements in cutting and shaping garments, and other articles of dress for the human body.—October 18.

George Shove, of Deptford, Kent, for improvements in manufacturing ornamented surfaces when glass and other substances are used. (A communication.)—October 18.

Joseph Stovel, of Suffolk-place, Pall-Mall East, Middlesex, tailor, for improvements in coats; part of which improvements are applicable to sleeves of other garments.—October 18.

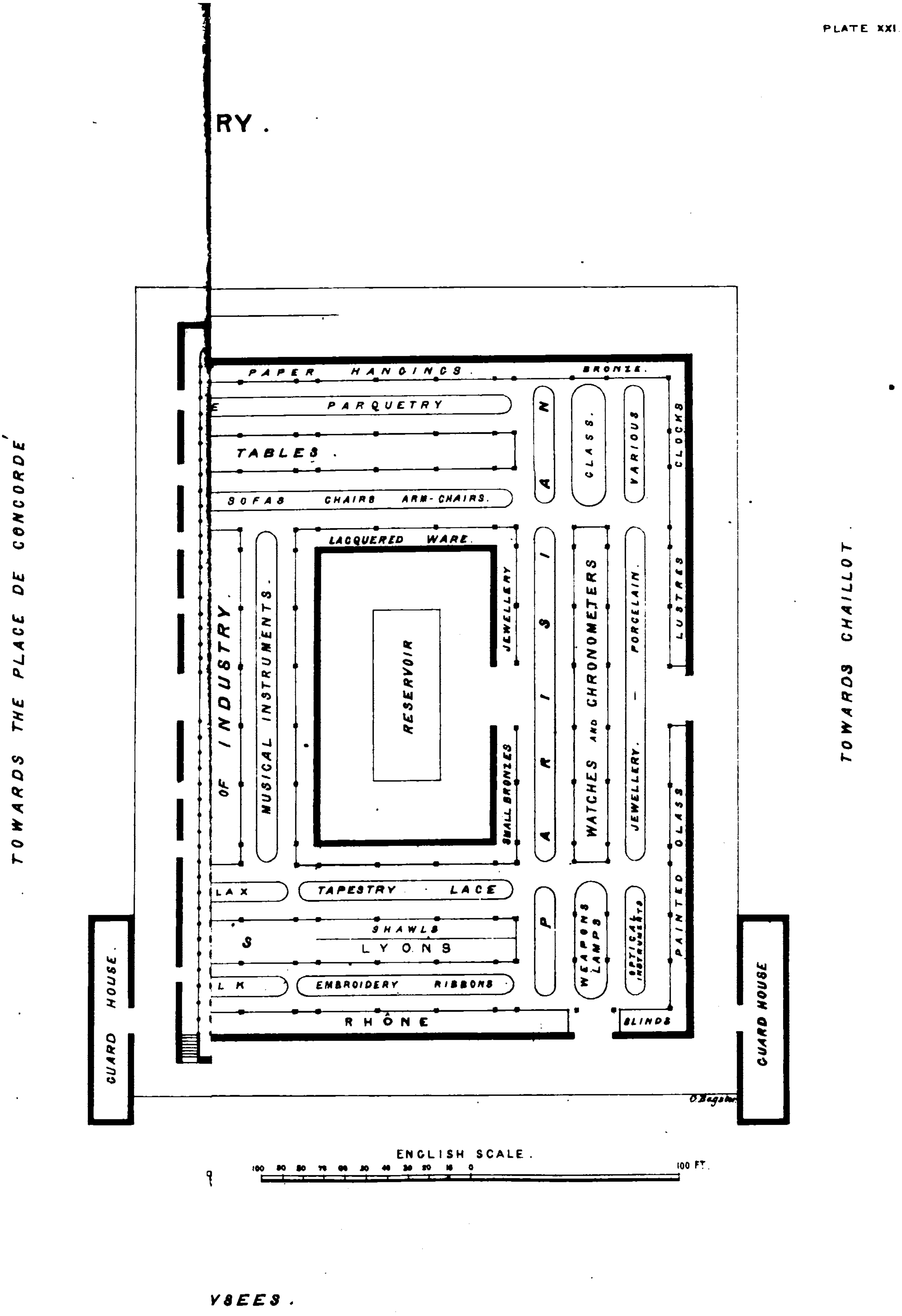
David Hulett, of Holborn, Middlesex, gas engineer, and John Birch Paddon, of Lambeth, gas engineer, for improvements in gas-meters and gas-regulators.—October 18.

Etham Campbell, of New York, in the United states of America, philosophical, practical, and experimental engineer, and a citizen of the said United States, for certain new and useful improvements in the means of generating and applying motive power, and in propelling vessels.—October 18.

William Wyatt, of Waterloo-cottage, Oldswinford, pump maker, for improvements in coating the surfaces of pumps, pipes, cisterns, and other articles of iron.—October 18.

Charles Felton Kirkman, of Argyle street, Middlesex, gentleman, for spinning or twisting cotton, wool, or other fibrous substances.—October 18.

PLATE XXI.


RY.
TOWARDS THE PLACE DE CONCORDE
TOWARDS CHAILLOT
PAPER HANGINGS.
BRONZE.
PARQUETRY
TABLES.
SOFAS CHAIRS ARM-CHAIRS.
N
A
GLASS.
VARIOUS
CLOCKS
LACQUERED WARE.
OF INDUSTRY.
MUSICAL INSTRUMENTS.
RESERVOIR
JEWELLERY
SMALL BRONZES
I
S
I
R
A
P
WATCHES AND CHRONOMETERS
PORCELAIN.
JEWELLERY.
LUSTRES
PAINTED GLASS
LAX
TAPESTRY LACE
SHAWLS
S
LYONS
WEAPONS LAMPS
OPTICAL INSTRUMENTS
LK
EMBROIDERY RIBBONS
RHÔNE
BLINDS
GUARD HOUSE.
GUARD HOUSE
O.Bagster
ENGLISH SCALE.
100 90 80 70 60 50 40 30 20 10 0
100 FT.
YSEES.

THE FRENCH EXPOSITION.

(*With an Engraving, Plate* XXI.)

We have thought it right to give Mr. Digby Wyatt's Report, and the plan of the Palace of Industry, as our readers will thereby see the kind of accommodation which will be provided in Hyde Park in 1851. The Report they will read with interest, as it is from the pen of a man who well understood and carried out the mission he had undertaken.

From what we saw at Paris, we feel quite sure no building like the one there, will be big enough for our Exhibition, which will require thrice the room. The ground taken up at our agricultural shows for tools and stock is great enough; and then there is all that is wanted for our mines, manufactures, and colonies, besides what may come from abroad. Whether we look to the resources of England or the situation of London, as compared with those of France and Paris, we shall see enough to show how much greater are our requirements. The population of London is twice that of Paris London will, by railway, receive productions from the whole land between Plymouth and Aberdeen; by her river and by canals from towns not reached by railway; and by sea from all the neighbouring lands. Bulky machinery can most readily be brought to London; and, indeed, it is more easy to get to London from the whole shore of France between Bayonne and Dunkirk, than to get to Paris. Bordeaux, Nantes, Rouen, and Havre, and the towns on their rivers, will ship straight for London. By our steamers, the hundreds of towns on the Mediterranean, the Atlantic, and the North and the East Seas, will send their productions;—and not only these, but every town on the ship-bearing rivers of Europe, be it on the head of the Danube or among the mountains of Bohemia. From the wide Atlantic our brothers will send to us; from the furthest East, wherever the daring of the English mind can reach,—from the shores of America, Southern Asia, and Australia, on which our steamboats daily ply, will produce be sent to London, for this town has means of communication which all France even does not possess.

A great building must therefore be raised, worthy of England, who has called the world to this meeting, and worthy of those who will answer to the call. It may, perhaps, be still worthy of consideration which of the Parks should be chosen. Hyde Park has a good field, and is between two great streets and in the neighbourhood of handsome buildings. The nearest canal, the Grosvenor Canal, is within half-a-mile of the walls. The Regent's Park is, however, likewise in a handsome quarter, and has ground enough, while it has the Regent's Canal running through it on the north, and is also near the North-Western and Great Western Railways.

A Report on the Eleventh French Exposition of the Products of Industry; prepared by the direction of, and submitted to, the President and Council of the Society of Arts. By Matthew Digby Wyatt, Architect.

To the President and Council of the Society of Arts.

Sir, my Lords, and Gentlemen,—In accordance with instructions which I had the honour to receive from you, I have visited the French metropolis, for the purpose of collecting all such details concerning the quality, extent, and general character of the present "Exposition of the Products of Industry," as might seem most deserving of the careful attention of your Society.

On my arrival in Paris I lost no time in studying the actual position of the building—the system which had been adopted as the basis of its distribution—the official arrangements connected with the selection and reception of the works of art exhibited—their leading characteristics, as contrasted with the parallel existing products of English manufacturing energy—and their comparative excellence in relation to the previous history of French commerce. I endeavoured immediately to make myself acquainted with the printed records of all previous similar National Exhibitions, and to put myself in communication, not only with the authorities, but with gentlemen not officially connected with the administration, from many of whom I have been fortunate enough to gain information of the most valuable kind.

When we consider that during *the last fifty years* constant and sedulous attention has been paid by the government to the great interests of manufacture in France, by precept, example, premiums, public exhibitions, the institution of Elementary Schools, "Societies of Encouragement," and, above all, by an incessant attempt to elevate the social and intellectual condition of all engaged in the great work of supplying the necessities, gratifying the tastes, and ministering to the resources and revenues of their native country, we cannot be surprised to find in the year 1849, that the impulse *originally* conveyed to manufactures *limited* in extent, and serving chiefly for the use of a *small* proportion only of the citizens, has been transmitted through infinitesimal ramifications, until it has become infused and incorporated into the very essence of the spirit of the people.

The traditions of excellence in manufacture reach in France to a very remote period: as early as the commencement of the *thirteenth century* her celebrity in the production of stained glass, of goldsmith's work, of Limoges enamel, of ornaments in carved ivory, and of illuminated manuscripts, had become European. Aided by the influence of the great banker and merchant, Jacques Cœur, the industrial arts attained an almost unrivalled development at the beginning of the fifteenth century; and under the patronage of the royal connoisseur, Francis the First, the union of the highest order of artistic ability, with the mechanical skill and experience accumulated during many centuries, stamped with a peculiar and unmistakeable character of perfection many of the celebrated productions of the period of the *Renaissance*. The establishment of the silk trade at Lyons about the year 1450—the ancient proficiency of Paris, St. Denis, Lagny, Beauvais, and Cambray, in all other branches of weaving—the Gobelin tapestry—the carpets of the Savonnerie—the Sèvres China Institution—and the commencement of the employment of cotton in the seventeenth century, are all land-marks in the great scheme of French manufacture. Now, although in all the departments of trade enumerated, the highest art was associated with manufacture in supplying the wants and gratifying the tastes of the lay and clerical *aristocracy*, it was not until the advent of the Revolution that the attempt was made in France to popularise any of these productions. From the year 1797 we may date a gradual attempt to disseminate, from the *few* to the *many*, the luxury of beautiful design in all objects of daily and universal use. It is true that, since this tide has set in, we have met with no such artists in manufacture as Benvenuto Cellini, Jean Goujon, Léonard de Limousin, Petitot and Bordier, Clodion, Girardon, Bernard de Palissy, Girolamo della Rohbia, Pierre l'Escot, &c., but in their stead have arisen myriads of earnest men, anxious to afford additional employment to the swelling masses congregating on the great points of centralization: and desirous, at the same time that they supplied to *all* at a moderate rate, an approximation to the enjoyments of taste, formerly the appanage only of the minority, to establish and maintain that great bulwark of the wealth, intelligence, and respectability of their native country—the enormous and now all-powerful *Bourgeois class*.

This generalization and dissemination of "Art Manufacture" has been much excited and aided by the establishment of great National Expositions, exhibiting from time to time the actual condition, advantages, deficiencies, capabilities, and variations of industrial exertion throughout the country. It may be scarcely necessary to *prove* the excellence, in principle and practice, of the institution of such a systematic stimulant to public emulation, since a recapitulation of the names of such men as François de Neufchateau, Chaptal, Napoleon, Berthollet, Dupin, Louis Philippe, &c. (all of whom, though differing most widely in their political views, have united in prosecuting these Exhibitions with the greatest ardour), would alone suffice to convince the most sceptical, that France at least has acknowledged the great *public* benefit of such competitions. When, furthermore, we find that similar exhibitions have been organised in Belgium, Italy, Austria, Spain, Prussia, Sweden, Bavaria, and Russia, and that the number of exhibitors has augmented in one constantly increasing ratio, it is manifest that the *manufacturers* themselves have derived a practical benefit, as direct and important as that received by the public. As far as I have been able to remark, there does not exist one single writer who has ventured to assert, either personally or anonymously, that France has ever acquired aught except benefit from this admirable Institution.

In order to convey, in as short a compass as possible, the facts prepared for your examination, it may perhaps be well to arrange them under three heads, giving,—

Firstly—A description of the *present building*, and generally of the nature of the *present* Exposition (A).

Secondly—A short account of the history of the institution of *past Expositions*, and their connection with the industrial progression of the country.

And, Thirdly—An analysis of the official arrangements, their routine, and in an appendix, copies of public documents connected with the organization of the present and past Expositions.

SECTION A.—THE PRESENT EXPOSITION.

No. 1.—*The Building, its Cost, &c.*

The vast edifice which has been erected to contain the specimens of manufacture selected for exhibition in the year 1849, is situated on the same site as that occupied by a similar building in the year 1844. The Carré de Marigny, on which it has been placed, is a large oblong piece of ground, abutting on the main avenue of the Champs Elysées, and as a site offers every possible advantage, being of a gravelly soil, already efficiently drained, and placed on the line of a continually moving series of public conveyances. The Champs Elysées, though at some considerable distance from the great centre of Parisian population, are still so universal a place of resort, that they may be fairly assumed to be "in the way" of even the poorest classes of the community. The elevation may be admirably seen from all the approaches to the building, and it has the advantage of being in the immediate proximity to the residence of the President of the Republic.

The architect, M. Moreau, was engaged in the year 1844 (the date of the last Exposition) on the design of a building almost similar to the present one, exhibiting a somewhat analogous arrangement, but presenting less complication of form. By a comparison of the two appended plans, the differences of his arrangement of the Palace of Industry in 1844, and that in 1849, will be apparent; and it will undoubtedly be perceived that the interior of the vast rectangular courtyard in the plan of 1844 must have presented a magnificent *coup d'œil*, which is totally wanting in its fellow of the present year.

The whole plot of the present building (exclusive of the agricultural department) covers a vast parallelogram of 206 mètres by 100 (about 675 × 328 feet English), round the outline of which runs a gallery about 90 feet wide, divided into two avenues by a double range of pilasters. In the centre of each avenue is a set of stalls, placed back to back, for the exhibition of merchandise; and both between the central pilasters, and round, and upon the walls, other objects are placed, so that on traversing either of the four gangways (each about 10 feet wide) the public have upon their right and left hands objects for inspection. In the part of the building appropriated to large machinery, of course this system cannot be carried out with the same regularity. The vast parallelogram, enclosed by a somewhat similar gallery in the year 1844, was left as one magnificent hall, within which were placed the most important objects; in the present building we find it divided by two transverse galleries, similarly arranged to those we have described, forming three courtyards; the central one being about 140 feet square, and the two lateral ones 80 feet by 140. The central courtyard is open to the sky; in the middle rises an elegant fountain placed on a platform of turf, and around are disposed sheds for the exhibition of flowers and horticultural ornaments and implements. One of the lateral courts (enclosed) receives a large collection of objects in metal-work, cast-iron, &c., and the other contains an immense reservoir, in which all the drainage from the roofs is collected, so as to form a supply of water immediately serviceable in case of fire. In addition to this great building, which corresponds with that previously erected, there is this year constructed a vast shed for the exhibition of agricultural produce, and stock. It extends to a length rather greater than the width of the great parallelogram, and is about 100 feet (English) wide. Its construction is ruder than that of the "Palace," but it is not on that account less effective. It appears to have been originally contemplated to fill the whole of this gigantic hall with cattle, &c., and to place the agricultural implements in a long narrow gallery intervening between it and the main building; but as the stock of animals forwarded for exhibition has not proved so large as was anticipated, it has been half-filled with semi-agricultural machines, and the whole of the long narrow gallery alluded to crammed with stoves, and miscellaneous domestic mechanism.

The whole of the building is constructed of wood; the roofs being covered with zinc: of the latter material 400,000 kilogrammes, equal to nearly 4,000 tons, are stated to have been used; and of the former, nearly 45,000 pieces of timber.

It is hoped that the accompanying plans, which have been prepared from some recent authorities, and an inspection of the sketches given in the pages of the *Illustration* and other journals, will convey a tolerably good idea both of the exterior and interior arrangements of the exhibitions. They will serve to show at least that a somewhat unnecessary expenditure has been gone into, and to manifest the possibility of constructing a much more simple building, possessing all the advantages of this one, at a far less cost.

Both externally and internally there is a good deal of tasteless and unprofitable ornament; all the pilasters are papered and painted in a species of graining to imitate light oak, and even the ceiling is covered over with the same work. Large *carton pierre* trusses apparently support the timbers, and a *painted* bronze bas-relief fills the tympanum of the pediment, at the principal entrance. The architecture of the whole is *mesquin*, although the gigantic scale of the building necessarily elevates the general effect into something of impressiveness; not, however, to nearly the extent which the same outlay might have produced.

In spite of a statement which has been going the round of the French papers, declaring that the building has cost 900,000 francs, I may, I believe, state with certainty, on the authority of M. Audiganne (Chef du Bureau de l'Industrie), who has kindly communicated to me a few official details, that nothing like that sum has been expended, and that about 450,000 francs is the real amount. In a letter I had the honour to receive from him, he informs me that—

			Francs.		£
The cost of the building in the year	1839	was	363,791	about	14,550
" "	1844	"	376,406	"	15,050
" "	1849	"	400,000	"	16,000

If to this last amount we add 2,000*l.*, the lowest estimated cost of the *agricultural shed*, making the whole sum expended equal to 18,000*l.*, the difference of about 3,000*l.* between the outlay of the present year and that of the year 1844 will be satisfactorily accounted for.

It is, of course, to be remembered in these calculations, that the money is paid only for the *hire* of the *materials* for about three months, the whole remaining the property of the contractor at the termination of the Exhibition.

We find that the Exposition of the year

1839 contained a total area of	11,362	mètres
1844 "	19,497	
1849 "	22,391	

That of these total areas,

In 1839 5,806 metres	consisted of space available for goods; and, consequently, that—	5,556	metres remained for the passages, hall, gangways, &c. &c.	
1844, 9,051 "		10,446		
1849, 9,734 "		12,657		

We may, therefore, infer that about half-and-half is a good working proportion; and since

	Sq. Metres.		Francs.		£	s.	d.	
In 1839, a total of	11,362	cost	363,791,	that is	1	5	7	per square mètre.
1844, "	19,497	"	376,406	"	0	15	0¼	
1849, "	22,391	"	400,000	"	0	14	4	

It follows that,

	s.	d.	
In 1839, the cost of the building was at the rate of	2	2	per sq. ft. English.
1844, " "	1	3¼	
1849, " "	1	2¾	

Now, setting aside the year 1839 as a manifest extravagance, we learn that 1*s.* 3*d.* has been the average of the cost of building per foot square in the two last French Expositions; but at the same time it is to be remarked that the work is done in an extravagant style, and that the expenses of some branches of building are considerably greater in France than in England.

N.B—It has not been possible to obtain more detailed information of cost, the returns having not yet been officially made up. These figures must, therefore, be regarded only as the nearest approximation to correctness procurable.

No. 2.—*The Classification of Products, &c.*

Not only in laying-out the scheme of building, but in the arrangements preliminary even to that point, it becomes necessary where objects of such various descriptions are to be assembled, to adopt some general system of natural or artificial classification, in order that facilities for the proper grouping of analogous arts may be uniformly and consistently provided, both in the Exhibition, the Catalogue, and the Report of those appointed to examine into the merits of the workmanship or design.

In the three first Expositions no system of classification was adopted, and consequently the labour of all employed in studying them must have been, and still is, very much enhanced.

If one of the objects of these exhibitions be, as it most assuredly should, to instruct the public, the clearness of their memories and impressions mainly depends upon the simplicity and perfection of the system of succession, subordination, and classification of all the elements composing the great display. If it be otherwise, they gain only a confused sense of weariness, instead of a series of important, mutually dependant, practical conclusions.

In the year 1806 we meet with the first attempt at arrangement by M. Costaz, who edited the Report of the jury on the Exposition of that year. He proceeded on a geographical analysis, and treated his examination of all the objects exhibited, under the heads of the departments of France from which they emanated.

In the year 1819 he again edited the Report, and on that occasion adopted an entirely material or natural system, dividing all the arts into thirty-nine heads. The consequence was, of course, great confusion.

In the year 1827, M. Payen took up a purely scientific arrangement into five great divisions, namely—

Arts.—1, Chemical; 2, Mechanical; 3, Physical; 4, Economical; 5, Miscellaneous.

This was deemed almost too artificial and abstract; and, accordingly, in 1834 we find M. Dupin very wisely establishing his system of division on the basis of the relation of the arts to man. Thus—

Anthropic Arts—1, Alimentary; 2, Sanitary; 3, Vestiary; 4. Domiciliary; 5, Locomotive; 6, Sensitive; 7, Intellectual; 8, Preparative; 9, Social.

In 1839 M. Dupin's analysis was adhered to, and found to work very well.

In 1844 the jury adopted a more material classification, uniting something of the spirit of each of the three former systems. They divided the Manufacturing Arts into—

Arts on the Accidental or Natural System.—1, Woven; 2, Mineral; 3, Mechanical; 4, Mathematical; 5, Chemical; 6, Fine; 7, Ceramic; 8, Miscellaneous.

This arrangement led rather to confusion, and unfortunately, as may be seen by a reference to the plan of the building of the present Exposition, in which this system (if any) has been followed, it is sufficiently complicated to render it extremely difficult to refer to any particular object, from its proximity to others having any analogy with it.

Perhaps some of the elements of Mr. Fergusson's excellent analysis of the Anthropic Arts might be advantageously adopted, or some classification referring to modifications of material in the raw state, in the manufactured state, in the ornamented state—treating them as representatives of the science of production, of manufacture, of decoration, might be found available in default of other better arrangements.

No. 3.—*The Nature and Character of the Products.*

It was a matter of common complaint among all connected with, or interested in, the present exhibition, that, owing to the commercial crises of 1848, it had become almost impossible to foresee either the probable amount or character of the goods forwarded for exhibition. I fear, therefore, that the most careful computations as to the relative spaces occupied by different trades would rather mislead than inform, if they were likely to be regarded as the slightest indication of what might be probable in England.

On examining and comparing the leading features of all the previous Expositions, we find that each one was specially characterised by some feature peculiarly it sown. Thus, Machinery, which this year is the great and predominating attraction, in 1839 was comparatively a minor item; while the products of Mulhausen, which in 1839 actually required a special great hall for themselves alone, this year sink into the ordinary space allotted to many other branches of industry. In forming a judgment as to the proper space to be occupied by any specific manufacture, in reference to its actual importance, much must naturally be left for decision to the constituted authorities for the time being, and they in turn must be swayed more by a sense of duty and justice, than by any laws with which precedent could provide them.

In quality of her position, as "mistress of the reigning *mode*," France this year, as in duty bound, exhibits a dazzling array of pretty and tasteful objects. Evidence is exhibited on all hands of the extent to which the education of her workmen have been carried. Scarcely ever do we recognise a piece of bad ornamental modelling; where the human figure is introduced, it is rarely ignorantly drawn. In the departments of manufacture requiring tender manipulation, such as the more delicate articles of jewellery, carving, tooling, &c., we recognise a practised hand, acting in unison with an ever-thoughtful head. Everything seems produced, to a certain extent, *con amore;* and on conversing with every tradesman he will be found to take an immediate pride in his occupation, as a means of elevating him in the social scale, rather than as a drag to prevent his entering into competition with a class, whose hopes, fears, associations, prejudices, virtues, and demerits, have little natural affinity to his own. Thus, French manufacture has a certain peculiar charm, which frequently paralyses the judgment in appreciating the numerous structural defects which her productions constantly exhibit. If a piece of furniture be well and artistically carved, the ordinary eye cares little whether it be or be not well fitted or well seasoned. A beautiful silver-gilt ornament is at once preferred to an ugly gold one, and a paper-hanging printed in two tints which harmonise is far preferable to one executed with sixty, all of which "fight" and weary the eye. The only important branches of manufacture in which, to judge from the present Exposition, France seems decidedly behind England, are those of the application of mechanism to carving on a large scale, the manipulation of gutta-percha, tin-plate and Britannia-metal working, earthenware, and japanning on papier-mâché, and generally, perhaps, in her immediate adaptation of new machinery to facilitate, and consequently cheapen, production; while in many departments, such, for instance, as the cultivation of the art of enamelling, of bronze-working, of the production of artistic stone-ware, the making and colouring of terracotta, and of riband and silk-weaving and dyeing, she appears as decidedly in advance. In such a Report as the present it would be needless to particularise the differences between the manufactures in detail; but it may, perhaps, be well to remind those interested, that the predominating feature of this year's exhibition in France is the manifestation of her *power* to get up those machines on the possession of which our facility in production has long depended, and that if once she attain in this department anything approaching our mechanical resources, at the same time retaining her present artistic capability, there is little doubt that she will be enabled to command many markets to which *we* alone *now* procure access, and which we are too apt to regard as permanent property, rather than as requiring peculiar and continued exertion to monopolise.

The exhibition of raw silk of the finest quality should make us turn with peculiar interest to the details of the experiments lately made, with a view to introduce the subject to the notice of the English cultivator, recorded in the last portion of your Society's *Transactions*, and encourages us to hope that ere long this important material may be naturalised in England.

The raw products of Algeria seem to promise much as a field for the outlay of French energy and capital.

No. 4.—*General Excellencies and Defects of the present Exposition.*

Perhaps the chief excellencies of the arrangements may be deemed the extreme liberality with which the building has been constructed, and the noble style in which the whole affair has been managed as regards the unlimited supply of public money, the number and civility of the keepers and attendants, and the ease with which the enormous masses of visitors were enabled to circulate by the width and uninterrupted lines of the gangways. There was considerable benefit in the opening of numerous outlets, though the public were generally admitted by one entrance only. The advantage afforded by this was, that if any persons were inconvenienced by heat or pressure, they could readily find an exit; while limiting the points of entry secured a tolerably *unanimous movement*, without driving those on whose inclination led them to dwell especially upon one particular spot. It also considerably simplified the overlooking and checking the receipts on entry. The placing at all these doorways, ladies, who benevolently devoted themselves to the collection of funds to be dedicated to the service of the poor, and more particularly to relieve those suffering from the cholera, has been productive of very great good, and by their means large sums of money have been raised for the purposes of charity.

The system which has been heretofore adopted of grouping together goods of a similar kind—affording great facilities for comparison and study—and increasing the ease with which particular classes of manufacture may be separately examined, without confusing the memory with the labour of recalling the exact position of kindred objects scattered about, it was found impossible to fully carry out, owing to the feverish political excitement, which, up to a late period, rendered the existence, even of this year's Exposition, quite problematical. A mode of arrangement of products of manufacture so *topographical* as to exhibit together all the energy and relative power of production, of different *districts*, has been suggested, but never tried to any great extent; the general opinion being that it would not convey as much practical information, or in half so agreeable a form, as if effected by the usual practice. Classified indices to the Catalogues would probably unite the advantages of both systems, and to a slight extent they have been adopted in France.

The Catalogue as at present arranged consists of two parts. The first, containing the numerical series in the order in which the products stand in the several stalls, the names of manufacturers, their addresses, and the nature of their goods, placed somewhat thus:—

No. 19	James White	Leeds	Patent Malleable Iron.
No. 20	John Smith	Broad-street, Birmingham	Cast-iron goods.
No. 21	James Brown	Mosely-street, Manchester	Cotton Prints.

And the second, the names of manufacturers arranged alphabetically, followed by the number of the stalls, &c., thus:—

White, James	Patent Malleable Iron	No. 19
Wilson, Robert	Stocking-frame, with patented Improvements	No. 524
Wood and Smith	Painted and Ornamental Glass............	No. 4218

In all cases where honours have in former years been awarded to individuals, their nature is indicated by distinctive marks attached to each name. In truth, however (excepting as a book of reference after the close of the exhibition), the French Catalogue, as at present arranged, is almost valueless: the names and addresses of each exhibitor being attached in a clear and legible form to every stall, and some one representing his firm being generally present to take care of his or her master's goods, and to convey whatever information may be requested. The present construction of the Catalogue is, on the whole, to be regarded rather as a defect than as an excellence. The self-evident principle of regulating the line of progression, and fixing the numbers so as to fall in with that order, seems to have been quite lost sight of, and thus considerable confusion would be created by any one who persevered in following out the series presented by the Catalogue. If it were determined to have one up and one down-current in a gangway, it would be well to let the numbers follow each other on either the right or left-hand sides; if, on the contrary, the whole stream of visitors poured in one direction, it might be well to place the odd numbers on the left-hand side-stalls, and the even numbers on the right, and thus the classes of fabric and material might be kept tolerably together in the Catalogue. Now on the former, the present French system, they get very much scattered about. There is considerable advantage in allowing the exhibitors to fit up (under certain general restrictions) their own stalls, at their own expense; since it affords an opportunity for the exercise of individual taste, is gratifying to those who would be dissatisfied if the charge of arranging their goods was entrusted to any but themselves, and effects also a considerable saving of time, trouble, and expense, to the executive. It is, however, absolutely necessary, that all goods should be finally arranged some time prior to the opening of the exhibition, and that none should be received after a certain day, except under the most extraordinary circumstances. The non-observance of such a regulation completely marred, for some time, the effect of the present Exposition; instead of inaugurating a perfect and splendid spectacle with fitting national solemnities, and thus interesting at once to the people and the press, the saloons were opened half-filled, or even less than half-filled;—upholsterers hard at work in all directions; boxes, packing-cases, lumber, and heaps of straw, dust and dirt, disfiguring and spoiling the whole effect. For nearly three weeks these inconveniences existed, in a greater or less degree; and, as might naturally be expected, the press scarcely praised, scarcely noticed, and the better class of citizens and foreigners scarcely visited, the exhibition for the first month. It is needless to insist on the importance of this error.

One of the most striking defects in the plan of the building was the total impossibility of converting it, for any great national purpose, into a vast hall, in which a multitude might assemble to witness such an exhibition as the bestowal of the prizes. In no position could more than a fourth of the whole extent be seen at one view, so that not only was the effect of a possible *ensemble*, similar to that which might have been gained by the adoption of a design proposed in the *Revue d'Architecture*, by M. Hector Moreau, entirely lost, but the stupendous effect of one enormous impression of grandeur on entering was perfectly sacrificed to a fancied regularity of plan. Another great disadvantage was the impossibility of adding to the beauty of the effect by the additional galleries, and the acquisition of more space to be appropriated, in the event of the contributions proving more numerous than was expected.

One peculiarity, which architecturally was most distressing, was, that a system of *sham* seemed to preside over all the ornaments and construction. Great *carton pierre* trusses which supported nothing—painted bas-reliefs to imitate bronze—fir covered all over with paper to make it look like oak,—were all unnecessary and wasteful professional forgeries. If each simple material had been allowed to tell its own tale, and the lines of the construction so arranged as to conduce to a sentiment of grandeur, the qualities of "power" and "truth," which its enormous extent must have necessarily ensured, could have scarcely failed to excite admiration, and that at a very considerable saving of expense.

The Agricultural portion of the building was by far the best in design, though comparatively rude; but, unhappily, since the exhibition was a very poor one (the provinces being scarcely at all represented) almost twice as much accommodation was provided as was needed.

We fully believe, that a better building might be erected, affording the same area and advantages as the Parisian Palace of Industry, and avoiding most of its defects, for an amount less—probably by one-fourth—than that which has been expended upon it.

The remaining sections of this Report consist of a short but interesting history of the origin and progress of the past Expositions, from their commencement in 1797, under the auspices of Napoleon, up to that of the present year; showing their connection with the industrial progression of the country; their cost; the official arrangements, and duties of the various authorities; the distribution of prizes; together with an appendix which shows the labour and judgment bestowed by Mr. Wyatt in collecting it.

LAW FOR PATENTEES IN FRANCE.

Whoever knows anything of law anywhere, knows it is a very bad thing; but those who have the ill-luck to bring a mechanical question before one of our law courts, learn it is the worst thing they have done in their lives. Law may be the perfection of reason—though we do not know why this is to be believed,—but as lawyers know nothing of mechanical affairs, and yet undertake them, the evil lot of patentees, manufacturers, engineers, and others, may be foreseen. Nor are we better off with juries. What are called special juries are not composed of men of education, though it might be thought if a special jury were needed, it would be of men of mind and knowledge. So far from this, special jurymen are taken from the wealthy or trading classes. To be a merchant or banker, is a qualification; but to be an engineer, architect, editor, author, professor, schoolmaster, chemist, doctor, or graduate, is none. Lawyers and medical men are exempt, even if otherwise qualified; so that to get an educated man on a special jury is a mere chance. If the judge go so far as to recommend a reference, to whom is the reference made? Not to practical men, but to barristers, who are not, of need, either lawyers or men of sense, and whose judgment may be utterly impossible to be carried into effect.

"They do these things better in France." It is quite true that they have law and lawyers: but they have, further, something reasonable. They have professional witnesses, or *experts*; but they have likewise, for trade cases, "Tribunals of Commerce," consisting of mercantile men, and chosen by mercantile men.

The "Syndical Chambers" are of recent institution, established not by the government, but by private exertion. The building trade, in Paris, some years ago found an inconvenience even in the Tribunal of Commerce and the *experts*, who made long inquiries, long reports, and long fees. M. Letellier de Lafosse, therefore, proposed to the building trades the formation of a Syndical Chamber, chosen by the trades,—which undertook to judge all questions referred to them, without delay and without expense. The Tribunal of Commerce took advantage of this institution, by referring, and the building trades have had great benefit from it.

In consequence of this success, the mechanical engineers have formed a syndical chamber, under the name of "Union des Constructeurs Mecaniciens." This has already worked so well, that *every* case brought before it has been settled amicably at the first sitting.

In these Syndical Chambers, and in the "Conseil des Prud-hommes," the French are coming back to the institutions of the middle ages, and we hope it will not be long before the same thing is done here. The jealousy of lawyers, and the quackery of the *doctrinaires*, has done its best to suppress old and local institutions; the lawyers gain, the public suffer: but in the end we shall have to begin again—to go back; and if we do not restore the functions of the Blacksmiths, the Carpenters, or the Goldsmiths Company, we must give a jurisdiction to the Institution of Civil Engineers, or the Institute of British Architects. We have official assignees and official referees, but we want self-government, and no lawyers.

SUPPLY OF WATER TO THE METROPOLIS.

It is not usual for us to comment on the proceedings of scientific bodies, reported in our *Journal*, but we cannot refrain from making some remarks at this time on the lecture delivered by Dr. Buckland, at the Royal Institute of British Architects, and published in our present number (p. 379.)

In the first place, we find it needful to question the accuracy of some of the Doctor's statements, for he says the supply of water wanted for the Trafalgar-square fountains could be obtained from the Chelsea Waterworks at much less than it now costs. This might be the case if the whole outlay of the well and machinery be set down to the account of the fountains, and, as the Doctor says, in pumping and re-pumping the same water. He must, however, be well aware the engines are likewise used for pumping the water to supply all the government offices, the palaces, the Houses of Parliament, and St. Martin's baths and washhouses. Does he know what is the contract price for pumping all the water for such supply,—and the sum demanded by the Chelsea Waterworks for such supply? If he be not possessed of such information, he will in a future number find the means of enlightening himself and the public on the subject.

We further contend, with all due submission to the learned doctor, that an *Artesian well* is a well sunk to a certain depth to form a reservoir, and whence a boring is made to the lower springs until the water rises and overflows the top of that boring into the well or reservoir. The learned Doctor holds that nothing is an Artesian well, unless the well itself overflows; as if there were any great good in that, or as if all the wells in the country of Artois are of that character. What the Dean calls an Artesian well, we call an *Artesian boring*, which is nothing more than a bore-hole made from the surface down to the springs, until the water rises and overflows at the surface of the ground, or above the surface of the bottom of a well. An Artesian well is therefore a well with such a boring.

Having said thus much on these two points, we wish to make a few remarks on the important question of the supply of London with water. The first step, we conceive, should be the appointment, by government, of a commission of scientific gentlemen, untrammelled and unfettered by any bias or connection with any other scheme, and to whom the whole subject should be referred.

We could much have wished that Dr. Buckland had, at present, held back from offering any opinion on the Henley water scheme. Had he wished to do so, it would have been far better to have reviewed all the plans proposed, for if any other than the learned and respected Dean had made such allusion to the Henley water scheme at such a moment, he would have been strongly suspected of aiding and abetting the promoters of that work, and running down the Artesian-well scheme. For ourselves, we will not attempt to give any opinion now on the various plans, but will in our next month's *Journal* review the whole, in order that our scientific readers may be in a position to join in the discussion, and to come to a correct judgment, for it is of the greatest importance the public mind should be led in the right direction.

It is very evident something must be done to improve the water supply,—the monopoly of the London water companies can last no longer, for they have had time enough to improve the supply, and have taken no heed. There is a pressure from without,—the companies must discharge the public duties with which they have been entrusted, or they must cease to be public servants. The contract is to supply such water as the public want to drink, not such as the companies choose to sell. As it now is, the companies, claiming a monopoly, are a hindrance in the way of those who offer to sell pure water. They claim a monopoly for trash. The New River Company, while the cholera was still raging, actually withdrew the supply to the courts and alleys. The quantity is now little more, the mode of supply still inconvenient, and the quality of the water no better.

The companies persist in using the Thames, while it is clear the public must have water from some other source than the Thames in the neighbourhood of the London drainage, and from a source in which there is no chance of contamination. The supply, too, *must be constant*. The practice of compelling the inhabitants to have cisterns, can no longer be upheld; and no engineer who has any respect for the honour of the profession, will any longer advocate *intermittent* supply, and the nonsensical stuff which has been put forward in its support.

The public are masters of the subject, and will not allow themselves to be talked out of their senses by any parade of figures, for what can be done in other parts of England can be done in London; and there is no need for the Londoners, after having shown the way forward, to be left behind the rest of the world. We shall do our best for the cause, and we think we can show there is no additional expense for constant supply, as the actual cost of lifting water 100 feet, for the supply of 100 gallons of water to each house daily, is not, on the average, above 2*s*. 6*d*. yearly.

We wish the Rev. Dean had in his lecture gone a little further, and explained why the wells in London have failed, for, with his great geological knowledge, his opinion would have had some weight. As he is aware, nearly all the deep wells of London derive their supply from springs below the level of the river Thames, and we ask him whether it is to be expected supply enough of water can be so obtained, when the natural outfall of the springs and drainage is by the river Thames? The Doctor may be able to inform us, that if we go much below the level of the sea, there cannot be any dependence on getting a large supply; but that if we go to the outcrop of the chalk, in the neighbourhood of London, and there sink wells, there can be little doubt a large quantity of water may be had from the bowels of the earth before the water has had time to overflow from the springs into the rivers. Indeed, how else are the rivers rising in the chalk formation, as the Colne, Mole, Wandle, and Lea, all of which derive their supply from the springs in the chalk, supplied with water but from such springs?

It may be said by the millowners, "This can be done, but then you will hurt us"—to which we answer: "You, a few in number, must not stand in the way of the health and life of millions; you must be recompensed,—the Water Clauses Act gives you ample protection; you can claim compensation, and set steam-power to drive your mills, instead of water." Much, too, may be done for the millowners by damming and storing-up the water of rivers in compensation reservoirs in the time of heavy floods, and letting it out in time of drought, for by such care, the stock of water now wasted may be made enough for the waterworks and the mills, and the latter have much steadier work and more working-days in the year.

In offering these few suggestions, we do not mean to say a supply for all London can be got from any one well, but we think it may from a few wells sunk north, east, west and south, within twenty miles of London. If the supply from such source to the full extent required for all sanitary purposes be doubled, this mode of supply might be confined to household uses, and the plants of the water companies at Brentford, Hammersmith, Chelsea, Battersea, London-bridge, and Old Ford be used for pumping up the water of the river Thames, as now, but for sanitary purposes only, as flushing the sewers, and watering and cleansing the streets; and by making an arrangement with the Regent's Canal Company, the water might be pumped into that canal, which is well situated for the purpose of sending a stream of water to the head of the main sewers, through which it would flow, cleansing them, and emptying the sewage into the river Thames below low-water mark.

In the way here shown, ten gallons of pure water could be given daily to each house in London, which would be enough for household uses; and, at the same time, the mains of the present companies might be kept for cleansing. It may further be observed, an arrangement could be made for connecting many of the present services with the new mains to be brought into London for the pure water supply, and also the present reservoirs might likewise be used for distributing such water. An arrangement of this kind depends, of course, on the present water companies, and, as we have said before, if they will not move and do something of themselves, it must be done for them, and they must be crushed. The result lies with them, and they have had warning, often and loud enough.

A Salt Water Spring in a Coal Mine.—During the past month the miners employed in sinking down to the Ardley Mine, at what is commonly called the Patricroft Colliery, Ince, completed their task; and during their progress they have cut through a white stone rock of 15 yards thick, in the centre of which, at 410 yards from the surface, they found a spring of salt water, which, according to their account, makes about 20 gallons per hour. The water is clear and bright, and on a temporary analyzation is found to contain about 14 grains troy of the different kinds of salts to 1 ounce of water. The mines are the property of Messrs. Lancaster, the Ince Hall Coal and Canal Company; and it now remains a question as to how far this excellent alkaline spring might be rendered available for baths, &c. Below this rock the miners cut through various metals for about 15 yards, when they came to the mine, which is 4 ft. 6 in. thick, exclusive of what is called the "buzzard" coal on the top. The miners have frequently found salt water in the mines in Ince, but we believe that this is the first discovery of the source from whence it emanated.—*Preston Chronicle.*

THE HEALTH OF TOWNS QUESTION AND THE ENGINEERS.

It is owing in no small way to the engineers that the health of towns is now so much thought of, and it behoves them to take care they themselves are not now lost sight of. The medical men have worked hard and earned their reward, and the engineers must have theirs; but unless they look out, the government will, as they commonly do, make the appointments a nest-egg of jobbery; and sons, brothers, military men, and lawyers will take off the hard-earned meed of the engineers. We therefore most earnestly call on our brethren to do their utmost so that neither the carrying out of the health of towns plan is lost sight of, nor their own claims; and they may make up their minds that, in upholding the public rights, they are also in the best way upholding and strengthening their own.

Hitherto the engineers have called loudly for better works, but it is now they must show they can be got. To talk is one thing, to work another; and if it is in doubt whether doctors or engineers have recommended or ought to recommend, there can be little doubt who ought to do the work. Unless, however, the engineers bestir themselves, the government will cheat them, as they did in the Commission of Sewers and the Survey of London. Doctors may say we ought to have good air to breathe, and clean dwellings wherein to live; bishops, deans, and archdeacons preached this on the thanksgiving day; the press have said so with one tongue—now the task lies with the engineers to answer to the common call.

While a buttful of water was thought enough for those who were rich enough to pay for it, waterworks were small undertakings; but now the task is far greater, and worthy of the highest minds. Here in London, a great commonwealth of more than two millions of men, one with as many men as the Netherlands in the height and might of their pride and wealth, as Switzerland with its many cantons; as Denmark, as Tuscany; with more than the kingdoms of Hanover, Saxony, Wurtemberg, Sicily, or Norway; with more than Athens, or Sparta, or Corinth ever knew—this is the great body of men, women, and children who are to be daily fed with fresh and wholesome water. So great an undertaking has seldom come within the reach of one mind, but it is to be done, and must be done. The neighbourhood must be searched far and wide, streams that flow farthest west must be brought east; if need be, the bowels of the earth must be sought, but water must be found; it must have room to settle down and be cleansed, and it must be sent even to the roofs of the topmost dwellings in this town, not of seven, but of many hills. Even the poorest man must have water and enough to his hand; the working man's wife must not, as now, be left to drag the child at her breast in the wearisome search for a pailful of heated and filthy water. If the rich are to have health unharmed, if they are to have their span of life unshortened by fever and by plague, it must be by taking care of the poor and their abodes.

So great is this town, so widely has it spread, that the task of the engineer is made every way harder. Already hills have been brought down, dells filled up, springs choked; wells, chalybeate, sulphurous, and saline, buried; rivers swallowed up, and the woods and fens which fed them built over; nay, even the Thames has become an outpouring of filth. The Fleet river, on which our fathers fought the Danes, and on which for hundreds of years ships traded, having become a sewer, has been hidden from the sight, and now the great Thames is in judgment. Our store of wholesome water has been taken from us, the outfall of London filth is overworked, and another great and new task is set before us—that of cleansing a mighty stream. By our own unskilfulness has the evil been done, and it needs more to do the work now than before the mischief was brought about. We have here a great warning, for, it may be said, knowledge run mad. We wished to cleanse the houses, and we drained them into the sewers; theretofore the sewers bore only the drainage water from the streets and houses; but when the new load of filth was poured in, the sewers became great dungheaps or cesspools, from which hurtful and deadly gases steamed off. The drains which bring down the filth carry up to the bedroom floors the sewer steams, and the heat of the fires lends a draught for their so doing.

This is a network of evil; but this is not all; the very filth which is in the sewers wrought up into deadly gases, is needful for dunging the corn-fields: nor can food be grown without such help, or without the husbandry of England being put to great shifts. It is the law in the working of this world that nothing shall be lost: corn is eaten—it takes another shape; but it is thereby made ready, as it were, for being again grown. The earth has its lime, its clay, and its sand,—these are lasting; but the nitrogen is not so, it grows up in the blade of grass or wheat, and is carried away; and until it be brought back again there can be no yield of nitrogenous crops. The farmer buys guano, bones, and oil-cake—of these many hundreds of tons; but it may fairly be said, the dung of three millions of people in the great towns, and of their beasts of burden, now wasted, would give greater crops than all the ship loads from the shores of Peru or the East Sea, yearly brought at a very heavy outlay. The dung of sea-birds can never be so fit a manure for corn crops as the dung which is made from the corn itself.

To keep the sewers clean, the solid and liquid fæces must not be sent into them, and, for the sake of the farmers likewise, they must be saved. The great stumbling-block in the way of saving street and town manure is the outlay for cartage, as was found by the National Philanthropic Association, in their first trials of the street orderlies. More must be laid out to carry a ton of street dirt two miles by cart than to carry it fifty miles by railway; and yet the same chemical constituents, when wrought up, will pay for sending to the West Indies.

It is needful, therefore, that steps should be taken to gather and carry the street and house refuse cheaply, as a beginning. This is much more wanted than plans for sewage-water, which can never pay. The next thing wanted is to get rid of the waterclosets. These need water, and which is either carried into the cesspools or the sewers. If in the former, there is a greater weight to be carted when they are emptied; if in the latter, there is a waste of water, as well as of manure. In reckoning the water for two millions and a half in London, as much must be set down for waterclosets as for household wants: three hundred thousand waterclosets must be daily fed. Plans have been brought forward for doing without waterclosets, and they are well worthy of being looked into.[*]

Waterclosets have been for some time held to be a great good, and they have been strongly recommended by the greatest masters of the laws of health, to be set up in every dwelling, even in the poorest. Now that the fearful state of the sewers is known, it is very much open to question whether anything of the kind should be done. A short time ago, no one would have been listened to who talked of shutting up waterclosets and privies, and taking away the fæces daily; and yet in the choice of evils it is against waterclosets.

Waterclosets, so far from being healthful, are unhealthful, by bringing the sewer steams into the houses and dwelling-rooms; they are wasteful in wasting water and in wasting manure, and, most of all, the liquid manures. If waterclosets are to be set up in every house, then they must have an outfall to themselves; a new, troublesome, and costly sewage, free from the street sewage,—and yet the evil will not be wholly got rid of.

It is quite within means to provide closets which shall not be unwholesome or unpleasant, and which can be daily emptied, and whereby the waste of manure and water shall be put a stop to, the health of the dwellings be kept free from sewer nuisances, the sewers themselves be in a more wholesome state, the gully-holes be less hurtful, and the river less polluted.

All this makes a great undertaking, and in a less way the same things have to be done in all our towns; but it will not be enough to lay down great and good works—they must be done cheaply. To give water to every house is so great an undertaking that the outlay and the income are among the first things to be borne in mind; and he will be the best engineer who can do his work at the least cost. Above all, there must be no rashness, there must be no low beginnings and heavy reckonings—all must be well settled at first; neither must we have any superfine or silver-fork engineering, using stucco for brick, and stone for timber, making things to last for ever, when at a tithe of the cost they may be made to do for our grandchildren, and setting up complicated machines where there is little for them to do. The pay-sheet is much more worth looking to than the drawing-board, though we are sorry to say few bear this in mind.

[*] 'Native Guano versus Sewer Water.' London: Sherwood, 1849.

Reclamation of Land from Rivers.—The Lords Commissioners of Woods and Forests have served notices claiming the land taken in from the river by the Cork, Blackrock, and Passage Railway Company, and they have written to say that a valuator is instructed to come over and value the property for their lordships. The corporation of Liverpool, within a few days, completed a compromise with the Commissioners of Woods and Forests, by consenting to pay to the credit of their lordships a sum of 160,000*l.* for land they took in from the river.—*Cork Constitution.*

IRRIGATION OF LAND IN INDIA.

Agricultural Resources of the Punjab; being a memorandum on the Application of the Waste Waters of the Punjab to purposes of Irrigation. By Lieut. R. BAIRD SMITH, F.G.S.

Watering land is of great worth at home, but still greater in the hot, burning fields, or rather sandbeds of Hindostan, where there are no small springs flowing, as here, in each township, nor even what our fathers called the "winter bourn," the stream flowing in winter only. The water comes from afar, perhaps from the snow-clad Himmalehs, and runs in one great stream, from which only can it be fetched to feed the wants of each neighbourhood. This is the business of the engineer; and some very old works are to be found in Hindostan. The writer, whose book is before us, says:—

> The river Jumna supplies two canals, denominated, respectively, the Eastern and Western Jumna Canals. Both were excavated, originally, during the period of the Mahomedan supremacy; the former in Shah Jehan's reign, about the year 1626, the latter about 300 years earlier, in the time of Feroze Shah, A.D. 1350. During the administration of the Marquis Hastings in 1817-18, the restoration of these old canals first attracted attention, and in 1821 the Western Jumna Canal was re-opened: 9 years afterwards the Eastern Jumna Canal was brought into active operation. This canal, leaving the Jumna under the Siwalic or sub-Himalayan range, rejoins it near Delhi, after flowing about 145 miles. Its subordinate channels, each a small canal with its complement of masonry works, exceed at this time 490 miles in length, and are extending annually. Not less than 2,000 miles of village water-courses spread their waters over the adjoining fields. It supplies 600 separate villages, covering 497 square miles of area, and containing a population of about 300,000 souls. From the lands under its influence, Government derives a revenue of upwards of 60,000*l.* per annum, which never fluctuates, as the crops are secured against all ordinary vicissitudes of the seasons. The agricultural produce thus secured is valued at nearly half a million sterling per annum, about an eighth of which forms the government land rent, the remainder being the property of the village communities.
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> The discharge of this canal is about 600 cubic feet per second. Its cost in works, up to the present time, has amounted to nearly 90,000*l.*; and its maintenance in repairs and establishments, European and native, entails an expense of nearly 7,000*l.* per annum. Its direct income amounts to nearly 15,000*l.* annually; and its indirect returns, from increase of land revenue derived from canal villages, are equal to about as much more; so that by an investment of 90,000*l.* government has secured a permanent revenue of not less than 25,000*l.* per annum. This large revenue is obtained, under the happiest circumstances, by contributing directly to the prosperity of the people; who, in districts to which canal irrigation has been thus plentifully extended, are in a state of material comfort far exceeding the average of other parts of the country.
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> The Western Jumna Canal is nearly four times as large as that on the eastern bank of the river. It has a discharge of 2,270 cubic feet per second, and, with its branches of large dimensions, has a course of about 430 miles in length. Its annual income is about 30,000*l.*, its current expenditure 12,000*l.*, and its cost for works has, up to the present time, amounted to about 140,000*l.* It has enabled government to derive from the tract of country under its influence a land revenue of 29,000*l.* per annum, in excess of what otherwise would have been obtained; and in the use of its water has redeemed a large portion of the districts of Hansi and Hissar from utter and hopeless sterility.
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> During the troubled periods of the latter Mahomedan Emperors, the old canal had become useless, and the country was consequently depopulated and reduced to the condition of a desert. Wherever the canal now extends, the richest cultivation covers the lands; the villages are prosperous and the population abundant. The total area of irrigated land amounts to 1,015 square miles; the population to about 300,000. The land revenue derived from the canal districts is nearly 100,000*l.* per annum, and is placed beyond all risk of fluctuation. The value of produce obtained from lands irrigated by the canal is estimated at 1¼ millions sterling per annum, of which about $\frac{1}{10}$th reverts to government as land and water rent, while the remainder supports in great material comfort about 600 village communities. During the great famine of 1837, when the crops failed everywhere else from want of water, the canal districts were safe and flourishing; and no more significant illustration of the beneficial effects of canals of irrigation could be found, than in the contrasts exhibited between irrigated and unirrigated districts, during the progress of this terrible calamity.

These will show the great worth of such works, and our writer is therefore earnest they should be carried out in the Punjab. He is one of the Bengal Engineers, was Superintendent of the Eastern Jumna Canal, and Assistant Field Engineer with the army of the Punjab; so that as he knows the latter land well, he has had good training in the management of canals, and what he says must have great weight. We do not think it needful to give his plan here, for that is a matter of which our readers cannot well judge, and we shall therefore lay before them what he says of the Great Ganges Canal, which is one of his strongest proofs in favour of his own system.

> The greatest work in this department, the Grand Ganges Canal, projected and superintended by Major Proby Cautley, of the Bengal Artillery, is now in progress of execution, and will be completed in about five years. It will have a discharge of 6,750 cubic feet per second, and is expected to cost about 1,250,000*l.* Its total length, navigable throughout, is 898 miles, and it will furnish irrigation to a tract of country, between the rivers Ganges and Jumna, having an area of 5,400,000 acres. Its annual income from sale of water, &c., is estimated at about 160,000*l.*, and the increase of land revenue, which will be derived from the country under its influence, will not be less than 240,000*l.* per annum.
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> The agricultural produce, which will be secured from loss in those very districts which were the seat of the great famine in 1837, is valued at upwards of 7¼ millions sterling per annum; and a population of nearly 6¼ millions of souls will be saved from a recurrence of those appaling scenes of misery which are still fresh in public memory. Under the influence of irrigation, the produce of the soil will be increased to an amount valued at 1,200,000*l.* per annum; and this result will be obtained at a cost to the cultivators less by 2¼ millions sterling annually than if the only other method of irrigation practised (that by wells) had been employed.
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> The works of the Ganges Canal are of magnitude unprecedented in India. The great aqueduct across the Solani river alone, will require for its constuction nearly 90 millions of the large bricks employed in this country, and a million cubic feet of lime. employing nearly 6,000 men daily for five years on the masonry and earthwork connected with it. The other works are of proportionate magnitude; and the whole, when finished, will form a monument worthy of our national character, and will leave lasting proof that the British government in India is not so unmindful of the great interests committed to its charge, as some would desire to have it believed. The works are advancing with great energy; and, to his honour be it stated that, even during the enormous financial pressure of the late campaign, the Governor-General of India, Lord Dalhousie, would admit of no check being given to an undertaking calculated to promote so materially the best interests at once of the government and the people.

Lieut. Smith gives a short sketch of the Indian canal system, which will be read with interest by professional men here.

> Indian canals of irrigation are essentially artificial rivers, having the inclination of their beds regulated by the introduction of masonry falls; to which, for purposes of navigation, chambers, gates, sluices, in a word—all the machinery of locks on ordinary reservoir canals, are adapted, with only such modifications as the existence of a considerable current requires. All the irrigation canals now in existence in this country are derived from Himalayan rivers, and the drainage of this great chain, where it crosses their beds, is controlled and regulated by dams of large dimensions, maintained amid great engineering difficulties, and liable, during the periodic rainy season, to serious damage from floods. When rivers at lower levels interfere with the course of the canals, aqueducts carry the water over them. The cross communications of the country are maintained by numerous bridges and immense numbers of masonry works of all kinds: inlets, outlets, irrigation drains, and sluices, &c., are scattered over the country through which the lines pass.
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> The water is sold to the cultivators, and distributed to the lands, either directly from the main canals, by openings of fixed dimensions in their banks, or indirectly by means of subordinate channels of smaller dimensions, designed to supply a limited number of villages. The latter is the favourite method; and with reason, as it has many advantages, especially in facility of control and distribution over the former.
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> Two systems of assessment are employed:—1st. The measurement system; under which water-rent is levied on ground actually measured after each crop, and rates charged, which are discriminating, both as regards the nature of the grain grown and the manner in which irrigation is supplied—*i.e.*, whether by natural flow over the land or by means of irrigating-machines. 2nd. The contract system; under which rents are levied on the area of outlet, variable in amount according to the facilities for irrigation in each particular case, but fixed for periods of 20 years. Under both systems, the average rate at which water is supplied amounts to about 1 rupee, or 2*s.* per acre. There is, however, no branch of the canal system which so imperatively requires reforming as the assessment; and, should canals of irrigation be introduced into the Punjab, it is to be hoped that the principles on which the water-rent is levied, may be established on a sounder and more scientific basis than now prevails. It is scarcely possible to conceive a ruder or more cumbrous plan than the first-mentioned; which entails the measurement twice a year, of every field irrigated, and which checks the extension of the valuable crops by the higher rates imposed upon them. The contract system is a step in advance; but it is very imperfect, and open to many grave objections as it now exists. This question is, however, too large to be discussed here, and this slight reference to it must suffice.

The writer has brought before the government of India a most important subject, and we hope it will receive early and earnest attention, as a means of increasing their own income, and bettering the condition of the people.

The description of great works elsewhere, must always have a claim on the attention of engineers; and the more so in proportion to their novelty. Although works of drainage are of great importance here, we are far from thinking that irrigation is only worthy of the small attention which it meets. The application of fresh and sewer water to meadow lands and market gardens, is approved by the best authorities; but little is done to provide a proper system for the supply of water. Now everybody is for deep-draining, the water is carried away, and little provision is made for its supply at the times it is wanted,—though the farmer is as ready to grumble about drought as wet. Wherever water has been applied to growing crops, the good is great; but the means of supplying it are very small. Lands need water several times a year; and there are many lands where a skilful engineer might usefully set to work to supply our farmers with water. A better supply of water would allow our farmers to give more land for meadows and market gardens.

A FEW NOTES ON 1849.

In former years polychromy was the cry of a zealous agitation, and now it is bearing its fruits all over the country; and, we think, good ones. We have, it is true, lost Montague House, but we have Montague Houses enough in Greenwich and Hampton Court; and we have also restored the Temple and Savoy Church. Who knows? we may live to see Westminster restored, for something is being done there; and St. Paul's painted by the Royal Academy, for we have new and working deans at each of our cathedrals. Westminster Palace, the British Museum, Reform Club, Conservative Club, Coal Exchange, Royal Exchange, St. George's Church, and Travellers' Club, are beginnings in inner decoration; not to speak of the Duke of Cleveland's, the Baron de Goldsmid's, and other dwellings. Polychromy will be a feature of the Victorian era, as stucco was of the Georgian.

Outer polychromy seems to have had its beginning. All Saints, Gordon-square, was a very meagre start with its four or five marble pateræ; but Mr. H. T. Hope's house is something of a step. The Museum of Economic Geology was a great miss. In the front of that building we might have had, and ought to have had, slabs of our English marbles, the introduction of which would have given the spur to a useful branch of home industry; for we have many ornamental marbles, and need not go abroad. The Russians and Americo-English do much better—they are fond of showing their home wealth. At Mr. Hope's more might have been done, but it will nevertheless serve as an example to others. It is a novelty, and will be followed.

What we in this time cannot help looking upon as a good feature of the Victorian era, though it would have been heresy in the days of Nash, is the growing use of stone instead of stucco, and even of ornamented brick in preference to the latter. The Hall of Lincoln's-inn is a more honest building than any in Regent-street. Not only are the buildings we have already named of stone, but the houses of the Earl of Ellesmere and Mr. Hope; and the carvings are made on the rough stone of the building, as in olden time.

If all goes on well, we shall be better off than ever. Charles changed wood for brick; George the Last trimmed up the dingy buildings of his fathers, and left London in stucco; Victoria will be able to say she left it stone.

A new agitation is the successor of that for the polychromy of buildings. It is the restoration of the polychromy of sculpture. Mr. Fergusson has sounded the war-horn, and others have followed, although the great world of art stands firm to the pseudo-classicality of whitewash. Gibson has made a slight innovation, but the Birmingham art-workmen are taking the lead, and by the use of many materials are showing how much the resources of formative art can be extended.

We are coming near Paris in some things; but it is strange that none of our public or private buildings are begirt with gilt railings or beset with gilt lamp-posts: the "Golden Gallery" of St. Paul's, glittering aloft, is all we have in this way. Handsome railings give an opening for the skill of the Birmingham men. Brass, glass, and pottery—anything which will wash and keep clean—may be used.

The iron inside of the Coal Exchange is another beginning. For the inside of churches, playhouses, halls, and lecture-rooms, iron can well be wrought up for fittings, as the Coal Exchange shows ornamentally, and we have no doubt cheaply. By the proper use of this material the erection of many public buildings will become possible, which heretofore have proved too expensive, and iron will be as regularly used by the architect as by the engineer; it has been so in railway stations and bridges.

The Coal Exchange has likewise given a good specimen of a large inlaid flooring, showing what Englishmen can do in this way. Last year, the great parquetterie was that at the Baron de Goldsmid's.

There are many little things to be seen in the streets, which may as well be set down among the notes of the year. One of these is the spread of the gilt letters of names, inlaid or stuck on the shop windows. Another is the introduction of glass lower-windows, instead of what used to be the skirting of shop-windows, so as to allow heavy goods to be shown below, as lamps, fire-grates, &c. There is likewise a tendency to have plate-glass in the first and upper floors, to light them with gas, and to make show-rooms of them.

Some of the streets are cleaner, on account of the new street-orderlies; but the leading thoroughfares are not enough so to allow of ornamental painting, carving, gilding, marble, glass, porcelain, &c. in the lower shop-fronts,—and thus by the obstinacy of the authorities, many worthy workmen are hindered from getting a livelihood.

Taking off the glass duties begins to yield fruits. In the shop-windows are to be seen much ornamental glass, English and outlandish; and glass is now used for many things where brass was before common, as candlesticks, door-pulls, finger-plates, &c.—being more readily kept clean than brass. Earthenware is likewise spreading for many purposes. In the fishmongers and cheesemongers, more marble slabs are to be seen—in the confectioners, handsomer glass-ware. Picture frames and glasses are very cheap, and there is, as it was said there would be, a large consumption of framed engravings. Glass shades, cases of stuffed birds, and bowls of gold fish, are much cheaper and more common. So, likewise, there are more greenhouses, more cucumber-frames and bells, and more hyacinth-glasses. If the window duties only were taken off, there is no saying what might be the improvement in internal decoration—nay, more, in the Arts. Painters would work in another manner if they got a better light; pictures, too, would be more bought.

Looking-glasses are getting more into use, but not so much as abroad. In Paris, looking-glasses are fixtures, and let with the rooms and shops.

Gutta-percha shops are among the new trades, and gutta-percha is now worked up for many things, and perhaps for none more than the Telekouphonon, which as a speaking-tube is being set up where tin would formerly have been. It would be worth the while of the glassmen to try glass speaking-tubes.

The material called "Parian" is in favour, and seems likely to take the place formerly held by plaster casts.

The improvements in wire-drawing have of late years made the brass birdcages handsomer, which are very different from the old wicker and iron bedstead-looking places. Even a well-shaped birdcage in a room may help to keep up the public taste.

Daguerrotype portraits have this year reached the prices of *7s. 6d.* and *5s.*, and will most likely in time be the same prices as the old black things were. If the price of common daguerrotypes is falling, so that of the coloured ones, by Messrs. Beard and others, is rising, and better artists are employed.

Electro-plating, or, as the French would say, galvano-plating, is becoming better understood, for there are more shops for it in London, no less than in Birmingham; and, as well as richer ware, coach-harness is now thus decorated.

Through the gas-cry, the gas is rather better; and with this and the plate-glass, the shops and streets are brighter at night,—as unlike as may be from the London of 1820, with its glimmering oil. Gas has been a great hindrance to the thieves; old gentlemen can no longer be knocked down between two lamp-posts;—gas has been very good to the shopkeepers and clerks, for they can now go to suburban dwellings; but it has had one evil, in making thousands of poor shopmen work late. Early closing must soon become the law of the land.

There is one thing as to which nothing has been done this year, and that is cleaning the public buildings, which as it is easy, so should it be set about forthwith. If we are to have London of stone, let it be clean.

In this year many officers of health have been named, and, it is hoped, they will do good; but their works have yet to be seen.

The Architectural Exhibition was a beginning of the year. We hope it will go on, and redeem us from the pauper show of the Royal Academy room. We still want a good public school of architecture as a Fine Art, nothwithstanding the Royal Academy, King's College, University College, and Putney College.

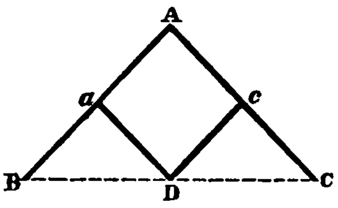
NOTES ON THE PENTAGRAPH.

The Pentagraph is an instrument so well known, and described in so many familiar works, that it may be thought nothing remains, deserving of special remark, belonging to it. These notes have not for their object anything new as regards its principle or construction; but rather to present somewhat systematically, and in a form that is useful in a practical sense, an explanation of its geometrical proportions, and some more precise directions for its use, than are found in modern treatises on mathematical instruments.

If two similar triangles having their homologous sides parallel, are subject to a change of position, and to the conditions that two of the adjacent sides in each constantly retain the same length or value, and are in all positions parallel, as they were at first—but that the magnitudes of the angles, as well as of the third sides, are variable; then these third sides will also be parallel, and will retain the same ratio to each other in all positions of the two triangles, because it is evident their similarity is preserved, although their magnitude is changed.

This, then, is the elementary principle of the Pentagraph; and the instrument is so devised, as to connect two such triangles by a simple arrangement of bars of brass, or of ebony, graduated in such a manner, and provided with such joints and moveable parts, as to adapt it to a great variety of proportions.

Thus, confining our attention to geometrical figures, suppose ABC, *a*BD, to be two triangles, so connected that *a*B may always form a part of AB; that *a*D may always be parallel to AC; that the angle at A, and therefore at *a*, may have any variable value; and that the three points B, D, C, lie in the same straight line in any given position of the two triangles.



It is evident, that whatever value the angle at A may have, B, D, C, once in a straight line will always be so, because, when they are first adjusted,

$$aB : AB :: aD : AC;$$

and, when from any change in the value of the angle A, we still have the angle *a* equal to it, by reason of the parallelism of AC, and *a*D, and of AB being a straight line; and nothing having altered the magnitudes of *a*B, *a*D, AB, AC, the ratio already established remains unchanged; therefore the two triangles are still similar, and the angles *a*DB, ACB are equal; but the line DC, connecting the parallels *a*D, AC, makes the alternate angles at C and D equal; hence the vertical and opposite angles at D are equal, and BDC is a straight line.

The instrument consists of a bar of metal, or of wood, to embrace the three points A, *a*, B, of which the two former are the centres of accurately-formed steel pivots, connecting it with two other bars shaped so as to include *a*, A, C, and to attach them by similar pivots to a fourth bar, of which the length should be exactly equal to A*a*, or as usually made equal to half of AB. The three points B, D, and C, are made the centres of metal cylinders or tubes, which are accurately turned and bored, so as to be true inside and out, and which each fit, with perfect precision, solid cylinders of metal forming a tracing-point, a pencil-holder, and a fulcrum about which the whole instrument may revolve with freedom and ease.

This fulcrum may therefore be fixed at either B, D, or C; or the pencil may occupy either of these three points; or the tracer may fill either of the three tubes alternately with the pencil;—consequently, there may be $1 \times 2 \times 3 = 6$, different arrangements.

The tube at C is permanently fixed to the bar AC, but the tubes at B, and D, are attached to boxes, which slide along the bars *a*B, BD, and may be secured in any desired position on the bars, by means of clamp screws. The letters B, D, C, are usually engraved on the ends of the several bars, in the same arrangement as they stand in the figure, and they will be used in these notes to designate the bars.

The part *a*B of the bar B, as well as the bar D, are graduated and figured, so as to indicate certain ratios which may be preserved between the original of any system of lines or curves, as a drawing, and its proportional copy,—the two being supposed to lie in one geometrical plane: the principles upon which this is done may now be developed.

Premising that the sliding-boxes may be adjusted to any points of the bars *a*B, and D, we must consider the length of either and both of these as variable. Let us represent

The constant length of $Aa = b$
" " of $C = c$
The variable length of $aB = x$
" " of $D = y$

Then, if the fulcrum is fixed at D, the tracer at C, and the pencil at B, the ratio of the *copy* to the ORIGINAL, considered in point of scale, will be that of the lines BD, DC.

Let $BD : DC :: n : m$; then, $x+b : x :: m+n : n :: c : y$;

$$\text{and } x = \frac{nb}{m}; \quad y = \frac{nc}{m+n}.$$

Suppose the drawing is to be copied to the same scale: then, $n = m$; $x = b$; $y = \frac{1}{2}c$.

In a 30-inch Pentagraph, by Troughton and Simms, from its construction $b = \frac{1}{2}c$; therefore, with this instrument, $x = y = \frac{1}{2}c$; and the divisions for this are figured 1——2.

If the copy is to be $\frac{1}{3}$rd the original, then $m = 3n$; $x = \frac{1}{3}b$; and $y = \frac{1}{2}b$. On the instrument, this division is figured 1——4.

Now, if $m : n :: 12 : 11$, then we have

$$x = \frac{11b}{12}; \quad \text{and } y = \frac{22b}{23};$$

The divisions on the instrument corresponding with these values are figured 11——12; and we should find, if $n = \frac{5}{6}m$, that the corresponding divisions were figured 5——6; and so on.

By changing the fulcrum to C, the tracer to B, and the pencil to D; $BC : DC :: m : n$, becomes the ratio of the ORIGINAL to the *copy*, and

$$b : x+b :: n : m :: c-y : c;$$

$$\text{hence, } x = \frac{b(m-n)}{n}; \quad y = \frac{c(m-n)}{m}.$$

For examples: Suppose $m = n$, $\therefore x = y = 0$, which the construction of the instrument does not admit of. If $n = \frac{11m}{12}$, we should have $x = \frac{1}{11}b$; $y = \frac{1}{6}b$, corresponding to the divisions figured 1——12. If $n = \frac{5m}{6}$, then the divisions corresponding to the values of x and y, would be found figured 1——6.

By extending this process to each of the six different cases, we are enabled to arrange the results so as to offer facilities in applying the instrument, as follows.

No.	Fulcrum at	Tracer at	Pencil at	Value of x.	Value of y.	
1	D	C	B	$\frac{nb}{m}$	$\frac{nc}{m+n}$	$n < m$
2	D	B	C	$\frac{mb}{n}$	$\frac{mc}{m+n}$	$n > m$
3	C	B	D	$\frac{b(m-n)}{n}$	$\frac{c(m-n)}{m}$	$n < m$
4	C	D	B	$\frac{b(n-m)}{m}$	$\frac{c(n-m)}{n}$	$n > m$
5	B	C	D	$b\frac{n}{m-n}$	$c\frac{n}{m}$	$n < m$
6	B	D	C	$b\frac{m}{n-m}$	$c\frac{m}{n}$	$n > m$

From the construction of the instrument, x cannot be greater than b; nor can x or $y = 0$, or have negative values.

Surfaces or areas may be enlarged or reduced in any ratio $m : n$, by finding values of x and y from the formulæ given above, but substituting $\sqrt{m}$, $\sqrt{n}$, for m, and n, therein.

Considering the equations here set forth, in connection with the values of x and y, as measured on the instrument, it appears that the divisions on the bars B, D, which have unity for one of the ratios, are figured in reference to the position of the fulcrum at B, their values being given by equations 5 and 6.

And that, by changing the fulcrum to C, we obtain a set of ratios, which consists, in any particular case, of the *difference* between the number figured on the *right-hand*, and unity to that *right-hand* figure;—and by placing the fulcrum at D, the ratio becomes this same *difference* to *unity*, which is figured on the *left-hand*.

Thus, supposing the boxes adjusted to the divisions figured 1——3; then, with the fulcrum at B, the ratio 1 : 3 holds good;—with the fulcrum at C, the ratio is (3——1) : 3;—and with the fulcrum at D, it is (3——1) : 1.

On the other hand, it appears that all the divisions, which have the ratios expressed by numbers, each greater than unity, are determined by placing the fulcrum at D; and it follows, that, changing the fulcrum to C, we obtain a new ratio, which consists of the *sum* of the two numbers to the *right-hand* number; and by changing it to B, it becomes the *sum* of the two numbers to the *left-hand* number. Thus, supposing the boxes to be adjusted to the divisions marked 5——6, this is the proportion when the fulcrum is at D; transferring it to C, the ratio becomes 11 : 6; and changed to B, it is 11 : 5.

This property increases the number of ratios as figured on the instrument, and is of value in adjusting it to the most convenient position as regards the drawing, copy, size of drawing-table, &c.

Instead of selecting a certain number of arbitrary ratios, as is the usual course with instrument-makers, and dividing the bars to conform to them, it has been proposed to make the divisions equal parts of b for x, and of c for y—the value of each part being very small, such as $\frac{1}{500}b$, according to the size of the instrument; and to adjust the boxes, for any required ratio, according to values which might then be readily ascertained from the equations given herein.

Thus, suppose it was required to reduce a plan on the scale of 100 feet to the inch, to a copy on the scale of 12 chains to the inch; then 12 ch. = 792 feet, and $\frac{n}{m} = \frac{100}{792}$, or $\frac{1}{8}$ nearly. Referring to the table of equations, three of them only belong to the case of reducing a drawing, and we can determine at once that the selection lies between equations 1 and 5. By equation 1, $x = \frac{nb}{m} = \frac{100}{792}b$, which corresponds nearly to the usual division, 1——9; and by equation 5, $x = \frac{bn}{m-n} = \frac{100}{692}b$, which corresponds nearly to the usual division, 1——8. Now, with the instrument as it is usually divided, the error of adjustment made by adopting the conditions of equation 1, would be $\frac{1}{792}b$; and for those of equation 5, it would be $\frac{1}{567}b$ nearly; and the accurate adjustment is a matter depending altogether upon repeated and careful trials:—whereas, if the bars were divided into equal parts as suggested, the adjustment would be determined at once, thus—

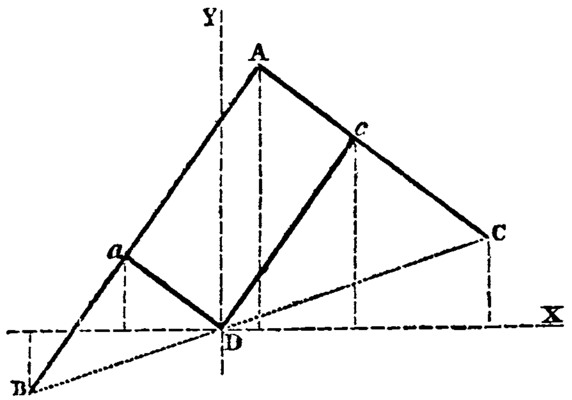
$$\frac{100}{792} = \frac{x}{500} = \frac{63\cdot1}{500}; \qquad \text{or,} \quad \frac{100}{692} = \frac{x}{500} = \frac{72\cdot25}{500}$$

If the decimals were neglected, the error by adjusting to the division 63, would be $\frac{1}{5000}b$; and to the division 72, it would be $\frac{1}{2000}b$. Thus the adjustment would be more readily made, and, by the aid of a vernier, it need not be necessary to neglect decimals.

The adjustment of the three tubes in a straight line has been already shown as essential to the correct working of the instrument, and it should be made by means of a steel straightedge; the drawing-board or table should be smooth and true, as a plane surface; the Pentagraph should move in every direction with the most perfect freedom; and the point of the pencil should be exactly in the axis of the tube which contains it,—this is ascertained by turning it round with the finger and thumb, and cutting the point with care, until the mark it makes on paper, after so turning it round, is a mathematical point, and not a diminutive circle. The drawing, and the paper to receive the copy, should be pinned to the table, and should be so placed that the angles of the rhomboid formed by the bars need not become very acute during any part of the process. With proper attention to these points, the Pentagraph will be found to be an instrument, when well made, for copying drawings on the same or different scales, deserving greater confidence from the draughtsman than is usually accorded to it. For obvious reasons, this confidence may be more complete when the copy is to be on a reduced scale.

The drawing to be dealt with may be one of considerable size, and can only be brought within range of the instrument in limited portions at one time. To connect the various partial copies together, corresponding lines should be traced on each of them, as well as on the drawing, of considerable length, in order that the various parts may occupy their just positions, or that the drawing and paper receiving the copy may be accurately shifted.

Although it may be evident that the lines and curves traced by any two of the points B, D, C, which are in motion simultaneously, are precisely similar, the consideration of the curves traced or passed over by the other points at the joints or pivots of the instrument, may not be wholly speculative or without use. These curves will now be discussed in a general sense.



Let $Aa = Dc = b$; $aD = Ac = c$; $cC = c'$; and $aB = b'$.

Also, supposing the fulcrum at D, take this as the origin of coordinates, the axes being DX. DY, and B, D, C, being always in the same straight line; then the co-ordinates will be expressed as follows:—

x, y, for the point C
x', y', for the point c
x'', y'', for the point A
v', z', for the point a
v, z, for the point B

By the properties of similar triangles—

$$\frac{y'-y}{c'} = \frac{y''-y'}{c} \quad . \quad . \quad . \quad . \quad 1.$$

$$\text{and,} \quad \frac{x-x'}{c'} = \frac{x_{,}-x''}{c} \quad . \quad . \quad . \quad . \quad 2.$$

$$\text{From equation 1,} \quad y' = \frac{cy + c'y''}{c+c'} \quad . \quad . \quad . \quad . \quad . \quad 3.$$

$$\text{From equation 2,} \quad x' = \frac{cx + c'x''}{c+c'} \quad . \quad . \quad . \quad . \quad . \quad 4.$$

By the properties of right-angled triangles—

$$b^2 = x'^2 + y'^2 \quad . \quad . \quad . \quad . \quad . \quad 5.$$

$$\text{and,} \quad (y'-y)^2 + (x-x')^2 = c'^2 \quad . \quad . \quad . \quad . \quad 6.$$

Now, expanding equation 6, and making substitutions, according to equations 3, 4, and 5, we obtain—

$$(x^2+y^2)(c'-c) + b^2(c'+c) = c'^2(c'+c) + 2c'(yy'' + xx'') \quad . \quad 7.$$

for one of the equations connecting the curves traced by the points C and A. The second is derived from equation 5, by substituting in it the values of x' and y', given by equations 3 and 4: hence—

$$(cx + c'x'')^2 + (cy + c'y'')^2 = b^2(c'+c)^2 \quad . \quad . \quad 8.$$

By similar reasoning we obtain for the corresponding equations which connect the curves traced by B and A—

$$(v^2+z^2)(b'-b) + c^2(b'+b) = b'^2(b'+b) - 2b'(vx'' + zy'') \quad . \quad 9.$$

$$\text{and,} \quad (bv - b'x'')^2 + (b'y'' - bz)^2 = c^2(b'+b)^2 \quad . \quad . \quad 10.$$

Now these two equations are of the same form as those connecting the curves traced by the points C and A, and they differ merely in a change of sign, which obviously arises from the different positions of the points C and B, in reference to the axes. Hence we see that any curve traced by the point B, is similar to the curve traced by the point C; the ratio being obviously that of $b' : b$, or of $c : c'$.

In the same way we may arrive at equations to connect the curves traced or passed over, simultaneously, by the points C, c, or c, A, &c.

To apply these equations,—let us take the 30-inch Pentagraph already mentioned, and adjusting the boxes to the divisions marked 1——2 on the bars D, B, fix the fulcrum at D, and with C trace a straight line which shall pass through D: it is required to determine the curve passed over by the point A.

From the construction of the instrument,

$$b = b'; \quad (b'+b) = (c-c'); \quad \text{and } c = b'; \quad \therefore c' = b.$$

Then equation 7, becomes $2b(yy'' + xx'') = 0$. Now, if the line traced by C is assumed as the axis of x, its equation will be $y = 0$; $\therefore 2bxx'' = 0$; consequently, $x'' = 0$; and this being the equation of the axis of y, the point A will describe a straight line perpendicular to the line passed over by C.

This is the principle and the arrangement (either with two or with four bars) which furnishes the most perfect parallel motion for the piston-rods of reciprocating steam-engines, as indicated by Mr. Scott Russell, in his 'Treatise on the Steam-Engine,' p. 210.

Preserving the same arrangement, except moving the box B to any other division towards A, to determine the curve traced by B. We have just seen, that under such circumstances, A passes over a straight line; and (since by construction $b = c$) it is evident that the curve passed over by B, as between the rectangular axes of y and v, will be the same as that which would be passed over by A, referred to the axes of x and y, when we consider $c' = b$, and $b > c$.

In this case, equation 7 becomes, since $y = 0$,

$$x^2(b-c) = 2bx''x; \qquad \therefore x = \frac{2bx''}{b-c}.$$

Also, equation 8 becomes,

$$(cx + bx'')^2 + b^2y''^2 = b^2(b+c)^2;$$

and substituting for x, and reducing, we have—

$$y''^2 = \frac{(b+c)^2}{(b-c)^2}\Big((b-c)^2 - x^2\Big).$$

This is the equation to an ellipse of which the semi-transverse axis $= b + c$, and the semi-conjugate axis $= b - c$; the former being coincident with the axis of y, and the latter with that of x, as is shown by considering x, and y, in the equation, as successively $= 0$.

Now, by substituting v for y'', z for x'', and b' for c, we have

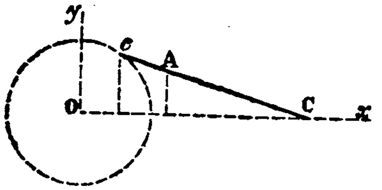
$$v^2 = \frac{(b+b')^2}{(b-b')^2}\Big((b-b')^2 - z^2\Big),$$

the equation to an ellipse whose semi-transverse axis, $b + b'$, is coincident with the axis vx; and whose semi-conjugate axis, $b - b'$, corresponds with the co-ordinate axis of y.

From the make of the instrument, b is a constant quantity, and to this $\frac{1}{4}$th the sum of the transverse and conjugate axes of any ellipse to be traced in this manner must always be equal; b' will then be equal to $\frac{1}{4}$th the difference of those axes. It is evident, too, that when $b' = b$, the equation is that of a straight line; and $b' = 0$, it is that of a circle.

This little investigation naturally suggests an ellipsograph of very simple construction. It also manifestly points to the determination of the curve described by a point in the connecting-rod of a steam-engine, one end of which moves round in the circle of the crank, while the other end performs a rectilineal, or a circular, reciprocating motion.

This curve possesses interest by reason of the "very beautiful method of working the valves of the steam-engine, invented by Mr. Melling," and is obviously a kind of oval—oblate at the end nearest the crank, and elongated at the other end.



Now, using the same notation, and referring to the annexed figure, in which Oc represents the crank-arm $= b$; cC, the connecting-rod $= c'$; and cA, the distance of the given point from the crank-end of the connecting-rod $= c$: it is evident, the formulæ 7, 8, will apply, by merely changing the sign of c, because the line represented by this letter has now a direction contrary to that hitherto assigned to it. Hence they will become—

$$(x^2+y^2)(c'+c) + b^2(c'-c) = c'^2(c'-c) + 2c'(yy''+xx'') \quad . \quad 11.$$

$$\text{and,} \quad (c'x''-cx)^2 + (c'y''-cy)^2 = b^2(c'-c)^2 \quad . \quad . \quad 12.$$

Thus, suppose the path of the piston-rod to coincide with the axis of abscissæ x, whilst the connecting-rod attaches the crank-arm and piston-rod together; then $y = 0$, and equations 11, 12, become, $x^2(c'+c) + b^2(c'-c) = c'^2(c'-c) + 2c'xx''$;

and, $(c'x''-cx)^2 + c'^2y''^2 = b^2(c'-c)^2$.

The first of these equations enables us to find x'', for any value of x; and the second gives the corresponding value of y''.

Suppose, as in Mr. Melling's arrangement, the connecting-rod to be four times the length of the crank-arm, or $c' = 4b$, and $2c = c'$; then, at the commencement of the stroke, $x = b + c'$, and we find $x'' = \frac{5}{4}c'$, as it should be. At half-stroke, $x = c' - b$; and then, $x'' = \frac{3}{4}c'$, as it should be.

It is only in the case of the crank-arm being equal to the connecting-rod in length, that *any part* of the curve described by a point in the connecting-rod is an ellipse—and then it could not be during more than half-a-revolution: but the conditions imposed by the mechanism render these proportions inadmissable. In no others is the curve described an ellipse; nor is it correct, that the *deviation* from a true ellipse becomes *more* and *more* as the connecting-rod becomes *shorter*.

October 29th, 1849. J. H.

LEVELLING STAVES.

A new Method of Graduating Levelling Staves, by which they may be much more accurately read and at much greater distances than at present.

At the present time, when drainage of towns with reference to sanitary arrangements, and drainage of lands in connection with agricultural improvements, engage so large a portion of public attention, the suggestion of any real improvement in the instruments usually employed in practical levelling is certain to be listened to with attention, if not with approval, by the numerous body of professional gentlemen now occupied in conducting the operations alluded to. The great benefit conferred upon engineers and architects as a body by Mr. Gravatt, by the arrangement which superseded the use of the sliding-vane in levelling staves, is too well known and appreciated to require comment: while, however, Mr. Gravatt's method is in general far superior to the old one, there are two particulars in which it is usually admitted to be inferior to it—viz. 1st, *the trouble and attention required to read the minute divisions on the staff*—an important point when we reflect on the vast number of readings taken in a single day's levelling; and, 2nd, *the difficulty of reading them at any considerable distance*. In order to remedy these defects, several eminent engineers and others have, at different times, proposed methods of graduating, which, however, seem to have failed to supersede that originally introduced by Mr. Gravatt. To ascertain the reason of this, as well as their comparative merits in connection with some by other engineers, I made a series of experiments on all such levelling staves, of new construction, as I could meet with; a very brief account of the results of which may not be uninteresting, and should perhaps, in justice to the inventors, accompany these remarks, in which shall be proposed a method of graduating levelling staves, which will, I believe, entirely get rid of the two difficulties already mentioned, without any counterbalancing disadvantage. Two levels were used, a 10-in. and a 12-in. focus of Troughton's, in the experiments. The staves compared were as follows:—

No. 1, Mr. Gravatt's: 10ths clearer and more readable at long distances than, perhaps, in any other; 100ths read generally with distinctness at about 8 chns.—10 chns. should not be exceeded; in this Mr. Williams coincides in his 'Practical Geodesy,' p. 63. On the whole, this staff has the advantage of all that have appeared since; in which opinion I am supported by Mr. Bourne in his 'Principles and Practice of Engineering,' p. 210.

No. 2, A mode of dividing, invented and adopted by Mr. P. N. Barlow, C.E.; the object being to obtain greater distinctness and less liability to error. The divisions are composed of triangles, each occupying $\frac{1}{200}$ths of a foot, except that at the even tenth, which is diamond-shaped, to render it more defined than in other staves. The chief advantage of this arrangement consists in the greater distinctness with which the point of intersection of the triangle, and the hair-line of the telescope is defined, compared with the horizontal divisions, and their parallelism with the hair-line. The peculiar difficulty of setting two parallel lines to coincide with one another is well known to astronomical observers, who can bisect a dot with greater precision than two of the finest lines are known to agree.—*vide Encyc. Metrop.*

No. 3, preferred by Mr. Castle ('Land-Surveying,' p. 255), goes by the name of "Stephenson's," and was first used on the London and Birmingham. The 100ths are obtained in the same way as in the common ivory protractor; the 10ths of a foot through the whole length of the staff are bisected, making the two divisions 20ths; and these division lines extend the whole breadth across the staff. The opposite ends of these lines are connected by diagonal lines, each one with its preceding—viz., the left of No. I. with the right of No. II., the right of No. II. with the left of No. III., and so on. And five vertical lines are drawn, at equal distances, along the whole of the staff, which thus divides each of these diagonal lines into five equal parts, each being $\frac{1}{5}$th part of $\frac{1}{20}$th, or $\frac{1}{100}$th part of a foot.

No. 4. Mr. Sopwith's: this on trial seemed altogether too complicated, and the subdivisions too minute. Mr. Bourne's remarks on this staff seem decidedly judicious—page 211 of the work before quoted: "Several attempts have been made at improvements in this (Mr. Gravatt's) staff, but their success is very problematical. Mr. Sopwith, for instance, has introduced one in which distinctive figures are attached to every-other 100th of a foot; the mechanical construction also differs from this,—it is more elaborate, which consequently makes the staff more expensive. It is very neat, however, but is subject to injury in windy weather."

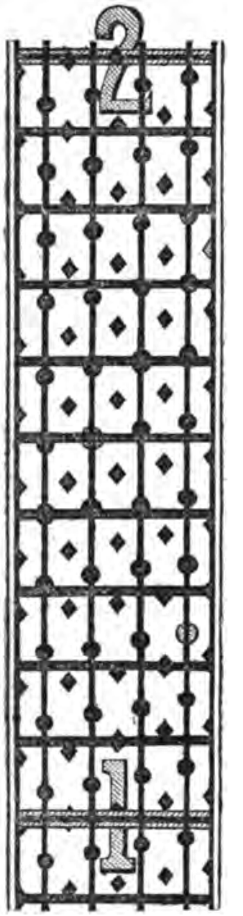
No. 5. A staff of my own invention, constructed with cylinders of block-tin, the largest 3½ inches diameter, to slide one within another, which seemed to afford great strength and lightness, and formed besides a case to carry plans in,—the particular object aimed at being, by obtaining a surface of 9 to 11 inches, to mark every 100th of a foot by a dot and figure, running in a spiral line from bottom to top; it should of course revolve slowly during observation. On actual trial, however, Mr. Gravatt's staff seemed preferable.

No. 6. A staff which, on actual trial, seems capable of being read with more distinctness at short distances than any staff now in use, and with facility at between four to five times the usual distance; it is graduated by an application of the *upright vernier*, the principle of which is usually expressed in the formula,

$$(n-1)\,\mathrm{L} = n\mathrm{V};$$

$$\therefore \mathrm{L} - \mathrm{V} = \mathrm{L} - \frac{n-1}{n}\mathrm{L} = \frac{1}{n}\mathrm{L}.$$

L and V being the length of a division on the staff and vernier respectively. And since to propose any form of sliding vernier would have been at once rejected, as introducing the old vane in a new form, I have got over the difficulty in the following manner:—



By inspecting the diagram, it will be seen that there are 9 rows, or columns of stars or dots, which it is impossible to confuse in a lateral direction one with another. The initial position of the first star in the first of these rows is zero on the staff; the others follow in regular succession at intervals of 100th-foot between each; then, all the stars in any one row are $\frac{9}{100}$ths of a foot from centre to centre, while the lines drawn across mark $\frac{1}{10}$ths of feet as usual: one star will therefore be found at every $\frac{1}{10}$th-foot, which is useful to recollect in graduating a staff in this manner.

In reading such a staff, we first read the feet and $\frac{1}{10}$ths of feet as usual; then, suppose the cross-hair of the diaphragm to occur anywhere within some particular $\frac{1}{10}$th, observe which dot or star it intersects, then count dots or stars upwards, in its vertical line, until a coincidence with a horizontal line is found: the numbers so counted will represent $\frac{1}{100}$ths of feet, and consequently gives us the second decimal place.

The great advantage gained is simply this: that whereas in all the staves now extant, we are obliged to distinguish between hundredths, to obtain the second place; in this levelling staff, we attend to no subdivisions less than $\frac{9}{100}$ths-foot apart, to obtain equal accuracy. On trial, it will be found that this staff can be read with *facility* at ½-mile sights: I found it practicable at 35 and 40 chains, with a 12-in. focus.

I should recommend the horizontal lines to be put in in vermillion, as the contrast between black and vermillion will be found distinct at the utmost distance at which any staff can be read.

J. D. Pemberton.

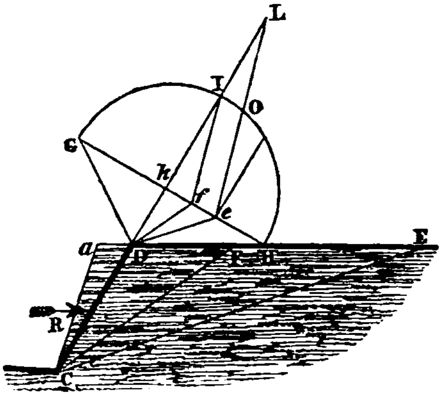
Royal Agricultural College,
Cirencester, November 9th, 1849.

PRESSURE TO SUSTAIN BANKS OF EARTH.

On the Maximum Amount of Resistance, acting in any direction, required to sustain Banks of Earth, or other materials, with Sloping Tops and Faces, and the effects of Friction between the Face of the Bank and the Back of a Retaining Structure. By J. Neville, Esq., Dundalk, County Surveyor of Louth.—(Paper read at the Royal Irish Academy.)*

If CDE be any bank with a sloping face CD, and a sloping top DE; CE the position of the plane of repose, CF that of the plane of fracture, and the arrow R that of the resistance: put

c' = the angle of repose;
c = the complement of the angle of repose;
β = the angle DCE contained between the plane of repose and the face of the bank;
δ = the supplement of the sum of the complement of the angle of repose, and the angle which the given direction of the resistance makes with the face;
θ = the angle KDF, contained between the face produced and the top of the bank;
ϕ = the angle DCF, contained between the plane of fracture and the face;
h = the length of the face CD;
w = the weight of a cubical unit of the bank;
R = the resistance.



Then, when the resistance is a maximum,

$$\tan\phi = \frac{\tan\beta\sqrt{(\tan\theta\tan\delta)}}{\sqrt{(\tan\theta\tan\delta)} + \sqrt{[(\tan\beta+\tan\delta)\times(\tan\theta-\tan\beta)]}} \qquad (1)$$

$$\left.\begin{aligned} \mathrm{R} &= \frac{wh^2\tan\theta\sin\beta\tan\beta}{2\cos\delta} \\ &\left(\frac{1}{\sqrt{[\tan\delta(\tan\theta-\tan\beta)]} + \sqrt{[\tan\theta(\tan\delta+\tan\beta)]}}\right)^2. \end{aligned}\right\} \quad (2)$$

Equation (1) furnishes the following geometrical construction for finding the fracture CF. Draw any line GH at right angles to the face produced, cutting the slope DE at H and the line DG; making the angle GDK=δ at G: on GH describe a semicircle cutting the face produced in I: draw D*e* parallel to the plane of repose CE, meeting GH in *e*: draw *e*O parallel to KI, meeting the circumference in O: make IL equal *e*O; draw I*f* parallel to L*e*, and CF parallel to D*f*: CF is the fracture requiring a maximum resistance to sustain the bank CDF.

If the top lying between F and D be loaded with a given weight, the values of ϕ and R are rigorously determined from the equations by producing the top ED to *d*, so that the triangle CD*d*, multiplied by w and the length of bank acted on, may be equal to the given weight, and then substituting the new values of h, δ, θ, and β, corresponding to the face C*d* and top E*d*, in the equations, in place of those to the face CD and top ED.

When the resistance is generated by the pressure of the bank against a structure at the face, δ may be taken equal $2c'$. Thus,

$$\tan\phi = \frac{\tan\beta\sqrt{(\tan\theta\tan 2c')}}{\sqrt{(\tan\theta\tan 2c')} + \sqrt{[(\tan\theta-\tan\beta)\times(\tan\beta+\tan 2c')]}} \qquad (3)$$

$$\left.\begin{aligned} \mathrm{R} &= \frac{wh^2}{2}\,\frac{\sin\beta\tan\beta\tan\theta}{\cos 2c} \\ &\left(\frac{1}{\sqrt{[\tan\delta(\tan\theta-\tan\beta)]} + \sqrt{[\tan\theta(\tan 2c'+\tan\beta)]}}\right) \end{aligned}\right\} \quad (4)\dagger$$

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* 'Proceedings of the Royal Irish Academy,' Vol. iv. Part 2.

† Equations (3) and (4) determine the direction of the fracture CF, and value of the

When the face is vertical and the top horizontal, $\theta = \beta$; in this case

$$\tan\phi = \frac{\cos c'}{\sin c' + \sqrt{\tfrac{1}{2}}} \qquad (5)$$

$$R = \frac{wh^2 \sec c'}{2}\left(\frac{1}{\sqrt{2}\tan c' + \sec c'}\right)^2. \qquad (6)$$

The value of $\tan\phi$ here derived is equivalent to that of $\frac{1}{\tan a}$ in equation (F) of Tredgold;* but the value of the resistance differs materially from his, and is far more simple. Tredgold's equation (G) for the value of the resistance acting horizontally, after making the necessary changes to our notation, is

$$R = \frac{h^2 w}{2} \times \frac{1}{\sin c'\sqrt{2} + 1 + \frac{\sin^3 c'\sqrt{2} + \sin^2 c'}{\cos^2 c'} + \frac{\sqrt{2}}{2\cos c'}}.$$

This value, however, is erroneous, and should be

$$R = \frac{h^2 w}{2} \times \frac{1}{\sin c'\sqrt{2} + 1 + \frac{\sin^3 c'\sqrt{2} + 3\sin^2 c' + \sin c'\sqrt{2}}{\cos^2 c}}$$

which, multiplied by $\sec c'$, to find the resulting resistance, is equal to the more simple form found above.

When $\theta = \beta$, the top slopes upwards at the angle of repose: in this case

$$\tan\phi = \tan\beta \qquad (7)$$

$$R = \frac{wh^2}{2} \times \frac{\sin^2\beta}{\sin(2c' + \beta} \qquad (8)$$

The second of these equations gives the greatest of the maximum values of the resistance: if the face be vertical, $\tan\beta = \frac{1}{\tan c'}$, and

$$R = \frac{wh^2}{2}\cos c' \qquad (9)$$

The horizontal portion of this resistance is

$$R = \frac{wh^2}{2}\cos^2 c' = \frac{wh^2}{2}\sin^2 c \qquad (10)$$

As this value is the same as (7*) the limiting value of the horizontal resistance, neglecting friction at the face, it appears that the limiting value of the horizontal resistance is the same whether friction at the face be taken in the calculation or neglected.

When the top slopes downwards at the natural slope,

$$\tan\phi = \tan\tfrac{1}{2}\beta \qquad (11)$$

$$R = \frac{wh^2}{2}\;\frac{\sin\beta\tan\beta}{\cos 2c'}\left(\frac{\sqrt{(\tan 2c' + \tan\beta)}}{\tan 2c'\sec\beta + \tan 2c' + \tan\beta}\right)^2 \qquad (12)$$

The value of the resistance here given is the least of the maximum values. If the face be vertical,

$$\tan\phi = \tan\tfrac{1}{2}c \qquad (13)$$

$$R = \frac{wh^2}{2}\sec c'\left(\frac{1}{2\tan c' + \sec c'}\right)^2 \qquad (14)$$

The value of the angle of fracture is of the same form as that of Prony for a vertical face and horizontal top.

The equations show that the stability imparted to a structure at the face of a bank, by friction, arises principally from the direction of the resulting force, which makes an angle equal to the complement of the angle of repose with the face, and that this force is in general less than the horizontal force derived from the equation of Prony, or any other in which face friction is neglected; that the values of both forces, for ordinary banks, are equal at angles of repose in and about 45°; that the former are least for angles of repose less than this, and the latter for angles of repose that are greater; and that the direction of the resulting force makes it in no small degree a crushing force.

It also appears from the equations, that when the angle of repose is 45°, the face vertical, and top horizontal, that the tangent of the angle of fracture is (¼) equal half the tangent of the angle of repose. The Equation of Prony, which neglects friction at the face, for the same case, gives the tangent of the angle of fracture equal to the tangent of half the angle of repose.

In the following Table of Co-efficients, for finding the maximum values of the resistances,—

Column 1 contains the engineering names for the slopes corresponding to some of the angles of repose in column 2.

Column 2 contains the angles of repose from which the co-efficients of wh_1^2 are calculated.

Column 3 contains the complements of the angles of repose in column 2; or the angle which the direction of the *resulting resistance* makes with the face, taking friction thereat into account.

Column 4 contains the co-efficients which, multiplied by wh_1^2, give the value of the horizontal resistances when the top is horizontal and the face vertical; calculated from the Equation of Prony, neglecting friction at the face.

Column 5 contains the co-efficients which, multiplied by wh_1^2, give the values of the horizontal resistances, rejecting friction at the face, required to sustain banks with a horizontal top; the face sloping 10° from the vertical: $\theta = 80°$.

Column 6 contains the co-efficients which, multiplied by wh_1^2, give the values of the *resulting resistances* when the top is horizontal and the face vertical, as in column 4.

Column 7 contains the values of the co-efficients as before, for finding the *resulting resistances* when the top is horizontal and the face slopes 10° from the vertical, as in column 5: now, in this case $\theta = 80°$.

Column 8 contains the values of the co-efficients for finding the values of the *resulting resistances* when the face overhangs 10° from the vertical, and the top is horizontal: in this case $\theta = 100°$.

Column 9 contains the resolved co-efficients of wh_1^2 for finding the portions of the resistances in column 6 at right angles to the face, which in this case are horizontal.

Column 10 contains the resolved co-efficients of wh_1^2 for finding the portions of the resistances in column 7 at right angles to the face. These, in this case, not differing much from the resolved horizontal portions, may be compared with those in column 5.

Column 11 contains the resolved co-efficients of wh_1^2, for finding the portions of the resistances in column 8 at right angles to the face.

Column 12 contains the values of the co-efficients which, multiplied by wh_1^2, give the ultimate or *maximum maximorum* values of the *resulting resistances*; the face being vertical and the top sloping upwards, at the slope of repose.

Column 13 contains the co-efficients for finding the horizontal portions of the resistances determined from column 12.

The length of the perpendicular from the toe of the face to the top, or top produced, is represented by h_1; and the length of the face itself by h.

wh_1^2 is to be multiplied by the co-efficients in columns 4 to 11, to find the resistances; and wh^2 by the co-efficients in columns 11 and 12.

TABLE *of Co efficients for finding the maximum Values of the Resistances for different Angles of Repose; also the Co-efficients for finding the ultimate Values of the Resistances when the Face is vertical, and Scarp at the natural Slope.*

1	2	3	4	5	6	7	8	9	10	11	12	13
3½ to 1*	16°	74°	·284	·228	·249	·218	·287	·239	·209	·276	·481	·462
	17	73	·274	·218	·239	·207	·271	·228	·196	·259	·478	·457
3 to 1*	18½	71½	·259	·207	·226	·193	·266	·214	·183	·262	·474	·450
2½ to 1*	22	68	·228	·177	·197	·164	·210	·183	·152	·196	·464	·430
2 to 1*	27	63	·188	·141	·165	·130	·208	·147	·116	·185	·446	·397
	29	61	·173	·129	·155	·119	·197	·136	·104	·172	·437	·382
	31	59	·160	·117	·144	·108	·188	·123	·093	·161	·429	·367
	32	58	·153	·111	·139	·103	·183	·118	·087	·155	·424	·360
	33	57	·147	·106	134	·098	·177	·113	·082	·149	·419	·352
1½ to 1*	34	56	·141	·101	·129	·094	·173	·107	·078	·143	·415	·344
	35	55	·135	·096	·126	·090	·169	·103	·074	·138	·410	·336
	36	54	·130	·090	·121	·086	·165	·098	·070	·133	·405	·327
	37	53	·124	·084	·117	·081	·161	·093	·065	·129	·400	·319
	39	51	·114	·077	·108	·074	·154	·084	·057	·120	·389	·302
	41	49	·104	·069	·102	·067	·146	·077	·051	·110	·377	·284
	43	47	·094	·062	·095	·061	·140	·069	·045	·102	·366	·267
1 to 1	45	45	·085	·054	·089	·055	·134	·063	·039	·095	·354	·250
	47	43	·077	·048	·083	·049	·129	·057	·033	·088	·341	·233
	49	41	·070	·042	·077	·044	·123	·051	·029	·081	·328	·216
	51	39	·062	·036	·072	·039	·118	·045	·025	·074	·315	·198
¾ to 1*	53	37	·056	·031	·066	·035	·113	·040	·021	·068	·301	·181
	55	35	·049	·027	·062	·031	·109	·036	·018	·062	·287	·165
	57	33	·043	·022	·057	·027	·105	·031	·015	·057	·272	·149

The slopes marked thus * are approximate.

In the preceding equations we have only considered the maximum *retaining-forces*. The minimum *overcoming-forces*, and the position of the corresponding fractures, are determined in a similar manner, and by similar equations. Retaining the same nota-

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resistance when a maximum, for any bank CDE, when supported at the face CD, by a retaining structure, taking the friction at CD into account; for, in this case, the resistance, when in equilibrium with the pressure, must make an angle equal to the complement of the angle of repose with the face, and hence $\delta = 2c'$.

* Philosophical Magazine, vol. ii. p. 402.

tion as before, we get, in this case, for the value of the *overcoming-force*,

$$R=\frac{why}{2}\times\frac{\sin(2c'+\beta-\varphi)}{\sin(\delta-2c'+\varphi)}$$

where y is equal the perpendicular from (F) on the face, or face produced.

If we put $\beta_1=2c'+\beta$, and $\delta_1=\delta-2c'$, the above equation, after a few reductions, becomes

$$R=\frac{why}{2}\times\frac{\cos\beta_1}{\cos\delta_1}\times\frac{\tan\beta_1-\tan\varphi}{\tan\delta_1+\tan\varphi} \tag{15}$$

When this is a minimum,

$$\tan\varphi=\frac{\tan\beta_1\sqrt{(\tan\theta\tan\delta_1)}}{\sqrt{(\tan\theta\tan\delta_1)}-\sqrt{[(\tan\theta-\tan\beta_1)\times(\tan\beta_1+\tan\delta_1)]}} \tag{16}$$

$$\left.\begin{array}{c}R=\dfrac{wh^2\tan\theta\sin\beta_1\tan\beta_1}{2\cos\delta_1}\\ \left(\dfrac{1}{\sqrt{[\tan\theta(\tan\beta_1+\tan\delta_1)]}-\sqrt{[\tan\delta_1(\tan\theta-\tan\beta_1)]}}\right)^2\end{array}\right\} \tag{17}$$

in which the usual changes of signs are to be made for the negative values of δ_1, and for arcs greater than 90°

When the direction of the force makes an angle equal to c with the face, then $\delta_1=0$, and,

$$\varphi=0, \tag{18}$$

$$R=\frac{wh^2}{2}\sin\beta_1 \tag{19}$$

If the force exceed the value of R here found, it will slide along the face, and when the face is vertical this value is equal to the *maximum maximorum* value of the resistance, in the same case, already found; or,

$$R=\frac{wh^2}{2}\sin c$$

When $\theta=90°$, the general equations become

$$\tan\varphi=\frac{\tan\beta_1\sqrt{(\tan\delta_1)}}{\sqrt{(\tan\delta_1)}-\sqrt{[(\tan\beta_1+\tan\delta_1)]}} \tag{20}$$

$$R=\frac{wh^2\sin\beta_1\tan\beta_1}{2\cos\delta_1}\left(\frac{1}{\sqrt{(\tan\beta_1+\tan\delta_1)}-\sqrt{(\tan\delta_1)}}\right)^2 \tag{21}$$

If the force in this case be supposed to act in an horizontal direction ($\delta_1+\beta_1=90°$), these equations may be reduced to

$$\tan\varphi=\cot\left(c-\frac{\beta}{2}\right) \tag{22}$$

$$R=\frac{wh^2}{2}\cot^2\left(c-\frac{\beta}{2}\right) \tag{23}$$

If the face be vertical, then $\beta=c$, and the equations may be further reduced to

$$\tan\varphi=\cot\tfrac{1}{2}c \tag{24}$$

$$R=\frac{wh^2}{2}\cot^2\tfrac{1}{2}c \tag{25}$$

TEMPERATURE AND ELASTICITY OF VAPOURS.

On an Equation between the Temperature and the Maximum Elasticity of Steam and other Vapours. By William John Macquorn Rankine, C.E.—[From the *Edinburgh New Philosophical Journal* for July 1849.]

In the course of a series of investigations founded on a peculiar hypothesis respecting the molecular constitution of matter, I have obtained, among other results, an equation giving a very close approximation to the maximum elasticity of vapour in contact with its liquid at all temperatures that usually occur.

As this equation is easy and expeditious in calculation, gives accurate numerical results, and is likely to be practically useful, I proceed at once to make it known, without waiting until I have reduced the theoretical researches, of which it is a consequence, to a form fit for publication.

The equation is as follows:—

$$\text{(1.)}\qquad \text{Log. }P=a-\frac{\beta}{t}-\frac{\gamma}{t^2}$$

Where P represents the maximum pressure of a vapour in contact with its liquid; t, the temperature, measured on the air-thermometer, from a point which may be called the absolute zero, and which is—

274°·6 of the *centigrade scale* below the freezing point of water.

462°·28 of *Fahrenheit's scale* below the *ordinary* zero of that scale, supposing the boiling point to have been adjusted under a pressure of 29·992 inches of mercury, so that 180° of Fahrenheit may be exactly equal to 100 centigrade degrees.

461°·93 below the ordinary zero of Fahrenreit's scale, when the boiling point has been adjusted under a pressure of 30 inches of mercury, 180° of Fahrenheit being then equal to 100°·0735 of the centigrade scale.

The *form* of the equation has been given by theory; but three constants, represented by a, β, and γ, have to be determined for each fluid by experiment.

The inverse formula, for finding the temperature from the pressure, is of course

$$\text{(2.)}\qquad \frac{1}{t}=\sqrt{\frac{a-\text{Log }P}{\gamma}+\frac{\beta^2}{4\gamma^2}}-\frac{\beta}{2\gamma}.$$

It is obvious that for the determination of the three constants, it is sufficient to know accurately the pressures corresponding to three temperatures; and that the calculation will be facilitated if the reciprocals of those temperatures, as measured from the absolute zero, are in arithmetical progression.

In order to calculate the values of the three constants, for the vapour of water, the following data have been taken from M. Regnault's experiments:—

Temperatures in Centigrade Degrees		Common Logarithms of the Pressure in Millemetres of Mercury.	Remarks.
Above the Freezing Point	Above the Absolute Zero.		
220°·	494°6	4·2403	Measured by M. Regnault on his curve, showing the mean of his experiments.
100·	374·6	2·8808136	Logarithm of 760 millemet.
26·86	301·46	1·4198	Calculated by interpolation from M. Regnault's general table.

These data give the following results for the vapour of water, the pressures being expressed in millimetres of mercury, and the temperatures in centigrade degrees of the air-thermometer:—

$$\text{Log }\gamma=5{\cdot}0827176 \qquad \text{Log }\beta=3{\cdot}1851091 \qquad a=7{\cdot}831247$$

Table I. exhibits a comparison between the results of the formula and those of M. Regnault's experiments, for every tenth degree of the centigrade air-thermometer, from 30° below the freezing to 230° above it, being within one or two degrees of the whole range of the experiments.

M. Regnault's values are given, as measured by himself, on the curves representing the mean results of his experiments, with the exception of the pressures at 26°·86, one of the data already mentioned, and that at —30°, which I have calculated by interpolation from his Table, series *h*.

Each of the three data used in determining the constants is marked with an asterisk*.

In the columns of differences between the results of the formula and those of experiment, the sign + indicates that the former exceed the latter, and the sign — the reverse.

Beside each such column of differences is placed a column of the corresponding differences of temperature, which would result in calculating the temperature from the pressure by the inverse formula. These are found by multiplying each number in the preceding columns by $-\frac{dt}{dP}$, or by $\frac{-dt}{d\,\text{Log }P}$, as the case may require.

In comparing the results of the formula with those of experiment, as exhibited in Table I., the following circumstances are to be taken into consideration:—

First, That the uncertainty of barometric observations amounts in general to at least one-tenth of a millemetre.

Secondly, That the uncertainty of thermometric observations is from one-twentieth to one-tenth of a degree, under ordinary circumstances, and at high temperatures amounts to more.

Thirdly, That, in experiments of the kind referred to in the Table, those two sorts of uncertainty are combined.

The fifth column of the Table shows that, from 30° below the freezing point to 20° above it, where the minuteness of the pressure makes the barometric errors of most importance, the greatest difference between experiment and calculation is $\frac{13}{100}$ of a millemetre, or $\frac{1}{200}$ of an inch of mercury,—a very small quantity in itself, although, from the slowness with which the pressure varies at low temperatures, the corresponding difference of temperature amounts to $\frac{38}{100}$ of a degree.

TABLE I.—*Vapour of Water.*

Temperatures in Centigrade Degrees of the Air Thermometer from		Pressures in Millimetres of Mercury, according to		Difference between Calculation and Experiment in Millimetres.	Corresponding Differences of Temperature.	Common Logarithms of the Pressures in Millimetres, according to		Differences between Calculation and Experiment in Logarithms.	Corresponding Differences of Temperature.	Temperatures above the Freezing Point.
The Freezing Point.	The Absolute Zero.	The Formula.	M. Regnault's Experiments.			The Formula.	M. Regnault's Experiments.			
-30°	244°·6	0·35	0·34	+0·01	-0°·42					
-20	254.6	0·89	0·91	-0·02	+0·25					
-10	264·6	2·07	2·08	-0·01	+0·06					
0	274·6	4·47	4·60	-0·13	+0·38					
+10	284·6	9·05	9·16	-0·11	+0·18					
20	294·6	17·33	17·39	-0·06	+0·06					
*26·86	301·46	26·29	26·29	0·00	0·00					
30	304·6	31·57	31·55	+0·02	-0·01					
40	314·6	55·05	54·91	+0·14	-0·05					
50	324·6	92·26	91·98	+0·28	-0·06					
60	334·6	149·15	148·79	+0·36	-0·05					
70	344·6	233·48	233·09	+0·39	-0·04					
80	354·6	355·04	354·64	+0·40	-0·03					
90	364·6	525·70	525·45	+0·25	-0·01					
*100	374·6	760·00	760·00	0·00	0·00	2·8808136	2·8808	-0·0000	0°·00	100°
110	384·6	1074·82	1073·70	+1·12	-0·03	3·031362	3·0307	+0·0007	-0·05	110
120	394·6	1490·1	1489·0	+1·1	-0·02	3·173204	3·1734	-0·0002	+0·01	120
130	404·6	2028·0	2029·0	-1·0	+0·02	3·307061	3·3076	-0·0005	+0·04	130
140	414·6	2713·8	2713·0	+0·8	-0·02	3·433576	3·4332	+0·0004	-0·03	140
150	424·6	3575·5	3572·0	+3·5	-0·04	3·553334	3·5537	-0·0004	+0·03	150
160	434·6	4643·6	4647·0	-3·4	+0·03	3·666853	3·6676	-0·0007	+0·06	160
170	444·6	5951·2	5960·0	-8·8	+0·06	3·774603	3·7750	-0·0004	+0·04	170
180	454·6	7533·7	7545·0	-11·3	+0·07	3·877005	3·8772	-0·0002	+0·02	180
190	464·6	9428·5	9428·0	+ 0·5	-0·00	3·974443	3·9743	+0·0001	-0·01	190
200	474·6	11675	11660	+15	-0·06	4·067268	4·0674	-0·0001	+0·01	200
210	484·6	14315	14308	+ 7	-0·02	4·155796	4·1561	-0·0008	+0·03	210
*220	494·6	17390	17390	0	0·00	4·240300	4·2403	0·0000	0·00	220
230	504·6	20945	20915	+30	-0·08	4·321083	4·3207	+0·0004	-0·05	230
(1.)	(2.)	(3.)	(4.)	(5.)	(6.)	(7.)	(8.)	(9.)	(10.)	(11.)

The sixth and tenth columns show that, from 20° to 230° above the freezing point, the greatest of the discrepancies between experiment and observation corresponds to a difference of temperature of only $\frac{8}{100}$ of a degree, and that very few of those discrepancies exceed the amount corresponding to $\frac{1}{20}$ of a degree.

A comparison between the sixth and tenth columns shows that, for four of the temperatures given, viz., 120°, 150°, 200°, and 210°, the pressures deduced from M. Regnault's curve of actual elasticities, and from his logarithmic curve respectively, differ from the pressures given by the formula in opposite directions.

If the curves represented by the formula were laid down on M. Regnault's diagram, they would be almost undistinguishable from those which he has himself drawn, except near the freezing point, where the scale of pressures is very large, the heights of the mercurial column being magnified eight-fold on the plate. In the case of the curves of logarithms of pressures above one atmosphere, the coincidence would be almost perfect.

The formula may therefore be considered as accurately representing the results of all M. Regnault's experiments throughout a range of temperatures from 30° of the centigrade scale below the freezing point to 230° above it, and of pressures from $\frac{1}{2200}$ of an atmosphere up to 28 atmospheres.

It will be observed that equation (1.) bears some resemblance to the formula proposed by Professor Roche in 1828—viz.:

$$\text{Log P} = \text{A} - \frac{\text{B}}{\text{T}+\text{C}},$$

where T represents the temperature measured from the ordinary zero point, and A, B, C, constants, which have to be determined from three experimental data. It has been shown, however, by M. Regnault, as well as by others, that though this formula agrees very nearly with observation throughout a limited range of temperature, it errs widely when the range is extensive. I have been unable to find Professor Roche's memoir, and I do not know the reasoning from which he has deduced his formula.

The use in computation of the equations I have given, whether to calculate the pressure from the temperature, or the temperature from the pressure, is rapid and easy. In Table II. they are recapitulated, and the values of the constants for different measures of pressure and temperature are stated.

In calculating the values of a, the specific gravity of mercury has been taken as 13·596.

Temperatures measured by mercurial thermometers are in all cases to be reduced to the corresponding temperatures on the air-thermometer, which may be done by means of the table given by M. Regnault in his memoir on that subject.

TABLE II.—*Vapour of Water.*

Formula for calculating the Maximum Elasticity of Steam (P), *from the Temperature on the Air-Thermometer, measured from the Absolute Zero* (t):

$$\text{Log P} = a - \frac{\beta}{t} - \frac{\gamma}{t^2}$$

Inverse Formula for calculating the Temperature from the Maximum Elasticity of Steam:

$$\frac{1}{t} = \sqrt{\frac{a - \text{Log P}}{\gamma} + \frac{\beta^2}{4\gamma^2}} - \frac{\beta}{2\gamma}.$$

Values of the Constants depending on the Thermometric Scale.

For the centigrade scale:—

Absolute zero 274°·6 below the freezing point of water.

$\text{Log } \beta = 3{\cdot}1851091$ $\text{Log } \gamma = 5{\cdot}0827176$

$\frac{\beta}{2\gamma} = 0{\cdot}0063294$ $\frac{\beta^2}{4\gamma^2} = 0{\cdot}00004006$

For Fahrenheit's scale; boiling point adjusted at 29·922 inches:—

Absolute zero 462°·28 below ordinary zero.

$\text{Log } \beta = 3{\cdot}4403816$ $\text{Log } \gamma = 5{\cdot}5932626$

$\frac{\beta}{2\gamma} = 0{\cdot}0035163$ $\frac{\beta^2}{4\gamma^2} = 0{\cdot}000012364$

For Fahrenheit's scale; boiling point adjusted at 30 inches:—

Absolute zero 461°·93 below ordinary zero.

$\text{Log } \beta = 3{\cdot}4400625$ $\text{Log } \gamma = 5{\cdot}5926244$

$\frac{\beta}{2\gamma} = 0{\cdot}0035189$ $\frac{\beta^2}{4\gamma^2} = 0{\cdot}000012383$

Values of the Constant a, depending on the Measure of Elasticity.

For millimetres of mercury . . .	a=7·831247
English inches of mercury . .	6·426421
Atmospheres of 760 mil. = 29·922 inches = 14·7 lb. on the sq. inch = 1·0333 kil. on the centimetre² .	4·950433
Atmospheres of 30 in. = 761·99 mil = 14·74 lb. on the square inch = 1·036 kil. on the centimetre² .	4·949300
Kilogrammes on the square centimetre .	4·964658
Pounds Avoirdupois on the square inch .	6·117817

N.B.—All the Constants are for common logarithms.

I have applied similar formulæ to the vapours of *alcohol* and *ether*, making use of the experiments of Dr. Ure.

In order to calculate the constants, the following experimental data have been taken, assuming that, on Dr. Ure's thermometers, 180° were equal to 100 centigrade degrees.

TABLE—*Vapours of Alcohol and Ether.*

	Temperatures on Fahrenheit's Scale from the Ordinary Zero.	Temperatures on Fahrenheit's Scale from the Absolute Zero.	Pressures in Inches of Mercury.	REMARKS.
For Alcohol, of the specific gravity 0·813	250°	712°·3	132·30	From Ure's Table.
	173	635·3	30·00	Do.
	111·02	573·32	6·30	Interpolated.
For Ether, boiling at 105° F., under 30 in. of pressure	200	662·3	142·8	From Ure's Table.
	148·8	611·1	66·24	Interpolated.
	105	567·3	30·00	From the Table.
For Ether, boiling at 104° F., under 30 in. of pressure	104	566·3	30·00	From Ure's Table.
	66·7	529·0	13·76	Interpolated.
	34	496·3	6·20	From the Table.

The values of the constants in equation (1.), calculated from these data, are as follows, for inches of mercury and Fahrenheit's scale:—

	a	Log. β	Log. γ
Alcohol, specific gravity, 0·813	6·16620	3·3165220	5·7602702
Ether, boiling point, 105° F.	5·33590	3·2084573	5·5119893
Ether, boiling point, 104° F.	5·44580	3·2571312	5·3962460

Absolute zero 462°·3 below ordinary zero.

The results of Dr. Ure's experiments on the vapours of *turpentine* and *petroleum*, are so irregular, and the range of temperatures and pressures through which they extend so limited, that the value of the constant γ cannot be determined from them with precision. I have, therefore, endeavoured to represent the elasticities of those two vapours approximately by the *first two terms* of the formula only, calculating the constants from two experimental data for each fluid. The equation thus obtained,

$$\text{Log P} = a - \frac{\beta}{t},$$

is similar in form to that of Professor Roche.

The data, and the values of the constants, are as follows:—

TABLE—*Vapours of Turpentine and Petroleum.*

Temperature on Fahrenheit's Scale from the Ordinary Zero.	Temperature on Fahrenheit's Scale from the Absolute Zero.	Pressures in Inches of Mercury	Values of the Constants for Fahrenheit's Scale, and Inches of Mercury.
		Turpentine.	
360°	822°·3	60·80	a=5·98187
304	766·3	30·00	Log β=3·5380701
		Petroleum.	
370	832·3	60·70	a=6·19451
316	778·3	30·00	Log β=3·5648490

Although the temperatures are much higher than the boiling point of water, I have not endeavoured to reduce them to the scale of the air-thermometer, as it is impossible to do so correctly, without knowing the nature of the glass of which the mercurial thermometer was made.

I have also endeavoured, by means of the first two terms of the formula, to approximate to the elasticity of the vapour of *mercury*, as given by the experiments of M. Regnault. The following table exhibits the comparative results of observation and experiment.

TABLE—*Vapour of Mercury.*

Temperatures in Centigrade Degrees from the Freezing Point.	Pressures in Millemetres of Mercury, according to The Formula (of two terms.)	Pressures in Millemetres of Mercury, according to M. Regnault's Experiments.	Differences between Calculation and Experiment in Millimetres.
72°·74	0·115	0·183	−0·068
100·11	0·480	0·407	+0·073
100·6	0·49	0·56	−0·07
146·3	3·49	3·46	+0·03
*177·9	10·72	10·72	0·00
200·5	21·85	22·01	−0·16
*358·0	760·00	760·00	0·00

The discrepancies are obviously of the order of errors of observation, and the formula may be considered correct for all temperatures below 200° C., and for a short range above that point. From its wanting the third term, however, it will probably be found to deviate slightly from the truth between 200° and 358°; while above the latter point it must not be relied on.

I have not carried the comparison below 72°, because in that part of the scale the whole pressure becomes of the order of errors of observation.

In conclusion, it appears to me that the following proposition, to which I have been led by the theoretical researches referred to at the commencement of this paper, is borne out by all the experiments I have quoted, especially by those of greatest accuracy, and may be safely and usefully applied to practice:—

If the maximum elasticity of any vapour in contact with its liquid be ascertained for three points on the scale of the air-thermometer, then the constants of an equation of the form

$$\text{Log P} = a - \frac{\beta}{t} - \frac{\gamma}{t^2}$$

may be determined, which equation will give, for that vapour, with an accuracy limited only by the errors of observation, the relation between the temperature (t), *measured from the absolute zero* (274·6 *centigrade degrees below the freezing point of water*), *and the maximum elasticity* (P), *at all temperatures between those three points, and for a considerable range beyond them.*

REGISTER OF NEW PATENTS.

COMPRESSED FUEL.

WILLIAM BUCKWELL, of the Artificial Granite Works, Battersea, Surrey, civil engineer, for "*improvements in compressing and solidifying fuel materials.*"—Granted March 28; Enrolled September 28, 1849.

The improvement consists in compressing fuel material by means of percussion force instead of a continuous pressure. The apparatus consists of a ram worked by steam or other power, the size of the ram to be about three tons weight, falling through about 4 feet, and making about 50 strokes per minute; and beneath the hammer is placed a mould, in which the blocks are to be formed. The mould contains two blocks, divided from each other by an iron plate; and when the upper of the two blocks is formed and sufficiently compressed, the lower one is removed, and the upper one takes its place, which allows another to be formed on the top. The mode of extracting the lower block is as follows:—There is no fixed bottom to the mould, but a loose one is provided, and held in its place by a rod or prop beneath it, which is attached to a piston within a steam cylinder. This loose bottom is held up by a catch while the hammer is in operation; but when the lower block has to be removed from the mould, the catch is withdrawn, and the next blow of the hammer forces out the block, carrying with it the bottom and piston. The upper block now takes the place of the former, within the lower part of the mould, and another block is

NEWTONS IMPROVEMENTS IN STEAM - ENGINES.

Fig. 2.

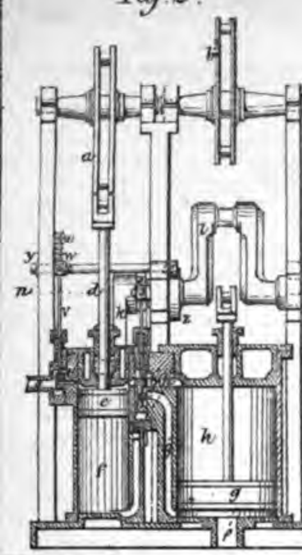


Fig. 1.

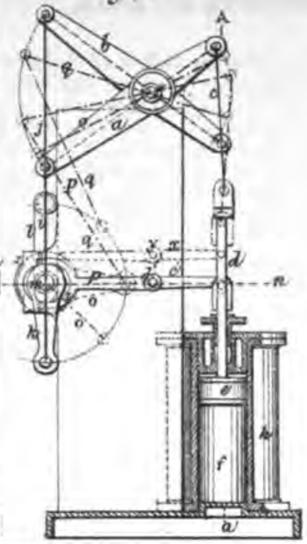


Fig. 5.

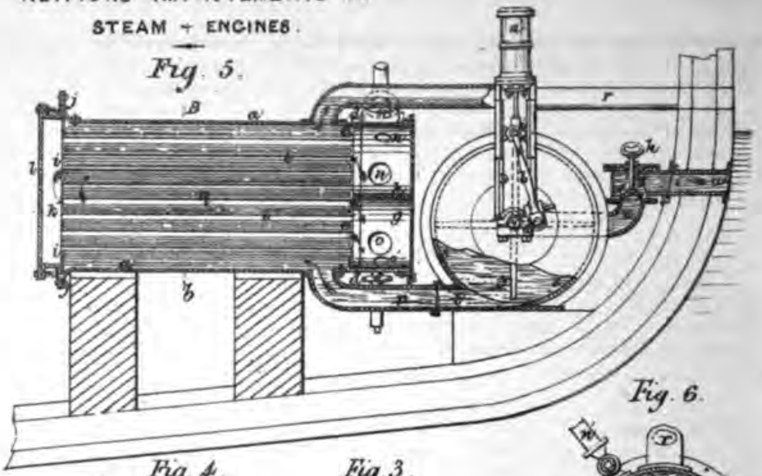


Fig. 4.

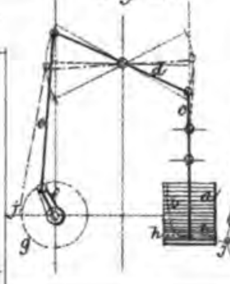


Fig. 3.

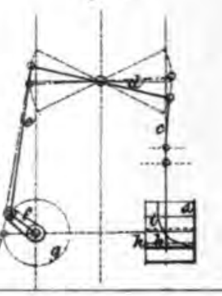


Fig. 6.

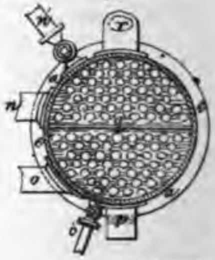
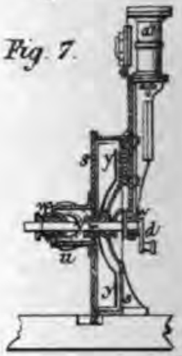


Fig. 7.



GORDON'S APPARATUS FOR VENTILATING MINES.

Fig. 1.

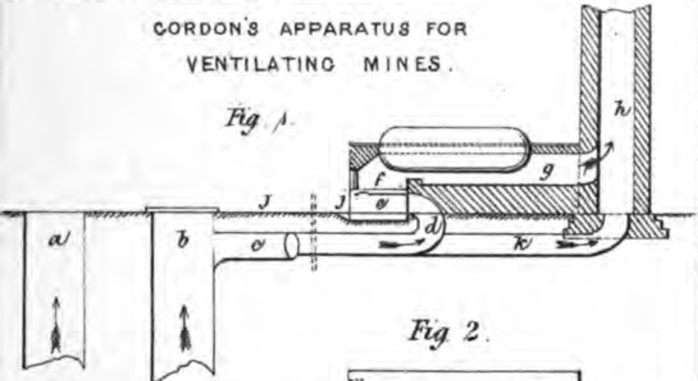


Fig. 2.

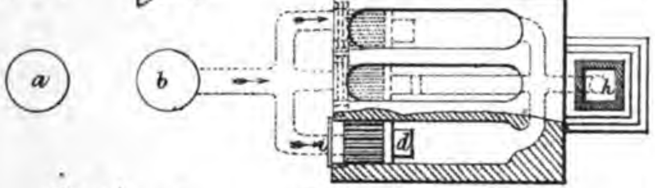


Fig. 4.

Fig. 3.

Fig. 5.

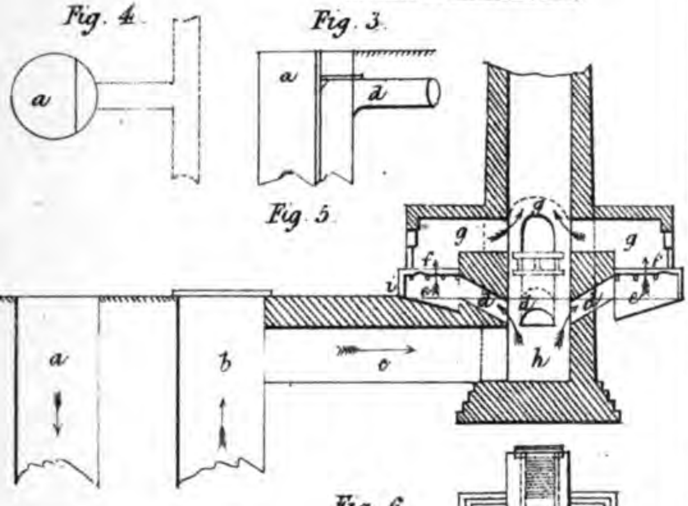
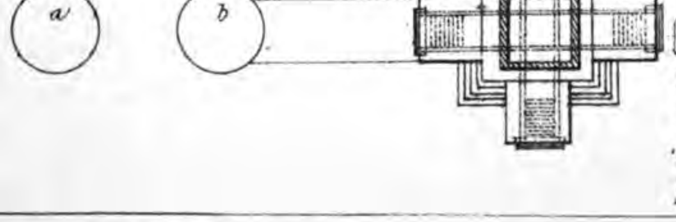
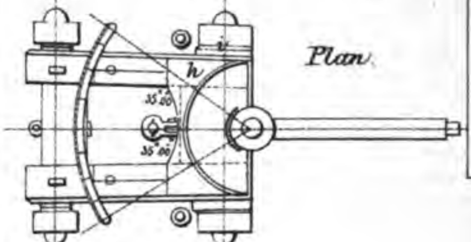


Fig. 6.

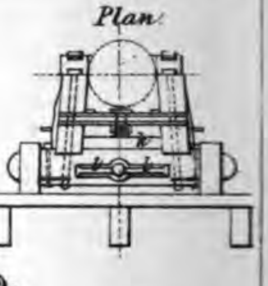


WOOLLETT'S GUN CARRIAGES.

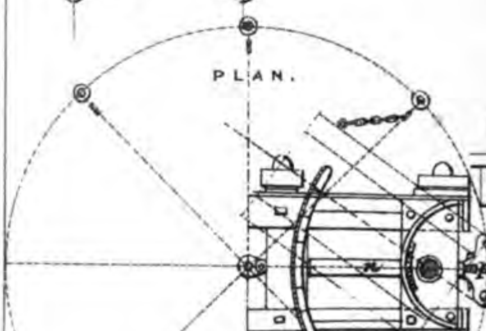
Plan.



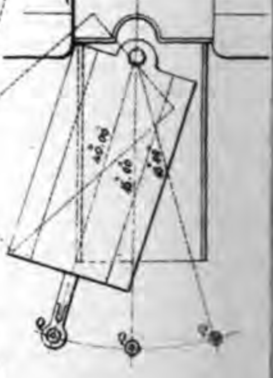
Plan.



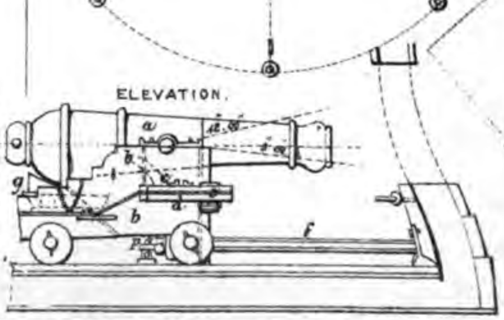
PLAN.



PLAN



ELEVATION.



formed on the top, upon the lower block being forced from the mould; the pressure of steam forces up the loose bottom, and, when up, it is secured by the catch, as before, and the hammer set to work to form another block. The blocks, after being compressed, are subsequently dried by exposure to the atmosphere or heated air.

STEAM ENGINES.

William Edward Newton, of 66, Chancery-lane, Middlesex, civil engineer, for "*certain improvements in steam-engines.*" (A communication from Charles M. Keller, Esq., New York.)—Granted December 28, 1848; Enrolled June 28, 1849. [Reported in *Newton's London Journal.*]

(*With Engravings, Plate* XXII.)

This invention of improvements in steam-engines is represented in the annexed engravings. Fig. 1, is a vertical section of a steam-engine of the improved construction, taken in a plane parallel with the beams, and passing through one of the cylinders and the crank-shaft; and fig. 2, is another vertical section, taken at the line A, *a*, of fig. 1. Figs. 3, and 4, are diagrams of the ordinary crank-beam engine, to illustrate the irregular mechanical force on the crank of a steam-engine working expansively. Fig. 5, is a longitudinal vertical section of an improved condensing apparatus; fig. 6, is a section thereof, taken at the line B, *b*, of fig. 5; and fig. 7, is a cross-section of the pumping part of the apparatus, with the auxiliary engine, by which it is operated.

The inventor, preparatory to explaining the nature of his invention, makes the following introductory remarks:—It is a well-known fact, in the application of steam as a motive power, that the more the principle of expansion is introduced the more economical will be the effect produced, provided some element or elements be not introduced in the mechanism to counteract it. To give the full effect to this expansive principle of steam, it should be either applied to a resistance which decreases in the exact ratio of the decreasing pressure of the steam, by reason of its expansion or dilatation; or, what amounts to the same thing, the leverage of the body, impelled by this force, should increase in the inverse ratio of the decreasing pressure. The ordinary crank-engine, in general use, presents in nearly every particular, the reverse of the requirements of this problem; and it would be difficult to conceive a mechanism theoretically so ill-adapted to the application of this principle; but still, from its practical advantages in other particulars, it continues in use, because of the practical objections to all other plans which have been suggested for overcoming its theoretical defects. The irregular mechanical force of steam applied expansively to the ordinary crank-beam engine, is illustrated in diagrams 3, and 4,—the former being based on the assumption that the steam is cut off at one-quarter of the stroke, and the latter at one-twentieth. In these diagrams, *a*, represents the cylinder; *b*, the piston; *c*, the piston connecting-rod; *d*, the beam; *e*, the crank connecting-rod; *f*, the crank; *g*, the circle described by the centre of the crank-pin in the rotation of the crank; and *i*, the line of pressure of the expanding steam. When the steam is cut off at one-quarter of the stroke, one-half of the whole mechanical force of the steam is expended in forcing the piston up to the dotted line *h*, a little more than one-quarter of the entire stroke,—the crank making but about one-third of its semi-rotation from the dead point, and therefore along that part of the rotation in which it presents the shortest leverage. During the next quarter of the stroke, the crank passes to the line *j*, which indicates the half of the semi-revolution; and, in passing to this point, the leverage of the crank increases nearly in the inverse ratio of the decreasing pressure of the steam on the piston; but this is the only part of the stroke in which the motion and leverage of the crank are in such relation to each other as to give an approximaton to the full mechanical force of the steam; whereas, during the remaining half-stroke, the leverage of the crank decreases as the pressure decreases. The great defect is to be found in the fact that (when the steam is cut off at the quarter-stroke) one-half of the mechanical force of the steam is exerted in moving the crank through only one-third of the circuit due to the entire stroke,—the other two-thirds remaining to be effected by the other half of the mechanical force of the steam, and that too by a force decreasing as the leverage to which it is applied decreases. But it will be seen, by reference to the diagram, fig. 4, that this irregularity, so wasteful of power, increases as the steam is cut off at a less portion of the stroke,—as, for instance, in this diagram the steam is supposed to be cut off at one-twentieth of the stroke. In this, the line of mean pressure *h*, is at one-eighth of the stroke; and therefore one-half of the mechanical force of the steam has been exerted in moving the piston only one-eighth of its stroke,—the remaining seven-eighths of the stroke having to be effected by the remaining half of the mechanical force. It follows, from these illustrations, that the more expansively steam is applied to the ordinary crank-engine, the more irregular will be the motion, and the more wasteful the application of the impelling force.

In view of the problem above given, and the theoretical defects of the ordinary engine, the desideratum has been the production of an engine which would present all the practical advantages of the ordinary crank-engine, such as simplicity and cheapness of construction, strength and durability, and which, at the same time, would admit of a more economical application of the principle of the expansion of the steam.

The accomplishment of this important end is the object of the first part of the present invention, which consists, first, in placing the axis of the crank-shaft in a plane nearer than heretofore to the axis of vibration of the beam which transfers the power from the piston to the crank; that is, instead of placing the axis of the crank-shaft in a plane midway between a plane passing through the axis of the connection of the connecting-rod with the beam at the two extremities of its vibrations, and a plane parallel to it, and passing through this point of the beam at the middle of the vibration, it is placed within this plane,—that is, in or near a straight line, passing through the axis of the connection of the connecting-rod and beam at the extremities of the vibrations of the beam; whereby less than the first half of the stroke of the piston shall carry the crank through one-half of its semi-revolution,—that is, from the dead point to the right angle; and the remaining portion of the stroke, more than one-half, shall give to the crank the remaining half of the semi-revolution,—that is, carry it from the right angle to the other dead point, and, at the same time, bring the line of the connecting-rod (which is shorter than heretofore, say a little more than double the throw of the crank), nearer to a right angle with the crank during the second half of its semi-revolution than during the first-half; and thus not only increase the proportional velocity of the piston whilst impelled by the expanding steam, but make it act on a longer lever than by any other known crank-engine. Secondly, in combining with the crank-shaft, located on the principle herein specified, two single-acting engines, acting on cranks placed on the shaft at an angle of 180°; whereby the force of expanding steam may be more economically applied, and a more regular motion obtained, than heretofore. And, thirdly, in making the second engine of greater capacity than the first, and receiving steam at one end only, and from the first; this end being also alternately connected with the first engine, to receive steam, and with the condenser for exhausting, that the piston may be acted upon in one direction by the expansion of steam, after it has acted in the first engine, there being a vacuum on both sides of the piston during its return motion, when this is combined with the first engine, which receives the steam at one end only,—its other end being connected with that end of the second engine which receives the steam; so that, during the return-stroke of the piston in the first engine, it shall be balanced by the expanding steam, whilst it is acting on the piston of the second engine.

In the drawings at figs. 1, and 2, *a*, and *b*, represent two beams, having the same axes of vibration, and both of the same proportions. The short arm of the one *a*, is connected by a rod *c*, with the piston-rod *d*, of a piston *e*, that works in the cylinder *f*, of the first engine; and the corresponding arm of the other beam *b*, is in like manner connected with a piston *g*, working in the cylinder *h*, of the second engine (see fig. 2), and which is to be placed as near as practicable to the first. The long arms of the two beams are connected by rods *i*, *j*, with two cranks *k*, *l*, on the crank-shaft *m*, and opposite to each other; that is, dividing the circle into two equal parts, that one piston may be up whilst the other is down, and *vice versâ*. The connecting-rods *i*, *j*, should be about two and a half times the length of their cranks. The axis of the crank-shaft is in the straight line *n*, passing through the centres of the connection of the connecting-rods *i*, *j*, with the beams *a*, *b*, when at the extremity of vibration of the beams; from which position, relatively to the proportions of either one of the beams and length of crank and connecting-rod, it results, that the long arm of the beam, in being moved to the position indicated by the dotted line *p*, about one-third of its entire vibration, by one-third of the down-stroke of the piston *e*, will carry the crank *k*, from the dead point to the right angle, one-half of its semi-revolution, as indicated by the dotted lines *p*; and that in passing through the remaining two-thirds of its vibration, to the position occupied in the drawings by the beam *b*, by the remaining two-thirds of the down-stroke of the piston *e*, the crank *k*, will be carried the remaining half of its semi-revolution to the second dead point. The dotted lines *o, o, o, p, p, p*, and *q, q, q*, illustrate how much nearer to a right angle the pull of the connecting-rod is on the crank during the second half of its semi-revolution than during the first half, for this directness of the pull, during the second half of the semi-revolution, must be greater than during the first half, in the proportion of the greater range of motion of the piston during the one than during the other,—that is, nearly in the proportion of two to one. So soon as the first piston has reached the end of its down-stroke, and its crank has performed the effective half of its revolution, the second piston begins to descend, producing the same effect on its crank; and in this way the two pistons and their cranks alternate,—no force being applied to either of their pistons during their up-motion: the cranks, therefore, each pass through the remaining half of their revolutions without any impelling force being applied to them. Steam is admitted to the upper end of the first cylinder *f*, from the steam-pipe *s*, by a slide-valve *t*, which is held up in the position shown in the drawing, and with the port closed by a helical spring *u*, on the valve-rod *v*,—one end of the said spring being attached to the valve-rod, and the other resting against a guide-stud *w*, attached to the frame. To the valve-rod is jointed one arm of a lever *x*, represented by dotted lines, which turns on a stud at *y*,—its other arm resting on the periphery of a cam *z*, on the crank-shaft. This cam, which is represented by dotted lines, is concentric from the point 1 to 2; and, during this part of the rotation of the crank-shaft, the valve remains closed by the tension of the helical spring; but from 2 to 1, the cam has an enlargement, which acts on the lever *x*, to depress and open the valve for the admission of steam to the cylinder; and therefore the extent of this cam-like projection, in the direction of the periphery, will determine at what portion of the stroke the steam shall be cut off. After the valve is closed, the steam acts on the piston expansively, until the end of the down-stroke; a sliding-valve a^1, then opens a port b^1, which establishes a communication between the upper end of the two cylinders, that the steam may act on the piston *g*, to force it down solely by its expansive force; the second cylinder *h*, being of much greater capacity than the first, and so much larger, that the steam, acting by expansion therein during the range of the piston, shall exert on it a mechanical force about equal to that which is exerted on the first piston. The steam of the valve a^1, is jointed to a lever c^1, that turns on a pin at d^1, its other end being forked, to embrace an eccentric e^1, on the crank-shaft by which it is operated. The lower end of the second cylinder is always in communication with the condenser by means of the pipe f^1; and the upper end also communicates with the condenser by means of a passage g^1, governed by the valve a^1; and the motion of the valve is such, that at the end of the down-stroke of the piston *g*, this passage is opened, whereby the steam from the cylinder is exhausted, and a vacuum established above as well as below the piston. There is a connection or passage h^1, between the lower end of the first and the upper end of the second cylinder (partly represented by dotted lines); so that when the upper end of the second cylinder is exhausted, the lower end of the first is also, to establish a vacuum below the piston *e*, during its descent; but when the valve a^1, is opened, to pass the steam from the first to the second cylinder, it also communicates with the lower end of the first cylinder by the passage h^1; so that whilst the second piston is being forced down by the expanding steam, the first piston is balanced, during its return motion, by the pressure of the steam on both sides of it;—thus making the full pressure of the steam on the large piston available, instead of having it react against the surface of the first piston, as in Wolf's expanding engine.

The inventor does not limit himself to the precise proportions or disposition of the crank-shaft, as these may be greatly varied within the principle of the invention, without affecting the result, except in degree. Nor does he confine himself to the combined employment of all the improvements in this part of the invention, as important results can be obtained from either one of them separately: as, for instance, the means of obtaining an equal, or nearly equal, mechanical force on the first and second halves of the semi-rotation of the crank, when using steam expansively, by the principle involved in changing the position of the crank-shaft, relatively to the axis of vibration of the beam, may be advantageously employed, with only one engine, for many purposes. The use of two engines, with the cranks on the same shaft, and on opposite sides of the centre, in combination with the location of the crank-shaft on the principle herein specified, may be advantageously applied to obtain a more regular mechanical action on the crank-shaft, by the use of expansive steam on two ordinary engines, and without the use of the third branch of this part of the invention; and the arrangement of and manner of connecting the expansion engine with the ordinary engine, so as to prevent the steam, whilst acting by expansion alone on the large piston, from re-acting on the small piston, may be advantageously applied, without the use of the first and second branches of this part of the invention; but the best results will be obtained when all three are employed together. Under this part of the invention he claims—Firstly, placing the axis of the crank-shaft of beam-engines, in which the steam is applied expansively, nearer to the axis of vibration of the beam, on the principle herein specified, and for the purpose of obtaining a more regular mechanical action on the crank by the application of the expansive principle of steam, as described.—Secondly, the employment of two engines, with their cranks on one and the same shaft, and on opposite sides,—that is, at an angle of 180°, substantially as described, when this is combined with the location of the crank-shaft on the principle herein specified.—Thirdly, expansion engines, having two cylinders and pistons, in one of which the steam acts by expansion alone, having one end of the large or expansion-cylinder at all times in connection with the condenser, and the other alternately in connection with the condenser and with the steam end of the other cylinder, that the large piston, during its return-stroke, may have a vacuum on each side, as described; when this is combined with the other cylinder connected with the boiler, and which is so arranged as to have both ends in connection with one end of the larger and expansion cylinder, so that when its piston is acted upon by the steam there shall be a vacuum on the other side, and when the steam is acting by expansion on the large piston, it shall be in connection with both ends of the small cylinder, as described.

The object of the second part of the invention is to condense the steam without admixture with the condensing water; that the water produced by the condensation may be carried back to the boiler, to prevent the evil consequences arising from the use of water that contains, in solution or suspension, mineral or other solid matter—and to condense the waste steam blown off from the boiler, to supply the waste arising from leaks, and also for the production of fresh water for any other use. In the fresh-water apparatus a tubular condenser is used, through the tubes of which the steam passes, and is condensed by the cooling influence of a current of cold water, taken from outside the ship or vessel, and made to pass outside of the tubes; and, to this end, the invention consists in combining a condenser of a steam-engine, for the propelling of a ship or other vessel, with a pump that receives the condensing water from outside of the vessel and causes it to pass through the condenser;—the said pump being actuated, irrespective of the engine that propels the vessel, by means of an auxiliary engine,—whereby the amount of condensation can be regulated, independently of the working of the engine that propels the vessel.

Secondly, in connecting the condenser with the boiler or boilers, or any part thereof, in addition to its or their connection with the exhaust of the engine, when the pump, which carries the condensing water through the condenser, is operated by an auxiliary engine; by means of which double connection not only is the steam that escapes from the safety-valve condensed, to be carried back to the boiler, but the boiler or boilers may be used to distil and produce fresh water for any purpose desired, when the engine is not required for propelling the vessel.

And, lastly, in connecting the tubes of the condenser with the cylinder or outer case thereof, by connecting one or both of the diaphragms, to which the ends of the tubes are secured, with the outer cylinder or case by means of a ring, or the equivalent thereof; so that the said ring or flanch may bend to adapt itself to the unequal contraction and expansion of the tubes and cylinder or outer case of the condenser.

At fig. 5, *a* represents a hollow cylinder, within which are arranged a series of small parallel tubes *b*; and the said tubes are secured at one end, in the usual way, to a diaphragm *c*, which has a turned flanch, through which rivets or bolts *d*, pass, to secure it to the cylinder *a*, and within such distance of the head as to leave a sufficient space between it and the head *e*, of the cylinder, for two chambers *f*, and *g*;—these two chambers being separated by a horizontal diaphragm or partition *h*. The outer ends of the tubes are, in like manner, secured to another diaphragm *i*, at the other end; which said diaphragm, instead of being bolted directly to the end of the cylinder, in the usual way, is bolted to a ring *j*, near its outer periphery,—the inner periphery thereof being provided with a turned flanch, bolted to the end of the cylinder. The said ring or flanch should be slightly conical, or bent, that the diaphragm may be at some distance from the end of the cylinder, that it may move in and out, to adapt itself to the unequal contraction and expansion of the tubes and cylinder, by reason of the passage of the steam through the tubes, and the water, for the condensation, through the cylinder. A chamber *k*, is formed at this end of the cylinder by means of a head *l*, secured to the diaphragm by means of a double-flanched ring *m*, and screw-bolts, so that it may be removed, when required, to give access to the tubes. The upper chamber *f*, at the end of the cylinder first described, communicates by means of a pipe *n*, in any desired manner, with the exhaust-pipe of the engine, and, by another pipe n^1, also with the escape-pipe of the boiler; and these connections should be governed by appropriate cocks or valves, so that either can be closed or opened at pleasure. Either of these connections being opened, the steam passes into the chamber *f*, thence through the range of tubes above the diaphragm or partition *h*, to the chamber *k*, at the other end, and thence back, through the lower range of tubes, to the lower chamber *g*, which communicates, by means of the pipe *o*, with the air-pump and supply pumps of the engine, or (this connection being closed) by means of a pipe o^1, with any desired recipient with which the pipe *o*, may be connected. The direction of the passage of the steam, and the water, produced by its condensation through the tubes, is indicated by the arrows. The steam, in passing through the tubes, is condensed by the cooling influence of a constant current of cold water which passes outside of the tubes, and which travels in a direction the reverse of the current of steam; so that the steam as it parts with its caloric, is constantly approaching a cooler medium. The water, for the condensation, is forced into the cylinder *a*, near the diaphragm *c*, through a pipe *p*, and passes around the lower half of the series of tubes, until it strikes the other diaphragm *i*; thence it passes up around the end of a horizontal partition-plate *q*, on the same plane as the partition-plate *h*; which plate *q*, extends from the diaphragm *c*, to within a short distance of the other diaphragm *i*; and from this the water passes around all the upper series of the tubes to the first, where it escapes at the top through a pipe *r*, that discharges through the side of the vessel above the water-line.

The water, for the condensation, is impelled through the condenser by a rotating pump, the case *s*, of which is provided with a tangential pipe *t*, at the lower part, connected with the pipe *p*, of the condenser. This case is also provided with another pipe *u*, which extends from the centre thereof to and through the side of the vessel, and so far down as to be always below the water-line, that the water may flow through it to the inside of the pump-case. To the centre of this case a shaft *v*, is adapted, the journals of which run in appropriate bearings *w*, *w*, in the case, and are properly packed, to prevent the escape of water. On this shaft is a hub *x*, with four arms or vanes *y*, accurately fitted to the case, but rotating without touching it. By the rotation of these arms or vanes, the water is drawn in near the centre, and, by centrifugal force, carried out through the tangential pipe *t*, to and through the condenser. The required rotation of the pump is given by an engine a^1, secured to the casing of the rotary pump, through the rod b^1, which is jointed to the cross-head c^1, and connects it with a crank d^1, on the shaft of the pump. This shaft is provided with an eccentric e^1, for working the valves of the engine a^1. The water supply-pump, which receives the water from the outside of the vessel, and is, for that purpose, below the water-line, is provided with a valve f^1, the stem g^1, of which passes through a stuffing-box, and has a handle h^1, by means of which the pipe can be closed at pleasure, when it becomes necessary to obtain access to the inside of the pump.

From the foregoing it will be seen that, by means of the auxiliary engine, which actuates the pump, a constant current of cold water is carried through the condenser, independently of the working of the propelling-engine of the vessel; and, as a necessary consequence, the more the propelling-engines labour, by reason of head-winds, or rough water, the more perfect will be the condensation and the vacuum produced,—thus increasing the power of the propelling-engine, when power is the most needed; whereas, if the current of cold water were dependent on the working of the propelling-engine, the sum of the mass of water, passing through the condenser, would be exactly in proportion to the motion of the engine, and, therefore, the condensation and vacuum would be decreased in the ratio of the decreased motion of the propelling-engine. It will also be seen that—by reason of the working of the pump which impels the water for the condensation, by means of an auxiliary engine, and the double connection of the condenser with the waste-pipe of the boiler or boilers, and with the exhaust of the propelling-engine—whenever the safety-valve is opened, the steam issuing therefrom, instead of being wasted, will be carried through the condenser and condensed, to be returned to the boiler,—thus avoiding the necessity of a separate supply of water to make up for the waste by the escape of steam from the safety-valve. When the propelling-engine is at rest, the condenser can be used for the distillation and production of fresh water for any desired purpose on board ship; for the condenser may, when desired, be rendered entirely independent of the propelling-engine.

By passing the current of steam in a direction the reverse of the current of condensing water, the greatest amount of caloric is extracted with the least amount of water. The condensing water, in its passage through the condenser, never reaches the point of evaporation, and therefore mineral and other matter held in solution, will not be deposited to incrust the apparatus; and, by insuring a constant and rapid current of water, unequal expansion and contraction is reduced to the smallest amount; so small, in fact, that all injurious effects may be prevented by the mode, above described, of connecting one of the diaphragms, to which one end of the tubes are attached, with the cylinder, by means of the conical or bent ring or flanch.

Under this head of the invention the patentee claims, Firstly,—the combination of the condenser of a steam-engine, used for the propelling of a ship or other vessel, with a pump that receives the condensing water from outside of the vessel, and causes it to pass through the condenser when the said pump is operated by an auxiliary engine, independently of the propelling-engine. Secondly,—the double connection of the condenser; that is, with the exhaust of the propelling-engine, and with the boiler, when the said condenser is combined with a pump that receives the condensing water from the outside of the vessel, and is impelled by an auxiliary engine. And, Lastly,—the method of connecting the tubes with the cylinder or external case of the condenser, by attaching the diaphragm, to which one end of the tubes are connected, to the cylinder or external case, by means of the conical ring, or any analogous means; by the bending of which allowance is made for unequal contraction and expansion of the tubes and cylinder or external case, as described.

GUN CARRIAGES.

Alfred Woollett, of Liverpool, artist, for "*improvements in gun carriages.*"—Granted April 3; Enrolled October 3, 1849. [Reported in the *Repertory of Patent Inventions.*]

(*With Engravings, Plate* XXII.)

The invention relates to improvements in the construction of gun carriages, whereby only the upper part of the carriage is required to be moved when pointing the gun, and the recoil of the gun is controlled, so as at all times to cause it to be run out at the centre of the port or opening through which the gun is to be fixed, with other details of arrangement, which are shown in the engravings.

a, is an eight-inch gun (sixty-eight pounder); *b*, *b*, upper and lower cheeks of the carriage; *c*, section of a wrought-iron plate; *d*, cast-iron plate; *e*, wrought-iron swivel bolt connecting the upper part of the carriage to the lower part, on which the gun can be moved round to the greatest nicety, and trained fore and aft with facility; *f*, is a moveable wrought-iron shaft or bar to secure the gun in the centre of the port, and serves to check the recoil; *g*, regulating-screw to adjust the upper part of the carriage; *h*, plan of cast-iron plate fixed in the lower cheeks of the carriage; *i*, fore-axle fitted with four friction-rollers or sheaves, the shaft *f*, passing through between them; *j*, graduated arch for supporting the rear of the upper part of the carriage, and measuring the angles of training; *k*, elevation of the fore-axle with trucks; *l*, *l*, friction-rollers, the wrought-iron shaft or bar *f*, passing through between them, as shown; *n*, wrought-iron shaft for bow or stern-gun or midship-gun; *o*, fighting-bolt and socket; the hinge *p*, being lifted up, the gun can be transported to the next fighting-bolt; from each bolt the carriage gives seventy degrees training by moving round the top part of the carriage only; *q*, *q*, *q*, fighting-bolts and sockets for a broadside-gun.

The following advantages result from these improvements:—First, momentary training of broadside guns, being able to point the guns to the greatest nicety fore and aft, or concentrate the fire in less time than with the common carrriage, and without the aid of handspikes. Secondly, the gun can be worked with much greater facility and precision, with less men to each heavy gun. Thirdly, the gun is capable of being trained forty degrees each side of the centre of the port, the gun can be elevated and depressed the same as with the old carriage, not covering more space on deck, and the gun recoils at right angles with the port ready for loading. Fourthly, a self-acting compressor, preventing the gun from recoiling home upon the breeching, consequently no breeching can be carried away, therefore the dangers attending such a misfortune are obviated. Fifthly, the gun much better secured within-board through the nature of the machinery, as when the gun being lashed by the usual tackle, no violent motion of the ship can act upon the guns to disarrange them. Sixthly, the invention is well adapted for a bow or stern-gun, being capable of transporting from one port to another, possessing the same advantages in firing as the pivot-gun, although less and considerably lighter; and, Seventhly, the invention allowing of being fixed on deck as a pivot-gun of any calibre, not covering so large a space on deck as the slide, and weighing less, and will be less expensive.

VENTILATION OF MINES.

ROBERT GORDON, of Heaton Norris, Lancaster, engineer, for *improvements in the ventilation of mines.*"—Granted April 4; Enrolled September 29, 1849.

(*With Engravings, Plate* XXII.)

The invention relates to improvements in the ventilation of mines, and consists of certain apparatus, as shown in the engravings, by which a larger and more uniform amount of atmospheric air is passed through the workings of a mine than by the arrangements at present in practice.

Fig. 1, is a vertical section of the shafts of a mine, along with the exhausting apparatus; and fig. 2, is a plan of the same. *a*, is the down-cast shaft through which the pure air descends; *b*, is the up-cast shaft, which is closed at the top with an air-tight door, below which a culvert or air-course *c*, is carried under-ground, and connected to the air-courses *d*, which terminates at the ash-pits *e*, to supply the steam-boiler or other furnace fire *f*, with air. The ash-pits *e*, being closed at the front by a door *i*, so that the whole of the air required to support combustion must ascend the up-cast shaft *b*. When steam-boiler furnaces are employed, as in figs. 1 and 2, from the air-course *d*, there is a connecting culvert or flue *k*, passing into the base of the chimney *h*, which may be opened when the steam is "up," and the furnaces *f*, do not require attention. By this arrangement, the power of the chimney *h*, is not checked by dampers when the steam gets too high, but it is checked and modified by the admission of air through the culvert *k*, all of which is drawn from the up-cast shaft *b*; and if at any time the air taken from the up-cast shaft in this arrangement should contain "choke-damp" or carbonic acid in such proportion as to endanger the combustion in the furnaces *f*, the door *i*, of the ash-pit can be opened and pure air admitted at pleasure.

Fig. 3, is a sectional elevation of a shaft divided by a partition or air-tight "bratice" into two compartments, one part being used as the up-cast shaft *b*, and the other as the down-cast shaft *a*. The *b* compartment is connected with the air-culvert *c*, which leads to the air-course *d*, and the ash-pits *e*, of the furnaces *f*, as in the former figs. 1 and 2.

Figs. 4, and 5, represent a sectional elevation and plan of another arrangement of the improvements, in which the culvert *c*, leading from the up-cast shaft *b*, is connected with the chimney *h*, and at the ash-pits *e*, by the air-courses *d*. This powerful chimney is placed in any convenient position, near the up-cast shaft, and provided with four furnaces *f*, *f*, *f*, *f*; the ash-pit *e*, being closed by doors *i*, as in the former arrangement, so that the supply of air required to support combustion is taken from the up-cast shaft *b*, through the culvert *c*, and the course or current of the air is indicated by the small arrows at fig. 4; the smoke, gases, and heated air from four furnaces returning to the chimney *h*, by the main flues *g*, figs. 4, and 5. By this arrangement not only the air and gases heated by the furnaces ascend the chimney *h*, but a large quantity of air from the up-cast shaft is drawn up direct without going through the furnaces, by the intensely heated gases passing off from the fires, making the exhaustion of the up-cast shaft more complete and efficacious. The result from measurement of the quantity of air passing through a large coal-mine ventilated by an ordinary under-ground furnace, as compared with one arrangement of the improved system, is as follows:—The sectional area of the up-cast shaft of the coal-mine in question is 55 square feet. The fire being 200 fathoms from the surface, the average amount of air found to pass through the workings was rather less than 18,000 cubic feet per minute. In one of the arrangements, a chimney 75 yards high, and connected with the furnaces of four steam boilers, gives an exhausting power equivalent to a column of 1 inch of water, and as a column of water an inch high equals a pressure of ·0316 of a pound, or 5·198 pounds on the superficial foot, which pressure will cause the air to pass through the said chimney at a velocity of 32¼ miles per hour, or 2,860 feet per minute; then 2,860 feet multiplied by 34·33, the sectional area of the chimney, gives 98,183 cubic feet of air per minute for ventilation in place of 18,000, or more than five times the quantity obtained by the ordinary system. Not only is the ventilation materially increased by the improved arrangements, but the ease with which they can be carried out render them much more valuable and efficient. The ventilating fires being at the surface and the stoker at all times under the cognisance of the bank-manager, preclude the probability of neglect. Should the mine be ventilated with one or more boiler fires, as shown in the drawing, figs. 1, and 2, a valve is placed in each of the air-courses *d*, with a spindle attached to regulate it, as shown at *j*, fig. 1, which may be closed to prevent the atmospheric air from returning should it be desirable to stop one or more fires for repairs.

It is further proposed to close up the top of the down-cast shaft *a*, figs. 5, and 6, at any convenient opportunity when the miners are absent from the pit, and at the same time keep up the ventilating fires until the workings are exhausted, equivalent to a column of 1 inch of water or more. This would extract the light explosive gas from the charged receptacles more effectually than any means at present employed, as the pressure of the atmospheric air being diminished in the mine the highly-charged cavities would discharge part of their contents, and when pure atmospheric air was allowed to rush into the workings, the explosive gas in the recesses would become adulterated and its dangerous power destroyed. The position in which the chimney and furnace are placed as regards the up-cast shaft may be varied to suit the locality and character of the mine, and it is obvious that a similar effect may be produced by building the chimney within the up-cast shaft, leaving an opening or annular space between it and the native rock, to allow the water to descend without cooling or impeding the ascending ventilating current, which is produced by an ordinary furnace at or near the bottom of the up-cast shaft.

RAILWAY AXLES AND WHEELS.

WILLIAM KILNER, of Sheffield, engraver, for "*certain improvements in manufacturing railway and other axles and wheels; and in machinery to be employed in such manufacture.*"—Granted April 24; Enrolled October 24, 1849. [Reported in the *Mechanics' Magazine.*]

1. The inside surface of the tyre, after being bent into a circle, is raised to a welding heat, by placing it into a hollow fire or closed hearth, after which it is laid on a block, and the spokes, previously heated at one end, are successively welded to it. The nave is composed of two half-naves formed of bar-iron coiled into rings, with the internal hollow of less diameter at one end than the other; and the inner ends of the spokes are arranged on the face (with the smallest bore) of one of the half-naves, and the corresponding face of the other half-nave laid on them. Care is taken to leave a space between each pair of spokes, and to punch holes in them, in order that the inside surfaces of the half-naves may be welded together at these points. The nave and spokes are heated to the welding point by being placed above the fuel in a furnace, the top of which is made moveable for the purpose of admitting the wheel, after which they are welded together by swages, and the small ends of the half-naves welded over the ends of the spokes. Or, two chains, united by a right and left hand screw-coupling, and passing through the centre of the wheel, are attached to the opposite sides. The wheel is placed in a projecting hearth above the fuel, and when heated to the proper degree of temperature, the chain is tightened and the wheel formed. Instead of welding the spokes to the tyre after the latter has been bent into a circle, they may be welded to a straight bar of iron, which is then bent to the required shape around the ends of moveable blocks arranged to form part of a circle, with intervening spaces to receive the spokes.

2. To give the necessary rotundity to the tyre, a bed-plate is employed which has a central vertical shaft, on which the wheel is placed, and is free to revolve thereon. Around the rim are two pairs of equidistant rollers, supported on spindles in the ends of four levers, the other extremities of which encircle two screw-rods, whereby they can be made to approach or recede from the tyre, while above and beneath it are two other rollers, capable of being brought closer together. The rollers are driven by toothed gear-

ing from any prime mover, and communicate their motion to the wheel. The felloe is formed with a dovetail, and the edge of the tyre bent over it by the action of the rollers. An adjustable scraper is made to act against the tyre, for the purpose of cleansing it.

3. For the purpose of turning the tyres, the patentee employs revolving circular cutters keyed on a shaft, resting on moveable bearings, which can be made to slide up and down simultaneously by means of a hand screw.

4. The axles are constructed of two tubes, placed one within the other, or of a tube filled with bar-iron, and welded at the ends only, or of a number of bars of iron, curved and overlapping one another, to give a spiral direction to the fibre.

Claims.—1. The use of the hollow fire or closed hearth for heating tyres to the welding point.—2. The projecting hearth.—3. Heating the inside surface of the tyre, by causing the flame and products of combustion to impinge against it, instead of by radiation.—4. Heating the spokes and tyre together, in order that they may be welded at the same heat; and arranging the spokes which have holes punched in them, at a distance from each other, between two half-naves, to allow of the surfaces of the latter being welded together at these points, as well as over the ends of the spokes.—5. The employment of two or more rollers acting uniformly and capable of being caused to approach or recede from the tyre, in conjunction with the scraper, for the purpose of rolling and cleansing it.—6. Boring and turning the inside and outside surfaces of railway wheels by revolving circular cutters.—7. The compound hollow axle.—8. The railway axle, composed of a tube filled with bar-iron welded only at the ends.—9. The railway axle, with the bars of iron laid so as to give a spiral direction to the fibre.

LUBRICATING COMPOSITION.

Alexander Munkittrich, of Manchester, merchant, for "*an improved composition of matters, which is applicable as a substitute for oil to the lubrication of machinery, and for other purposes.*"—Granted May 1; Enrolled November 1, 1849.

This invention consists in forming a compound which is to be used as a substitute for oil, grease, and other matters, for lubricating machinery. The compound is formed in the following manner: 4 lb. of caoutchouc dissolved in spirits of turpentine, or any other suitable solvent; 10 lb. of carbonate of soda; 1 lb. of glue; 10 gallons of animal or vegetable oil; and 10 gallons of water; and the mode of incorporating these ingredients is as follows: the water is to be heated in a suitable vessel, in which the carbonate of soda and the glue are to be then dissolved; the oil is then to be added, well stirring and agitating the mixture, to incorporate the ingredients; the caoutchouc, previously dissolved, is to be added last, and the whole well stirred together until it becomes homogeneous and as fluent as oil. It is then ready for use, and may be stored in casks or bottles until wanted. Any substances possessing the same properties as the above-mentioned, may be substituted for them, and that when the caoutchouc and oil are previously purified, the carbonate may be dispensed with; the proportions, also, may be varied according to the consistency required.

WATERPROOF PAPER.

William Brindley, of Twickenham, papier-maché manufacturer, for "*improvements in the manufacture of waterproof paper.*"—Granted February 28; Enrolled August 28, 1849.

The improvement consists in causing the long webs of machine-made paper, and sheets of paper, to be rendered waterproof by saturating them, when dry, with linseed oil at high degrees of heat. The machine-made paper is caused to pass into a trough containing oil by means of a roller, and by a pair of pressing rollers any excess of oil which may be on the paper is pressed out as it rises out of the trough, in like manner to what is now practised in sizing machine-made paper; or the oil may be applied in any other convenient manner to the webs of paper. The paper is then placed in a suitable stove heated to 200° to 300°, the paper being kept opened out so that both surfaces may be acted on by the heat, and in about three hours the desired effect will be obtained; a somewhat less temperature and longer time will produce a like result, but the temperature above-mentioned is preferred.

If sheets of paper are to be treated according to the invention, the patentee prefers to apply the oil by using boards such as when making panel-boards, saturated with oil, and then place several sheets of paper between each two boards, and subject a large number thus surrounded to a press, or the sheets may have the oil applied in any other convenient manner. The separated sheets are then to be hung separate in a suitable stove heated to the extent before mentioned and dried.

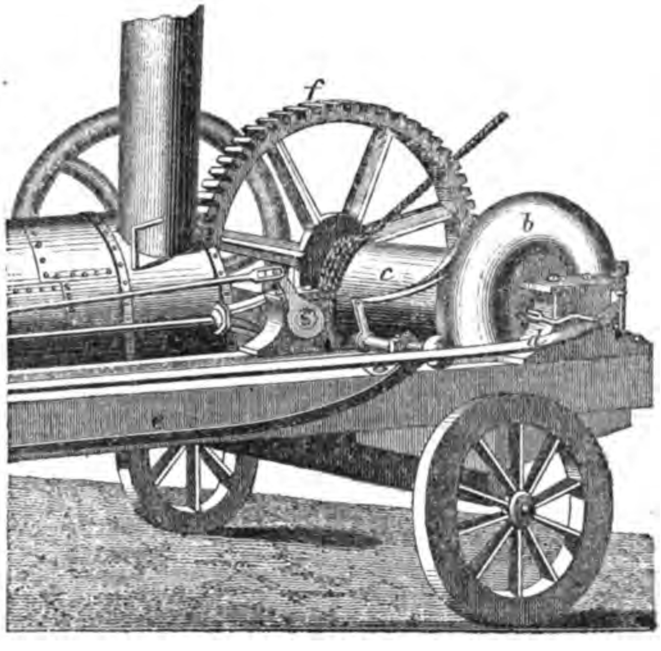
The paper thus prepared will be found applicable to many purposes where waterproof paper is desired, and where any oily character remaining would be objectionable: it may be written or printed on, and paper-hangings thus made will be found of great importance when the walls are damp; and paper-hangings may be either printed before or after rendering the same waterproof, excepting where the high temperature will interfere with the colours thereon.

STEAM HOISTING MACHINES.

Improved Portable Steam Hoisting Machines for Loading and Discharging Cargoes. By A. L. Archambault, Philadelphia, U.S. [From the *Journal of the Franklin Institute.*]

This useful invention, of which the annexed cut is a representation, was built for Charles Bentric, a stevedore of Philadelphia, who has successfully tested it in discharging the cargoes of the ships *Austria*, *Monongahela*, and *Hercules*.

The operation of the machine is briefly as follows:—The motion of the engine is communicated to the fly-wheel shaft S, which carries a small pinion gearing into the large wheel *f*; the winding barrel *c*, to which the hoisting rope is attached, is locked to the shaft of the wheel *f*, by means of the driving friction coupling *a*, the latter being thrown into or out of action by the lever *d*; and the motion of the drum *c*, when free from the shaft of the wheel *f*, is controlled by the friction-band *b*, which is tightened or slackened by the break *e*.



The machine requires but a single person to keep up steam and attend to the breaks, and is capable of hoisting twelve hogsheads of tobacco from the hold of a vessel and turn them out on the wharf in ten minutes, or can discharge cotton at the rate of 300 bales per hour. In case the hogshead or other article being raised should strike on the combings of the hatchway, the engineer has only to slacken the break, and it is lowered, without stopping the motion of the engine, so as to clear the obstruction; and then, by drawing the lever of the break tight again, the ascending motion is restored. The lowering break is so arranged that a hogshead of tobacco can be suspended at any point required with the greatest ease. The machine being on wheels, is portable in its character, and can be moved about with a single horse.

INSTITUTION OF MECHANICAL ENGINEERS.

At a meeting of the above Institution, held at Birmingham, Nov. 24th, R. Stephenson, Esq., M.P., in the Chair, the following papers were read:—

ON THE ECONOMY OF RAILWAY TRANSIT.

On the Economy of Railway Transit. By Mr. James Samuel, of the Eastern Counties Railway.

The object of the paper was to show the necessity of working branch lines with lighter and less expensive trains and locomotives than are at present in use, with a view to diminish first cost, consumption of coke, and deterioration of permanent way. By returns of the number of passengers conveyed on the Eastern Counties and Norfolk Railways, they showed that the greatest number of passengers in any main line train at any one time was 231, and the least number 7; the greatest number in any of the branch line trains being 82, and the least number 3. And that there were conveyed on the Eastern Counties branch lines during the year 1847, 42,644 tons of passengers (calculating each passenger with his luggage at 168 lb.), and that the weight of engines and carriages required to convey them was about 1,112,500 tons, being in the proportion of 26 to 1.

The main line engines consumed from 24¼ to 40¾ lb. of coke per mile, and the engines for working the branch line trains consumed from 16½ to 35½ lb. per mile, varying of course with the size of the engine employed to do the work, the smallest engines invariably consuming the smallest quantity of fuel for the same work done. The average consumption of coke during the half-year ending 4th July, 1849, was 31¼ lb. per mile for passenger engines, and 47¾ lb. per mile for goods engines. These returns refer to a stock of about 200 engines, and a length of line of about 310 miles.

Thus the writer came to the conclusion that it would be possible to construct a carriage and engine combined, of sufficient capacity for branch traffic, and by his advice the directors of the Eastern Counties Railway gave orders to Mr. Adams to construct such a carriage, subject to the approval of Mr. Hunter, the locomotive superintendent.

The carriage was accordingly built, and called the *Enfield*, from the branch which she was intended to work. The engine has 8-in. cylinders, and 12-in. stroke; driving-wheels 5 feet diameter; distance between centres 20 feet; width of framing 8 ft. 6 in. The boiler is of the ordinary locomotive construction, 5 feet long by 2 ft. 6 in. diameter. The fire-box is 2 ft. 10½ in. by 2 ft. 6 in. There are 115 tubes of 1¼ inch diameter and 5 ft. 3 in. in length, giving a total of 230 feet heating-surface in the tubes. The area of the fire-box is 25 feet, giving a total heating surface of 255 feet. The weight of this steam carriage is 15 tons 7 cwt. in working trim. The engine and carriage being combined, it is evident that the weight on the driving-wheels is increased by the load carried, and that this weight increases in the same ratio as the load required to be taken. The extreme distance between the centres of the leading and trailing wheels being 20 feet, accounts for the steadiness of this machine; there is indeed no perceptible oscillation when travelling at the highest speed, and this verifies the observation "that the steadiness of an engine depends not on the position of the driving-wheel, but upon the length of the rectangle covered by the wheels." This engine at the same time daily traverses curves of 5 or 6 chains radius.

The *Enfield* steam carriage was originally intended to convey 84 passengers, but as it was found that when she was put on as an express train the passengers increased in number, a *North Woolwich* carriage was attached capable of conveying 116 passengers, and also a guard's break van, making provision altogether for 150 passengers, which is now her regular train taken at a speed of 37 miles per hour.

This engine commenced her regular work about eight months since, and the following return shows the miles run and coke consumed by this engine during the 7½ months' regular working from January 29th to September 9th, 1849:—

14,021 total miles run.

705 hours, running time.
1.457 hours, standing time.

2,162 total hours, in steam.

743 cwt. coke consumed in running.
408 cwt. „ standing.
286 cwt. „ getting up steam.

1,437 cwt. total coke consumed.
11·48 lbs. per mile average consumption of coke.

The *Enfield* is in steam 15 hours per day, the fire being lighted about six in the morning and drawn at ten o'clock at night. But of these 15 hours it appears by the return that she is engaged running only five hours, the remaining ten being employed standing in the siding. It was found by experiment that the quantity of coke consumed standing was 32 lb. per hour, and after deducting this and the quantity consumed getting up steam, it will appear that the actual consumption of coke running is under 6 lb. per mile. It must also be particularly borne in mind that this consumption of coke includes the total goods and coal traffic on the branch, amounting to 1,410 tons—viz. 169 tons of goods and 1,241 tons of coal.

The *Enfield* steam carriage worked the 10 a.m. passenger train from London to Ely on 14th June, a distance of 72 miles, taking behind her three of the ordinary carriages and two horse-boxes; she arrived at Ely 8 minutes before time, and the total consumption of fuel, including the getting up steam, was found to be 8¾ lb. per mile. The tubes of the boiler are only 5 feet 3 inches in length, and the economy of fuel is consequently scarcely at the maximum.

Another engine on a similar plan to couple with a 40 feet carriage is now nearly ready, the tubes being 6 feet 6 inches long, from which is expected even more economical results.

The result of the writer's experience is the conviction, that for express purposes, and for the larger portion of the branch traffic on railways, the light steam carriage is the best adapted and most economical machine, both as to first cost compared to the work done, and in working expenses.

The first cost of a large engine, tender, and four carriages has been 4000*l.* The steam carriage for the same number can be made for something less than one-half the cost.

Remarks.—Mr. M'Connell gave much credit to Mr. Samuel for the introduction of this branch traffic-carriage. If managers of railways could always calculate the number of passengers to be carried, he (Mr. M'Connell) could conceive that a great economy might be effected, even under the present system. But this was impossible. How far, under these circumstances, Mr. Samuel's carriage might become useful, he was not prepared to say. Undoubtedly with the present carriages the proportion of the tare to the passengers carried was very great; and although a case which rarely happened, instances had occurred where the tare was 50 tons to 3 tons of passengers. But even taking the weight of passengers at 10 tons, 50 tons of carriages was unquestionably a large proportion of dead weight to carry; and he considered that the long carriage, if always likely to be well employed, would be an advantageous mode of saving the dead weight, more especially on branch lines, and at the junctions where such branches came in.

Mr. Samuel further explained, that as the length of coupling of the engine-wheels in the *Enfield* was only 5 ft. 4 in., with an 8-inch cylinder, it was necessary to attach the carriage and engine on one frame, otherwise it would be too short to run steadily; the effect produced by the carriage was like the stick of a rocket in steadying the motion. But in the Cork and Bandon engine with a 9-inch cylinder, the length of coupling of the wheels was 10 feet, and no carriage was required to produce steadiness, as the rectangle on the rails was so much longer. In the case of large engines, where the distance between the axles had been increased to 16 feet, a greater steadiness was observable. There was accommodation in the carriage for 15 first-class and 116 other passengers, giving a total accommodation for 131 passengers; and this he considered the most serviceable for working the express traffic. One of these steam-carriages was being prepared for working on a railway in Scotland, at a contemplated speed of 40 miles an hour. At the present time it was impossible to keep the road in good repair, especially on the old lines, in consequence of the enormous weight of the engines. The *Enfield* engine was worked at 120 lb. pressure, while in ordinary engines it did not exceed 80 lb., and hence an advantage of 40 lb. was obtained. The heating surface of the fire-box was 25 feet. He had, with the *Enfield* engine, made the quickest journey that had ever been performed between Norwich and London. With a train capable of containing 84 passengers they performed the distance of 126 miles in 3 hours 35 minutes, including stoppages. Another advantage in a large carriage of this description resulted from making use of the side space, for there were only 8 wheels to do the work of 24, and at the same time they had no greater amount of weight on each wheel than under the ordinary arrangement. The whole weight was 9 tons without passengers, and 84 passengers might be taken at an average as weighing 6 tons.

The President considered that they were much indebted to Mr. Samuel for his excellent paper, and he regretted that many interested in the economical working of railways had absented themselves from that meeting. The subject of economical transit had, of course, occupied his attention, and he must say, that, although he considered the suggestion of Mr. Samuel, so far as certain branch lines were concerned, was entitled to the consideration of all railway companies, yet he (the President) did not agree with Mr. Samuel to the full extent. On small local lines—such as those from London to Greenwich, and London to Blackwall—such carriages would be very valuable in lessening the expense of working, but he could not agree in thinking that for express purposes, or any other, such carriages would or should become popular on main lines. He could not agree with Mr. Samuel, also, with reference to the necessity of fixing the engine to the carriage, for the purpose of giving it steadiness. It appeared to be like riveting harness to a horse. There was no mechanical necessity for it. He would advise Mr. Samuel not to overstrain his principle by endeavouring to apply to trunk lines what would be manifestly beneficial to branches. The public expected certain comforts in railway travelling, and no system that could be devised would reconcile passengers to be packed together like fish. He (the President) felt that, occupying as he did a position in the management of railways that might give his opinion weight, he had thought it right to say what he had done, lest he might be considered tacitly to admit that that which engineers had been doing since 1831 in increasing the weight of engines, had been practically wrong.

ON RAILWAY AXLES.

On the Construction of Railway Axles. By Mr. J. E. M'Connell.

When the railway system was first introduced into this country, the question of strength of materials for constructing the new stock was (it is to be presumed) materially influenced by the amount of experience derived from the vehicles which had previously been in use for the conveyance of traffic.

As the new system became extended and improved in all its arrangements, and the facilities which it possessed for conveying greater loads at higher speeds were gradually developed, the working stock was necessarily changed from time to time in conformity with the greater demands for convenience and stability. Improvements in almost every point have been carried out, until we have now in operation the railway stock, generally speaking, in an excellent condition for the purpose to which it is applied. It is remarkable that, notwithstanding the importance of proportion and quality as first elements in considering the strength of the materials of which railway moving stock is composed, no rule, generally applicable for even the main features of this great system of machinery, has been established. Without attempting to embrace the whole subject, although one of great importance to proprietors of railways and the public generally, I conceive it is proper, in this place, to express my strong conviction that the general question of the strength and quality of those materials justly proportioned to the strains to which they are subject, and bearing reference to accidents from collision, faults of road, deterioration from a variety of causes, &c., must eventually be treated with great attention and consideration; and, in order to insure safety to life and property for all who use railways, as well as the greatest possible economy for the profit of those who have embarked their capital in their construction, I believe it will be found essential to have some regulations founded upon the joint experience of those parties who have been practically engaged in managing and working the different departments of railways.

It is well known that short-sighted economy has been practised in many instances in giving directions for the purchase and repair of railway stock, and it is only dear-bought experience which can effectually convince those who, to make a little saving by purchasing a cheap, ill-constructed machine, gain a great and constant loss whilst it is in use. The advantages of a general and constant interchange of opinion among those parties to whose judgment and management the working expenses of the different railways are entrusted is most important; and if such varied experience could be collected, regularly and systematically into one focus, where it might be digested and prepared for practical use, the effect for good to the general system of railways would be very great, and, in a scientific point of view, the results recorded would prove highly interesting. Having thus briefly stated a portion of my views as bearing upon the introduction of the best means of producing uniformity in the working stock of railways, I will now proceed to consider Railway Axles, which, as an important part of the great machinery, are deserving of the most marked attention.

I have endeavoured to ascertain whether any data were available which might assist me in forming a groundwork of the results of combined experience on this subject; but I regret to say that, although my inquiries have been in all cases promptly and carefully attended to, yet the object which I had in view has not been attained. As an example of the diversity of opinion, or rather, perhaps, the want of some certain rule to guide engineers in proportioning the strength of axles to their weights and strains, I would refer to different forms of axles now in use on one portion of one railway, and in doing so would remark, that a clearer proof could not be afforded of the desirableness of having some defined principle to guide us in deciding on the strength for railway axles. For obvious reasons I wish particularly to guard against expressing, directly or by inference, any opinion on any description of manufacture of axle, or even quality of iron of which axles are composed. I would wish to limit the scope of the present paper simply to the question of form and dimensions of axles, with the changes and deterioration to which they are subject in process of working, assuming, in all cases, the material of which the axle is made, and the mode of manufacture, to be of the most approved description.

In order to arrive at a knowledge of the best form and dimensions of axles, we have first to ascertain the load and friction to which they are to be exposed; and, secondly, to estimate, as nearly as possible, the strains to which they will be subject whilst in motion. Supposing a wagon or carriage to be constantly in a state of rest, it would, of course, then only be necessary to consider the axle as a beam or girder, sustaining a load of five tons upon the two journals, the points of support being the wheels resting upon the rails, the middle portion of the axle being of sufficient strength to sustain the wheel or prop in its perpendicular position. We then require to find out the proportionate strength, so that each section of this beam or girder shall only be sufficiently strong to resist the strain or load to which it is then subject.

It is ascertained, by an approximate calculation, *that a journal of 1·128-inch diameter is not capable of sustaining a heavier load, when in a state of rest, than 2½ tons, or 5,600 lb.; and allowing, in practice, that the wagon or carriage axle is made ten times the breaking strength, the diameter of the journal would be, adopting the same calculation, 2·43 inches.* In these calculations the strength alone is considered: but we have also to take into account the question of friction, and likewise the tendency to abrasion. With our present means of information, no accurate data are available for determining the best proportion of journal or bearing according to the weight it has to bear, or the velocity at which it is required to move. A great variety of proportion is in use, but it is fair to note that in engine-axles, particularly the length of bearing, depends, to a certain extent, upon the construction and arrangement of the engine; as a general rule the length of the bearing is not in due proportion, according to our general experience, to the diameter.

It has always been considered that having first ascertained, from example and experience, the strength of sectional area necessary, under every circumstance, to sustain the load which the journal has to carry, the length of it was determined by the velocity or amount of friction to which it is liable. Judging from axles at present in use in carriages and wagons, *the length of bearing is twice the diameter of the journal;* but on this, as well as other points on strength of material, there exists a great variety of opinion. Even the forms of journals are found to differ very much. Without attempting to decide on the merits of any of them, I shall in the present instance content myself with stating that all my experience has proved the desirableness of maintaining rubbing or wearing surfaces of bearings as free as possible from sharp abrupt corners, sudden alterations in diameter, or sectional strength. Having thus treated the journals as regards the load and the friction upon them, I now proceed to estimate the various strains to which the axle is exposed whilst in motion.

The first strain to which the axle is subject is that arising from the weight of the wagon and load, which being received or resting on the journal, produces the greatest effect upon the axle at the outer face of the wheel-boss, and to which is to be added the momentum of the load in falling through spaces caused by inequalities or joints of rails. The injurious consequences of inequalities on the road, surface, and flat places on the surface of the wheel-tyre, upon the axle, by the jolting or perpendicular motion which they produce, cannot be accurately estimated, and these are very much increased when the bearing springs of the wagon or carriage are not sufficiently elastic, and do not yield to the shock or blow downwards, so as (to use the expression) to cushion its effect. As an instance of the imperfect action of the springs, I would allude to those in use on many wagons, in which the form and construction cause them to be so rigid that the downward blow is more like a hammer upon an anvil. To obviate this strain as much as possible, it is necessary to proportion the spring so as to sustain the load properly, and yet to be of sufficient elasticity to absorb the effect of the load oscillation. The strain arising from the oscillation of the wagon on curves from imperfect coupling, and increased by the lateral freedom or space on the bearings or play between the rails and flanges of the wheels which, when an irregularity occurs on the side of the rail, or any sudden cause disturbs the direct motion of the wagon onwards, is in effect the same as a blow upon the flange of the wheel, the radius of the wheel tending to act as a lever to break the axle at the inner face of the boss of the wheel. This strain is in the compound ratio of the momentum of the load, the angle at which the wheel strikes the rail, and the distance from the centre of the axle to the point of impact; producing an effective strain upon the axle at the inner face of the wheel boss, which extends proportionately over the whole axle between the wheels. To lessen in practice as much as possible the deteriorating effect of these descriptions of strains upon the axle, the following conditions are important:—

That the bearings or journals of the axle fit as closely to the brasses as is consistent with freedom, the allowance of flange gauge of wheel being quite sufficient for the carriage to move freely round curves and meet any irregularity in the gauge of the rails. That the wagons or carriages be as equally loaded as possible, and the draw-chains be exactly in the centre; and as side chains are dangerous, they should be completely removed, provision being made for a duplicate centre draw-chain should a failure take place. As the damage to the loading of wagons is in proportion to the oscillation, they should all be screwed together by means of screw-couplings, having spring buffers upon both ends of every wagon. It is well known that the injury to the wagon, to the load which it conveys, to the axle which carries it, and to the road over which it runs, is very much aggravated if the wagons are allowed to oscillate from side to side, and become like so many battering-rams, injuring themselves and all substances in contact with them. A train of wagons or carriages should be jointed together similar to the vertebræ of an animal, by which means any sudden lateral action would be neutralised by the support derived from the neighbouring vehicle. The road to be kept as accurate as possible to gauge and line. The third class of strains to which axles are liable are the shocks produced by starting and stopping a train, and which are in proportion to the momentum of the wheel and axle at the time of collision when stopping, and to the velocity of the impelling force and the inertia of the wheel and axle when starting; these strains are felt principally on the neck of the journal. Fourth strain, the torsion or twisting produced owing to wheels travelling over curves of the line; the difference in length of surface of the inner and outer rail compels the one wheel to grind or slide upon the rail, while the other is free to roll. This strain is proportionate to the load on the wheel, determining the amount of friction upon the rails, and the length of axle between the wheels; a slight amount of torsion is also produced from any variation in the diameter of the wheels on the same axle, by any inequality of load upon each journal, the quality of the brasses, or the amount of lubrication proportionately, and the strain of the break-block on one side, because when any of these occur separately or jointly, one-half of the extra strain on one journal is transmitted through the axle to the other, and twisting or weakening the axle is necessarily produced. To lessen the amount of the above strain, it is obvious that the wheels should be kept in the best possible state of repair, so far as equal diameters and true circular surfaces are concerned, the wagons or carriages should be loaded equally on each side, the journals carefully lubricated, and all break-blocks to bear the same pressure on both wheels of the same axle. Fifth strain, the constant vibration of the whole axle. This is more particularly the case, and is accelerated when the axle is fixed in a rigid, unyielding wheel. My experience has proved that the axles fixed in cast-iron wheels are very much more liable to deterioration than those in wrought-iron wheels, and the jar or vibration tending to deteriorate the quality of the iron, by altering its texture from fibrous to crystalline, is clearly visible in its effects in several fractures which I have seen. It would appear that the cast-iron wheel acted more like a hammer on the axle, and as in the cold-swaging process a gradual breaking-up of the fibre at the back of the wheel goes on, which is shown by an annular ring, varying from $\frac{3}{8}$-inch to $\frac{3}{4}$-inch in breadth, the strength is completely destroyed of this outer portion, and a sudden shock of the wheel upon some point of the road completes the fracture.

Among other causes which contribute to the deterioration of axles may be mentioned—the practice of throwing cold water on the axle to cool it, when it has become nearly red hot for want of proper lubrication in the journal. With regard to the strain to which the portion of the axle between the wheels is subject, there can be no doubt if the form of the axle is so proportioned that any blow transmitted through the wheel is received equally along the whole body of the axle, and the sectional strength at each point is fairly balanced to resist the effect of the blow, the axle will then be best suited to prevent deterioration at any particular place. With the view of determining the weakest point of a common wagon axle under different circumstances, I made a few experiments, as follows:—

In the first experiment the power was applied to the flange of the wheel, and the resistance (as in the case of a railway axle when running) at the centre of the opposite wheel; the result was that the axle began to bend from a straight line $12\frac{1}{2}$ inches from the boss of that wheel to which the power was applied, and there is no doubt that if the power had been continued the fracture would have taken place within the $12\frac{1}{2}$ inches.

As a proof of this, in the second experiment, an axle of the precisely same dimensions and form, on being bent alternately backwards and forwards (the power being always applied on the same wheel at opposite points) was broken at the twelfth time of bending, within 6 inches of the back of the wheel.

In the third experiment the power and resistance were exactly in a parallel line to the centre of the axle, and the result, as might be expected, was a curve of a nearly uniform radius; proving that although the form of this axle was adapted to receive the blows of both wheels at precisely the same instant, and to the same extent (an impossible circumstance in practice), it was not suited to receive alternate strains or shocks, to which all axles are subject in ordinary use. The sizes of the axles in the above three experiments were precisely alike.

In the fourth experiment another axle of the same dimensions was taken, and reduced at the centre in a lathe to the following dimensions:—The axle was divided into eight equal spaces from the back of the wheel to the centre of the axle. Immediately at the back of the wheel the axle was 4 inches diameter, and the deflection was $9\frac{1}{2}$ inches; at the first space the diameter was $3\frac{3}{8}$ inches, and the deflection $8\frac{3}{8}$ inches; at the second space the diameter $3\frac{3}{16}$ inches, and deflection 7 inches; at the third space the diameter $3\frac{1}{16}$ inches, and deflection $5\frac{5}{8}$ inches; at the fourth space the diameter $2\frac{15}{16}$ inches, and deflection $4\frac{1}{4}$ inches. Up to this point the axle maintained a straight form from the back of the wheel; and from this point to the centre of the axle, as shown by the deflections, it assumed a fair curve, proving that the axle was weaker towards the centre than it ought to have been, and that the first 12 or 14 inches from the wheel having maintained the straight form was stronger in proportion.

In the fifth experiment the axle was reduced to $2\frac{1}{2}$ inches in the centre, and with power applied similar, as in the last case, the weakness at the centre was more perceptible.

In the sixth experiment the axle was made of another form, weaker immediately at the hack of the wbeel and at the centre. We had here two bends or curves, with a straight portion between them.

In the seventh there was an improvement upon the sixth, but it did not realise a perfect balance of strength at the different points.

In the eighth experiment, this was fairly accomplished, the proportion being as follows:—From the back of the wheel to the centre of the axle, the sizes were $4\frac{1}{16}$ in. diameter, $3\frac{1}{4}$ in. diameter, 3 in. diameter, $2\frac{7}{8}$ in. diameter, $2\frac{13}{16}$ in. diameter, $2\frac{3}{4}$ in. diameter, $2\frac{11}{16}$ in. diameter, $2\frac{11}{16}$ in. diameter, $2\frac{5}{8}$ in. diameter; the half-length of the axle being divided as before, into eight equal spaces.

It must be evident that this can only be an approximate result, but we found that these proportions enabled us to attain the nearest approach to a regular curve in bending the axle; and it is worthy of notice, that when the dimensions of the axle at the journal and in the boss of the wheel are determined, a calculation to ascertain the exact proportion between the wheels seems to confirm the above statement of dimension in the eighth experiment. The greatest strain to which this portion of the axle is subject being received at the bottom flange of the wheel, and transmitted through its radius, the amount of strain which any portion of the axle has to resist is inversely as its angular distance from the point of impact is to the radius of wheel. Assuming the blow on the flange of the wheel to exert a breaking force equal to 102,229 lb., and the diameter of the axle to be 4·71 inches to resist this blow, then, dividing the axle into four equal spaces to the centre, the proportionate breaking force at each point would be as follows:—At the first, 94,381 lb., relative diameter, 4,59 inches; at second, 80,697 lb., relative diameter, 4·35 inches; at third, 67,798 lb., relative diameter, 4·11 inches; at fourth, 58·829 lb., relative diameter, 3·92 inches. With regard to engine axles, these proportions will apply where no circumstances exist of employing the centre of the axle for transmission of power. The crank axles of locomotive engines cannot be treated by any of the rules applicable to straight axles; and our experience would seem to prove that, even with the greatest care in manufacturing, these axles are subject to a rapid deterioration, owing to the vibration and jar which operates with increased severity, on account of their peculiar form. So certain and regular is the fracture, at the corner of the crank from this cause, that we can almost predict in some classes of engines the number of miles that can be run before signs of fracture are visible: a certain amount of injury can be prevented by putting counterbalance weights opposite to each crank, which lessens the vibration very considerably. It is right to observe in this place, that to some extent the injury to all axles may be increased, if the wheels in which they are fixed are not properly balanced; and I have no doubt that a great portion of the constant vibration to which they are subject may be traced to the knocking action of the wheel upon the rail, owing to a want of balance. The question of deterioration of axles arising from the various causes which I have enumerated, is a very important one to all railway companies: that some change in the nature of the iron does take place is a well-established fact, and the investigation of this is most deserving of careful attention.

I believe it will be found that the change from the fibrous to the crystalline character is dependent upon a variety of circumstances. I have collected a few specimens of fractured axles from different points, which clearly establish the view I have stated. It is impossible to embrace in the present paper an exposition of all the facts on this branch of the subject; but so valuable is the clear understanding of the nature of the deterioration of axles, that I am now registering each axle as it goes from the workshops, and will endeavour to have such returns of their performances and appearances at different periods as will enable me to judge respecting their treatment. When it is considered that on the railways of Great Britain there are about 200,000 axles employed, the advantage of having the best proportions, the best qualities, and the best treatment for such an important and vital element of the rolling stock, must be universally acknowledged.

Remarks.—The President said, that Mr. McConnell had expressed a strong opinion, that a change took place from a fibrous structure in iron to a crystalline one during the time of its being in use: and it would be satisfactory if an instance could be pointed out where this change had occurred, owing to vibration or any other treatment, for he had not been able to satisfy himself, from many experiments, that any such molecular change took place. Hammering a piece of hot iron till it is cold produced a hardness called crystalline; but the question for consideration was, supposing an iron axle were annealed by heating to a dull red heat and being allowed to cool slowly, would the "texture" of that iron undergo any alteration afterwards, from the vibration of the railway or any piece of machinery they were in the habit of employing? He had not been able to detect an instance of the kind; and in giving evidence before the Iron Girder Bridge Commission, he mentioned cases of vibration going on from year to year without any sensible change occurring in wrought or cast-iron. For instance, they had the Cornish engine-beam with a strain of 50 lb. per inch, working 8 or 10 strokes per minute for more than 20 years; and certainly if a molecular change was introduced by vibration, it ought to be by that continual concussion and vibration, but none was perceived. Again, the connecting-rod of a locomotive was a piece of iron in a most perplexing situation, for one having more to do and having the strain changed more frequently it was difficult to conceive; and yet he had known the connecting-rod of a locomotive engine to vibrate 8 times in a second for several years' regular work, making more than 200 million times altogether, but the iron retained its fibrous structure; and he thought axles could not be subject to so much vibration. When, therefore, he found that a connecting-rod did not change its molecular texture, he must say there were good grounds for doubting that iron changes its state in axles. Then with regard to the experiments made by Mr. McConnell with a view to ascertain where axles were most exposed to tension, he could not quite agree with him; for he subjected the wheels and axles to a slow, steadily increasing pressure, till he bent the axles in different positions. The results were correct as far as regarded the slow pressure on the flanches of the wheel under the circumstances of the experiments recorded by him, but they were not a faithful representation of what takes place in practice. for it would be found that when the wheels of a carriage jarred, a violent blow was inflicted on the rail, and the strain on the axle was totally distinct from a slow pressure. He would refer to the experiments made some years ago by Mr. John Gray, on the Hull and Selby Railway, and which were published in the *Civil Engineer and Architect's Journal*, or the *Mechanics' Magazine*, to show how important is the element of time in the fracture of an axle. He took a round bar of iron 3 feet long and 2 inches diameter, and turned it down in the middle to 1 inch in diameter for 2 inches in length. He then took another bar, 1 inch in diameter uniformly throughout, and he tried the strength of these bars under *concussion* and not mere pressure. Now the severest point of strain would evidently be the middle of the bars where the diameter was the same in both, and consequently if weights were gradually and quietly laid on, the results would be alike in both bars; but when small weights were let fall on them, the bar 1 inch in diameter throughout its whole length was found to be much stronger than that which was in the main 2 inches and 1 in the middle. For as time is an element when the resistance of material is concerned, regarding the axle as elastic like a piece of india-rubbber, the only particles that could yield to percussion from the falling weight were those between the shoulders in the part of the axle that was turned down, but in the case of the bar an inch in diameter throughout its whole length, the whole of the particles would yield; the one being a good spring and the other a very bad one. It therefore appeared to him that the experiments recorded by Mr. McConnell, though correct as regarded the position in which he put them, were not correct as regarded concussion. The axles rarely if ever broke in the middle, but generally at the end close to the boss of the wheel, because of the sudden change in the elasticity of the axle at that point; the portion of the axle fixed within the boss of the wheel being very rigid whilst the rest remained elastic, which caused the vibrations to be suddenly checked at that point. No doubt the plan of weakening axles in the middle had done good because it made them spring, and in crank axles it relieved the strain in the cranked part.

Mr. Henry Smith suggested that in the case of bar-iron, the exterior portion had greater tenacity than the interior or under part; and the strength would be more than proportionately diminished where the exterior portion was cut through. He also referred to some experiments in which he had cold-hammered fibrous iron till it became crystalline, and the effect produced corresponded with the description given by Mr. McConnell of the fractured axles.

Mr. McConnell observed, that he had met with several cases of broken axles in which a distinct annular space was observable all round the surface of fracture, that was quite short-grained and appeared changed into a crystalline texture, whilst the centre of the axle remained fibrous. He admitted that his experiments were only approximate, and that he had not put the strain in the natural way; but it was almost impossible to do so in consequence of the great trouble and expense that would have accompanied it; at the same time the results were proportionate in each case, and the accuracy of the experimental results had been confirmed by calculation. With regard to the axle fitting into the wheel, they now allowed only a very small shoulder, not exceeding a sixteenth of an inch; and this shoulder was not square but tapered, and the boss of the wheel was slightly coned to fit the shoulder.

Mr. Cowper did not believe that any axle which when broken proved to be crystalline had ever been fibrous in its character.

Mr. Ramsbottom considered that a change took place in the axle from the effect of mere mechanical action, and his observations tended to confirm him in that opinion. Some time ago he selected an axle which had not a very good form of journal, and the end broke off with two blows of a 12 lb. hammer. This axle had for three years been subject to a strain vertically, which was reversed at every revolution, and it came off with a crystalline fracture. He then tried the part that had been within the boss of the wheel, which had not been subject to this great strain, and found the strength was very much greater than that of the journal, for it required 79 blows to break it off, and in that case the fracture was fibrous. A parallel case might be observed with reference to an ash stick, which if doubled would break with a fibrous fracture; but if subjected to vibration, however slight, running through it a great number of times, it would break in a different mode. He thought the strain on a locomotive connecting-rod was by no means so great for the sectional area as upon an axle-journal; and the latter had two reversed strains for every revolution of the small wheels, but the connecting-rod had only two for each revolution of the driving-wheels.

The President said, he was only desirous to put the members on their guard against being satisfied with less than incontestible evidence as to a molecular change in iron, for the subject was one of serious importance, and the breaking of an axle had on one occasion rendered it questionable whether or not the engineer and superintendent would have had a verdict of manslaughter returned against them. The investigation hence required the greatest caution; and in the present case there was not evidence to show that the axle was fibrous beforehand, but crystalline when it broke. He therefore wished the members of the Institution, connected as they were with the manufacture of iron, to pause before they arrived at the conclusion that iron is a substance liable to crystallise or to a molecular change from vibration. For his own part, he was now induced to look upon wrought-iron as literally elastic, like a piece of india-rubber; for in the case of the Britannia Tubular Bridge, where they had two 10-inch square chains or bars, each 100 feet in length, it was found that before the tube was raised, the chains or bars stretched nearly 2 inches in length at each time of lifting, but resumed their original length when the strain was withdrawn; the same action being repeated every time the tube was lifted. He could therefore only regard these 10-inch bars of iron as analogous to a piece of india-rubber.

Mr. McConnell said, he had one specimen of an axle which he thought furnished nearly incontestible evidence of the truth of his position, that a change took place in the texture of the iron. One portion of this axle was clearly fibrous iron, but the other end broke off as short as glass. The axle was taken and hammered under a steam hammer, then heated again and allowed to cool, after which they had to cut it nearly half through and to hammer it a long time before they could break it.

The President remarked, that this was a case of converse reasoning; for it was an instance of a piece of crystalline iron being converted into fibrous iron. Iron when it was once heated and allowed to cool gradually, acquired a close and fine grain, but became neither crystalline nor fibrous; if cooled suddenly it acquired a crystalline grain, and if rolled while being cooled it became fibrous, but he did not think that it underwent any molecular change from mechanical action after it was cold.

Mr. Henry Smith observed, that throwing cold water upon hot journals did great injury by crystallising that portion of the axle.

Mr. Slate did not think that any change from a fibrous to a crystalline texture was produced in iron unless it were strained beyond the limit of its elasticity. Some of the pump-rods in Staffordshire which had been in use for 18 or 20 years, were subject to a strain of 3½ tons per square inch; and a short time ago he had occasion to ascertain their actual performance with reference to this very question, and this not being considered conclusive, he had made a machine in which he had put an inch square bar subjected to a constant strain of 5 tons, and an additional varying strain of 2½ tons, alternately, raised and lowered by an eccentric 80 or 90 times per minute, and this motion was continued for so long a time that he considered it equal to the effect of 90 years' railway working, but no change whatever was perceptible; and therefore he was one of those who did not believe in a change from a fibrous to a crystalline structure in iron. He remembered a case where a question having arisen as to the manufacture of a certain shaft, it was agreed to hammer it until it split, as a means of discovering the nature of the manufacture of the shaft: the result was satisfactory; and the iron appeared still fibrous in texture.

The further consideration of the paper was then adjourned, and the Chairman said he wished that more of the members had been present at the meeting, and hoped they would attend and assist in the further discussion of the subject.

The third and last paper read was "*On Nasmyth's Patent Girders and Fire-proof Floors*," contributed by Mr. S. Lloyd, of Wednesbury. The paper was illustrated by drawings and models. A discussion followed the reading of the paper, and after a vote of thanks to the President, the meeting adjourned.

SUPPLY OF WATER TO THE METROPOLIS.

On Monday evening, the 19th inst., I attended a meeting at the Institute of British Architects, to hear a lecture delivered by the Very Rev. Dr. Buckland, Dean of Westminster, on "Artesian Wells."

This lecture was for the avowed purpose of proving that it is impossible to procure from the chalk formation, situated beneath the London clay, sufficient water to supply the requirements of the inhabitants of London; and that the level of the water in wells under London, deriving their supply from this service, has been lowering for several years past.

In numerous instances, the lowering of the level of the water in deep wells beneath London, is so well attested, as also the fact, not alluded to by Dr. Buckland, that water thus procured contains a large quantity of alkaline bi-carbonates, and is consequently unfitted for general domestic use,—that much good may result from widely diffusing this information.

The explanation offered by Dr. Buckland, and referred to by him to account for this fact, is contained in his *Bridgewater Treatise*, entitled 'Geology and Mineralogy considered with respect to Natural Theology,'—in which it is asserted that floods, evaporation, the support of animal and vegetable bodies, and springs supplying rivers, will account for the consumption of the rain falling upon the earth's surface, as shown in the following quotation, page 557, edition 1837:—

> "The great instrument of communication between the surface of the sea, and that of the land, is the atmosphere, by means of which a perpetual supply of fresh water is derived from an ocean of salt water, through the simple process of evaporation. By this process water is incessantly ascending in the state of vapour, and again descending in the form of dew and rain.
>
> Of the water thus supplied to the surface of the land a small portion only returns to the sea directly *in seasons of flood* through the channels of rivers. A second portion is re-absorbed into the atmosphere by evaporation. A third portion enters into the composition of animal and vegetable bodies. A fourth portion descends into the strata, and is accumulated in their interstices into subterranean sheets and reservoirs of water, from which it is discharged gradually at the surface, in the form of perennial springs that form the ordinary supply of rivers."

If the above quotation contained a true explanation of the consumption of rain falling upon the earth's surface, it would follow that no water found its way by subterraneous drainage to the sea, and that no large amount of water could be procured at considerable depths beneath the earth's surface.

This conclusion is in direct opposition to every day's experience, as likewise to that of all other authorities. In a note at the end of the first proposition, before quoted, from Dr. Buckland's *Bridgewater Treatise*, the following remark appears:—

> "It is stated by M. Arago, that one-third only of the water which falls in rain, within the basin of the Seine, flows by that river into the sea: the remaining two-thirds either return to the atmosphere by evaporation, or go to the support of vegetable and animal life, or find their way into the sea by subterraneous passages."—*Annuaire pour l'An.* 1835.

From this it will be seen, that M. Arago, unlike Dr. Buckland, accounts for the disappearance from the earth of a large body of rain by subterraneous drainage into the sea; and all who choose may ascertain the fact that large bodies of fresh water are discharged from the fissures of the chalk formation into the shingle and sand that covers the sea-coast, and even into the bed of the sea itself, in the vicinities of Dover, Folkstone, New Romney, Brighton, Weymouth, and other places.

This water may be traced at various places along the coast, issuing in large quantities (doubtless where the greatest fractures in the chalk occur), between high and low tide; and the large amount which must be discharged in this manner will be apparent from the fact, that the chalk formation, when it appears near the surface, is full of small fissures (caused possibly by the action of frost), which, communicating with larger ones, rapidly absorb and carry off all the rain falling upon it. This fact must be familiar to every observing person; Dr. Buckland himself dwelt upon it in his lecture. It is only when the surface of the ground is severely frozen, and a rapid fall of rain follows, or when a sudden thaw of snow takes place, that a flood is found in rivers fed entirely from the drainage of a chalk district; the heaviest rains, at other times, is absorbed as it falls. This fact is alluded to in Conybeare and Phillips's 'Geology,' where it is stated, "All the rain and snow which fall upon chalk percolate downwards to the base, where the water is stopped by a subsoil of blue clay, and that occasions it to accumulate in the chalk, until it rises to such a height as doth enable it to flow over the surface of the adjoining land."

In the south of England the area of the chalk formation, almost bare or only slightly covered with porous layers, consists of 4,117 square miles, as measured upon Knipe's geological map. The average annual depth of rain falling upon this area of chalk country will be certainly under than over rated at 20 inches; and allowing that as much as one-half of this quantity either finds its way to the rivers, or is consumed in supporting vegetation and evaporation, still 10 inches in depth remains to percolate down through the fissures of chalk, till arrested by the impervious clay which lies beneath; and it accumulates in fissures, or faults, to such a height as to occasion sufficient hydraulic pressure to cause its exit by subterraneous drainage at the sea-coast.

This depth of 10 inches of rain per annum percolating through an area of 4,117 square miles, is equal to a supply of 1,595 (one thousand five hundred and ninety-five) *millions of gallons of water for every day in the year;* and this quantity is the least which *must* find its way by subterraneous drainage to the sea-coast.

If the amount of water before-named as daily running uselessly into the sea, could not be clearly demonstrated by an appeal to facts and figures, such a statement would hardly appear credible, yet is nevertheless the case: the largest portion of this water is probably discharged through large fissures, or cavities, which in many places may be distinctly traced.

Borings in the valley of the Colne, prove that these fissures vary from 2 feet to 12 feet in depth, producing when tapped enormous quantities of water, which immediately flow to the surface: and when it is remembered that the chalk formation to the north-west of Watford is in some places 900 feet above the sea, or 738 feet above the valley of the Colne, this fact will not appear at all surprising.

From the foregoing, it will be perceived that more water may be expected to be found at some places in the chalk formation than at others,—and this, in fact, is found to be the case: it is necessary to intercept the fissures in the chalk to collect large bodies of water, for solid chalk being almost impervious, will allow but little to pass through it. Thus it is doubtless owing to the density and closeness of the interstices of the chalk underlying the London clay, caused probably by the weight of the clay itself, that the lowering of the level of the water in many wells in the London basin is to be accounted for.

It also appears, from chemical analysis, that the water procured from under the London clay is partly replenished with sea-water by means of the fissures of the chalk formation, which to the east of London communicate with the sea,—for the principal constituent of sea-water is found in that procured from under the London clay.

The above narration will show that the theory laid down by Dr. Buckland, and before quoted, cannot be accepted as the true explanation of the falling of the level of the water in so many deep wells in the London basin; but that it is to be accounted for simply from the fact that the fissures in the chalk underlying the London clay are not sufficiently large to admit water into the basin as rapidly as it is pumped away.

It is also clear that by means of a well, or wells, sunk in a suitable locality, combined with the driving of adits to intercept the fissures in the chalk, an enormous body of water may be collected at a high level, and made available for practical use. This water, at present, is not used either for navigation or manufacturing purposes, but runs uselessly by subterraneous drainage to the sea.

I shall in a future number again allude to this subject, as I find, to say all I could wish, at present, would take up more space than I could reasonably ask for.

Samuel Collett Homersham.

19, *Buckingham-street*, *Adelphi*,
November 24th, 1849.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

Nov. 5.—Earl de Grey, President, in the Chair.

At the opening meeting of this Society, the following gentlemen were elected honorary and corresponding members:—The Signor Antolini, architect, Prof. of the Academy of Fine Arts at Bologna; the Abate Antonio Magrini, and the Signor Miglioranza, architect, of Vicenza; the Signor Vantini, architect, of Brescia; Mynheer J. B. Weenink, architect, director of the Academy at the Hague.—The decease of Herr de Lassaulx, of Coblentz, honorary and corresponding member, W. T. Pocock and John Woolley, fellows, during the recess, was announced. Numerous donations to the Library were laid on the table.

The President, in addressing the meeting, alluded to a statement which had been made some months back as to the powers of the Senate of the University of London to institute examinations for certificates of special proficiency in architecture, as well as in other professions. By a communication from that body it appears that the new regulation will not at present include architecture.

"*Remarks on the earlier and later Gothic Architecture of Germany.*" By the Rev. Dr. Whewell, Master of Trinity.

Dr. Whewell stated that he came forward but as an amateur. To determine the progress of styles, to trace their growth, seemed to him an important object, and to aid in this it was that he strove. Deductions from the examination of existing monuments would not of themselves suffice,—these must be confirmed by reference to history. He had already put forth the theory, founded mainly on the churches of the Rhine, that the leading features of Gothic architecture had grown out of the necessities of structure, and his object on this occasion was to carry his theory a little further, treating of the tendencies which had changed the character of buildings in the later Gothic period. He should be assisted in this by the works of some recent German writers, who had pursued the investigation to a considerable extent. The rev. Doctor then proceeded to discriminate what he considered the three important principles concerned in the formation of the Gothic style—namely, the principle of frame-work; the principle of tracery,—which he thought quite distinct from frame-work; and the principle of wall-work; but the inquiry was sufficiently subtle to prevent us from attempting to convey now a general notion of it in a few words: we may perhaps be able to refer to it at greater extent hereafter. He spoke at considerable length of what he called the principle of upward growth. Speaking of unconstructive forms of the later Gothic, Dr. Whewell said that the outer portion of Strasburgh spire would not hold itself together; the joints, as he had ascertained, were vertical, and could not stand; but there were internal ribs rightly constructed, which really did the work.

At the close of the meeting a letter was read from Mr. Mocatta, asking advice as to the means of ridding a house of a great and increasing nuisance, the domestic ant. The annoyance is one of great magnitude in London, and applications are constantly being made to us to learn the best mode of getting rid of them.—The Dean of Westminster thought poison the only remedy.—Several members said they had failed in all endeavours to eradicate them.

Nov. 19.—Thomas Bellamy, Esq., V.P., in the Chair.

The Very Rev. Dr. Buckland, Dean of Westminster, delivered a lecture this evening, on the subject of "*Artesian Wells.*" There was a very numerous attendance of members of the institute, and several strangers were present by invitation, among whom we observed Lord Ebrington, M.P., Mr. Mangles, M.P., Mr. R. Stephenson, M.P., Mr. Stanford, M.P, Sir F. Dwarris, Mr. G. Rennie, and Mr. A. Goldsmid.

Dr. Buckland commenced by observing, that the architecture of the globe was a subject which he thought ought not to be foreign to the consideration of members of an architectural institute, for he must humbly submit that no architect could perfectly understand his profession unless he had acquired some knowledge of the materials with which he had to deal; and he believed no one would deny, that had their ancestors known as much as they did now touching the durability of various kinds of stone employed in the construction of ecclesiastical and castellated buildings, they would not have to deplore the ruin of so many of those edifices. It would be his duty to-night to direct their attention to the architecture of that particular portion of the earth which they themselves inhabited—a subject possessing an interest literally of vital importance. It was, as had been proved by the events of the last six months, a question of life or death to thousands and tens of thousands in this great metropolis, whether they should have the means of obtaining an abundant supply of fresh water. It was, unfortunately, too notorious that the supply of water was at the present time awfully defective, and the last month had been fertile in schemes of various kinds for supplying that defect. He would not now enter into the relative merits of those schemes, but he would explain to them—so far as it was ascertained—the structure of that portion of the earth on which they dwelt in this great metropolis. He had affixed the term "*Artesian Wells*" to the subject on which he had to address them. In his *Bridgewater Treatise*, which was published 13 years ago, he had written a chapter on this subject, and he might say that the result of his observations in England had been entirely confirmed by the practical experience of some of the most eminent scientific men in Germany and France, including M. Arago. It had been asserted that sufficient water might be obtained in this metropolis, by Artesian wells, to afford an ample supply to ten such cities as London; but he would venture to affirm, that though there were from 250 to 300 so-called Artesian wells in the metropolis, there was not one real Artesian well within three miles of St. Paul's. An Artesian well was a well that was always overflowing, either from its natural source or from an artificial tube; and when the overflowing ceased, it was no longer an Artesian well. 20 or 30 years ago there were many Artesian wells in the neighbourhood of the metropolis,—namely, in the gardens of the Horticultural Society, in the gardens of the Bishop of London at Fulham, and in Brentford and its vicinity; but the wells which were now made by boring through the London clay were merely common wells. He had heard it said that Artesian wells might be made in any part of London, because there was a supply of water which would rise of its own accord; but he could state, with regard to the water obtained to supply the fountains in Trafalgar-square, that it did not rise within 40 feet of the surface, it was pumped up by means of a steam-engine; and the requisite supply of water could be obtained at a much less cost from the Chelsea waterworks. Indeed, the same water was pumped up over and over again. No less than 18,000*l.* had been spent upon an Artesian well which had been made on Southampton-common, but the water never had risen within 80 feet of the surface, and never would rise any higher. The supply of water formerly obtained from the so-called Artesian wells in London had been greatly diminished by the sinking of new wells. Many of the large brewers in the metropolis who obtained water from these wells had been greatly inconvenienced by the failure of the supply; and he had received a letter from a gentleman connected with a brewer's establishment, stating that the water in their well was now 188 feet below the surface, while a short time ago it used to rise to within 95 feet of the surface. Indeed, the large brewers were actually on the point of bankruptcy with regard to a supply of water. There were, as he had said, more than 250 Artesian wells, falsely so-called, in London, one-half of which had broken down; and those from which water was obtained were only kept in action at an enormous expense. The average depth at which water could now be obtained from so-called Artesian wells in London was 60 feet below the Trinity high water-mark; and he believed that in 20 or 25 years more, water would not be obtained at a less depth than 120 feet. This was, as he had said, a subject of vast importance to the inhabitants of the metropolis, who had not now a supply of water equal to one-fourth of what was required for their ordinary use. The rev. Doctor, after going into a lengthy and elaborate geological description of the soil in the metropolis and the neighbouring districts, illustrating his observations with well-executed and interesting plans and sections, proceeded to inquire by what means a sufficient supply of water could be obtained for the inhabitants of the metropolis? He considered that an ample supply might be obtained from the Thames in the neighbourhood of Henley, after that river had been fed by the Loddon, the Kennett, and other tributary streams. The water might be conveyed to London by an open aqueduct of sufficient depth, parallel with the Great Western Railway; and, as it would have a fall of three feet, it would flow without the aid of any engineering works, and might be brought to a reservoir in a valley north of Paddington. It would there be at a level of 105 feet above high-water mark, and at that level two-thirds of the inhabitants of London might, by means of an engine, be supplied with water at high-pressure. The rev. gentleman concluded by saying that upon careful consideration, this plan appeared to him the most feasible that had yet been suggested for affording to all the inhabitants of this metropolis an abundant supply of pure water; and he sat down amid loud and general applause.

After a few words from Mr. Clutterbuck, in explanation of some of the sections which had been prepared by him,

Mr. Tite said, that, as a member of the Institute, he felt bound to tender his thanks to the very rev. Dean for the interesting paper with which he had favoured them to-night. This was not a mere question with regard to the nature of Artesian wells. He had not been aware before he heard it from the rev. Dean that an Artesian well was one that was constantly overflowing; but of this there could be no doubt—that what were called Artesian wells required frequent deepening, and were a source of constant expense. He sincerely hoped that the Government would take up this question. It ought to be looked upon as a national question; for a large city like this, containing so immense a population, ought not to be left dependent for the supply of so important and necessary an article as water upon private companies or individual speculators. He would not express any opinion as to the means by which a sufficient supply of water should be obtained; but he believed that a public discussion of this nature would be attended with very beneficial results.

Mr. R. Stephenson expressed his gratification at the paper which had been read by the rev. Doctor, and observed, that though he did not wish to give any opinion as to the mode in which the rev. gentleman's views should be carried out, he must say that he had some doubts as to the practicability of the plan he had suggested. He thought that a measure which might tend to obstruct the navigation of so important a river as the Thames should not be decided upon without most careful consideration; but the obstruction of the waters of the tributary streams would not be open to the same objection. He quite agreed with the rev. Doctor that it could not be expected that anything like an adequate supply of water could be provided for the metropolis from Artesian wells.

Mr. Homersham expressed his opinion, founded upon experience which he had had in Watford and the neighbourhood, that a sufficient quantity of water might be obtained by means of Artesian wells to meet the wants of the inhabitants of the metropolis.

Mr. W. Horne said that, as the owner of an Artesian well in the vicinity of Goswell-street, his experience tended to confirm the Dean's views as to the inadequacy of such wells as a source of supply to the people of London. It had been found necessary to deepen the well twice, and its working had been found very expensive, as the pipes and joints were constantly getting out of order.

Mr. Dickenson had had a good deal of experience with regard to Artesian wells in the valley of the Coln. He had bored wells in four different places to a considerable depth, and in none of them did he find the water rise to the surface, although it rose somewhat above the level of adjacent springs.

A gentleman said he knew that an arrangement had been made by some of the brewers who obtained their supplies of water from what were called Artesian wells that they should not brew on the same days, in order that they might all have a sufficient quantity of water.

After a few words from Dr. Buckland in reply,

Mr. Stanford expressed his thanks to the Council of the Institute for having allowed him the opportunity of attending a discussion in which, as a member of the Legislature, he felt great interest. He thought they were much indebted to the very rev. Dean for the interesting information he had afforded them on the subject. The question was one in which his (Mr. Stanford's) constituents took much interest, and he hoped it would receive the attentive consideration of Parliament.

On the motion of the Chairman, a vote of thanks to Dr. Buckland was unanimously carried, and, the rev. Doctor having briefly acknowledged the compliment, the proceedings terminated.

SOCIETY OF ARTS, LONDON.

Nov. 14.—W. Tooke, Esq., F.R.S., V.P., in the Chair.

"*On a new Principle for Suspension Bridges and Landing Piers.*" By Mr. H. H. Russell.

The paper commences with some preliminary remarks on the origin and adoption of suspension bridges, which would appear to be of great antiquity, Humboldt and other travellers having seen them in uncivilised countries constructed of bark, reeds, and bamboo-cane, &c. slung across wide and dangerous chasms, and used for passenger-traffic. In Thibet and China they have been found sufficiently strong to enable beasts of burden, and men with loads and palanquins, to pass over in safety. The application of this mode of constructing bridges in our country was first made by Captain Samuel Brown, R.N., in what he termed his "Chain Cable Bridges," and was first suggested to him by the rope-bridge of Penipe. Bridges of this description were constructed, and others proposed, by Telford, Mr. Tierney Clerk, and others. The success of these bridges gave so great a stimulus, as to cause their introduction into almost every civilised country in Europe; and their partial destruction has led to various arrangements for increasing their stability, especially with a view of arresting the undulations which may be excited in them. The principle adopted by Mr. Russell was first suggested to him by witnessing the rigidity of two lines of cobwebs crossing a street in the direction of the main-chains of the bridge; a third, running in a nearly horizontal direction underneath, was supported at intervals from the upper two in the one spandrail, and in the other had a circular web, of large dimensions, also stayed in all directions to the upper and lower webs; and a spider was observed to cross the lower cord without causing sensible deflection. The model and drawings exhibited were of a bridge with piers; the main-chains are arranged so as to pass over the top and under the bottom of the outer piers; thus presenting two systems of chains, having their extremities fastened at different points. By this arrangement the structure will, it is conceived, be more rigid, and the disturbance to which the bridge is subject less felt.

The disturbances to which chain bridges are subject are of two kinds—undulatory and oscillatory. The proposed plan prevents, it is conceived, the undulation, by relieving the summit of the piers from a great part of all strain, and throwing it upon their lower parts, where it is resisted by the roadway in the direction of the greatest strength. The oscillatory disturbances, or those from side to side, are considered to be practically annihilated by reason of the smaller curvature of the chains; and the more equal distribution of the load renders any local pressure less effective in causing disturbance; and additional facility is afforded for the introduction of stays between the chains, so as to equalise to a greater extent the tension and strength of the parts. The attachment of chains to the upper and lower points of the piers diminish, it is conceived, the tendency to general oscillation, while the alternation of long and short suspension-rods, and the steadying of the longer rods by passing between links of the lower chains, must almost entirely obviate local oscillation. Mr. Russell is of opinion, that, by the mode suggested, a counteraction to any passing weight is obtained by the lower portion of the catenary curve being supported on the pier through which it passes. The masonry above supporting the upper chain, acts so as to prevent deflection of the upper chain, unless the lower chain or pier should ascend, which is impossible, for the weight upon the suspension-rods is applied to both piers, thereby affording rigidity against action upwards.

Nov. 21.—T. Webster, Esq., F.R.S., V.P., in the Chair.

The Assistant Secretary read a paper "*On Flexible Breakwaters and Lighthouses.*" By Mr. W. H. Smith, C.E.

The paper, after alluding to the losses and amount of property annually sacrificed on our coasts, referred to various efforts that have been made, by means of floating breakwaters, to effect an economical barrier to the sea. The peculiar principle of Mr. Smith's proposed breakwater is to give elasticity to the structure. The models exhibited were formed of a long wall of open piles, divided into separate sections, each having an independent motion at the top, but secured and pivoted at the bottom, on the screw-pile. The braces (with counterbalance weights at the centre), extending seawards from each side, are also affixed by the screw-pile. The sections, on being struck by the sea, yield to it, thereby eluding violence, and the waves passing through the close grating are disseminated. The structure recoils when it becomes in equilibrium with the waves, and on its return still further cuts it up. Excepting in a storm, the breakwater is comparatively motionless. The author conceives it applicable in every situation to the formation of harbours. The material employed may be either wood or iron. The same principle of giving elasticity is proposed to be applied to lighthouses, whatever the variation of circumstances as regards depth of water, situation, &c.,—the object being to obtain the greatest possible strength and least possible shock from the force of the sea or wind draft.

ROYAL SCOTTISH SOCIETY OF ARTS.

Nov. 12.—John Cay, Esq., F.R.S.E., President, in the Chair.

The President, on taking the Chair, opened the session with the following address:—As the time had now come when he must vacate the chair to which the Society had done him the honour to elect him, he could not do so without adverting to the interesting session which they were that night to wind up. They had had a great many excellent communications connected with the practical arts, both of chemistry and mechanics, as the prize-list and models on the table abundantly testified. He must advert, in a particular manner, to the papers of Mr. Buchanan on the Strength and Strain of Materials. He was sure that these papers were of the highest importance to practical engineers, and that every member who had heard them must agree with him in thinking that the thanks of the Society were especially due to Mr. Buchanan for his valuable communications. He had to deplore the loss of several members by death during the last session. He could not but name Dr. S. Hibbert Ware, a distinguished naturalist, and a member of the Society from its commencement. Their ranks were continually thinning from various causes, and hence the necessity for continued recruiting to keep the Society in healthful working order. It was manifestly the interest of this country, he said—a country which depended so much upon its mechanical efficiency—to promote and encourage improvements in the useful arts, more especially as, from the report of the Society of Arts of England, to which he referred, it appeared that the French are treading very closely upon our heels. The Americans, too, he understood, were now spinning and weaving their own cotton, and that to such an extent as to give no little anxiety to those great English towns which depended so entirely for their prosperity upon this article of commerce. He had, however, no fear for our British machinists—they had long stood unrivalled for their mechanical ingenuity, and he did not for a moment doubt that British skill and British enterprise would still maintain their wonted superiority. He called the attention of the Society to two most important opportunities for the exhibition of mechanical skill and research, which would soon occur—namely, the great exhibition to be opened to all nations in London, under the patronage of H.R.H. Prince Albert, and the meeting of the British Association at Edinburgh next year, and expressed a hope that the members of this Society would avail themselves of these occasions for distinguishing themselves. In quitting the Chair, he thought it his duty to state that his experience of ther constant attention to the interests of the

Society, warranted him in stating that the thanks of the Society were most especially due to their excellent Secretary, to whose unwearied and laborious exertions they owed so very much; also to their Treasurer and Editor of Transactions.

The following communications were made:—

STRENGTH OF MATERIALS.

"At the request of the Council an Experimental Exposition was given, containing his concluding observations on the 'Strength of Materials' as applicable to the construction of Cast or Wrought-Iron Bridges, and on the Conway and Britannia Tubular Bridges" (Part I.) By GEORGE BUCHANAN, Esq., F.R.S.E., late Pres. R.S.S.A.

In this exposition, Mr. Buchanan, after apologising for the length to which he had been imperceptibly drawn in these communications, commenced by recapitulating the general principles which had formerly been laid down regarding the tensile and compressive strains of materials, and, in addition to the results of former experiments, made at the request of the Society, on the stones from different quarries in the neighbourhood, gave now the results of others which had since been carefully made on the harder materials of Caithness and Arbroath pavement, along with white marble and whinstone, as follows—viz.:—

	Tensile.		Compressive.
Whinstone	1469 lb.	....	8270 lb.
Arbroath pavement	1261	....	7884
Caithness do..............	1064	....	6493
Marble....................	722	....	6431

In all these experiments the peculiar nature of the two strains is distinctly exhibited; the specimens exposed to the tensile strain showing a clean fracture and no fragments; those exposed to the compressive being generally crushed to powder, and the fragments flying in all directions by lateral divergence; and generally, when any considerable fragment remains, showing the appearance of a pyramid from which the sides of the square had been broken—a form which has also been observed in the compression of cast-iron.

In regard to the transverse strength, he repeated the principles and general rule for calculation formerly explained by adopting what he termed a unit of strength, which differs in each material; but being once determined by actual experiment, affords a *datum* for calculating the strength of that material in every case, whatever be the dimensions of the masses acted on. This unit expresses the strength of a cubic inch of the material—*i.e.*, a bar 1 inch square, supported on bearings 1 inch apart, and loaded in the middle till it breaks. The strength of such a unit for cast-iron had been given on a former evening at 11 tons. In regard to timber, he had himself made various experiments on Memel fir, and had found the unit 4,000 lb. Oak and beech, by other experimenters, was found 6,000 lb.; ash, 8,000 lb.

In regard to the tranverse strength of stones, few experiments, he said, had been made on our building materials, although it was a strain they were much subjected to in stairs, balconies, covers of conduits, &c. He proposed, therefore, to try several specimens which were now before the meeting—viz., Hailes pavement, Craigleith, and Arbroath. Each of these specimens was 3 inches thick, 9 inches broad, laid flatways and supported at each end between two upright pillars, the distance between the bearings being exactly 3 feet. These specimens were loaded by weights successively laid on a scale hung from the centre of the pavement, until it broke. The Hailes was first tried, and, after carrying successively 4 cwt. and 5 cwt. for a little time, at last it gave way with 7 cwt. 10 lb. A specimen of the same rock and dimensions previously tried gave nearly the same result, being 7½ cwt. The Craigleith carried considerably more. After bearing 7 cwt. and 8 cwt. for some time, it gave way at last with 10½ cwt. The Arbroath pavement was found still greatly ahead even of the Craigleith. After carrying 12 cwt. and 14 cwt. for some time, it went on bearing 16½ cwt. This it bore for a short interval; and while an additional weight was in the act of being put on it gave way. These experiments are important, and appeared to excite much interest. From these the unit of strength is easily calculated.

The transverse strength and the forms of cast-iron girders for spanning wide openings were formerly explained, and the application of malleable iron in the form of hollow tubes or girders; and, connected with this subject, he explained a plan which had lately been proposed by Mr. Beardmore, C.E., London, who had favoured him with the results of some interesting experiments made by him. The plan consisted in constructing fire-proof or other floors by girders, consisting merely of thin plates of sheet-iron running parallel to each other at intervals, like ordinary joists resting on the walls at each end; these plates strengthened and united to angle-irons on the top, and to a thin plate below, running the whole way between the girders. The interval between them is filled up with a mass of concrete, the use of which is chiefly to keep the thin plate girders in their place, so that being incapable of bending, the full effect of the section of the iron is obtained, whereby the strength of such flooring, considering the thinness of the metal employed, is remarkable. In one experiment, where the girder consisted of sheet-iron, No. 14 gage, or $\frac{1}{12}$th of an inch thick and 13 inches deep, and placed 18 inches apart, and the length or span between the walls or bearings 23 feet—also the total sectional area 6¾ inches, while that of the concrete was 331 inches. This was loaded 8,000 lb., which is nearly double the weight of any number of persons that could have room to stand on the beam, and only deflected ⅛-inch. With 12,000 lb. it deflected about ⅜-inch, which was considered the probable limit of safe deflection. With 18,670 lb. it deflected 1 inch; it was not loaded farther, but the calculated breaking weight was 25,000 lb. Mr. Buchanan then showed a model of a floor on this principle, consisting of the thinnest tin-plate iron-girders, 3 feet long, 1½-inch deep, and 9 inches apart, and the spaces filled-in with plaster of Paris. Even this slender material carried with safety a person standing in the middle, and gave way with 3 cwt., chiefly owing to the joints in the bottom plate not being soldered, but merely laid over.

In regard to the application of hollow girders, or tubes, and the wonderful discoveries on this subject which the progress of engineering works had recently brought to light in the construction of the Conway and Britannia Tubular Bridges, he had formerly given a particular account of these, and had only now further to add, that he had the pleasure recently of visiting these structures, and was in every respect highly gratified with the result, and with the progress and state of the works, which were all pointed out to him and explained in the most liberal manner by Mr. Edwin Clarke, the very able and accomplished engineer on whom the active charge of the principal department in this undertaking had been devolved by Mr. Stephenson.

The Conway Bridge, as we know, has been long since finished, and the trains on the Chester and Holyhead Railway are seen daily passing and repassing. It ceases already to be any longer a wonder in the neighbourhood, yet the stranger pauses to gaze with admiration on this extraordinary triumph of science and engineering skill, as the train enters the tube, and again emerges under the walls of the magnificent remains of Conway Castle. In passing through the tube the sound of the train is peculiar, but not greatly louder than in ordinary tunnels. No sensible tremor or vibration is experienced, and the heaviest trains, when observed externally, do not produce any visible deflection. The line of the under surface of the tube is quite horizontal. The upper surface rises with a gentle curve towards the centre. The under surface had also when constructed a slight rise or camber in the centre of about seven or eight inches; but when the supports were removed from beneath, leaving it standing on the two extremities, it sunk in the middle by its own weight into a straight line, and this exactly as was intended by the engineers; showing the accuracy of the principles and data on which such nice calculations could previously be made of the probable deflection, and this chiefly from the experiments on the model tube by Mr. Fairbairn, described on a former evening.

The Britannia Bridge, to which he next proceeded, is a still greater work even than the Conway, and connected with many circumstances calculated to impart interest to this structure, and everything connected with it. The curiosity and wonder excited by the famous Bridge of Suspension over the Menai Straits were great: and he well recollected visiting this work during its progress, and the vast operations, as they were then considered, of fabricating, connecting, and finally lifting the enormous chains of which it is composed, each of which after all, hardly exceeded 100 tons, between rock and rock, and the central portion, which alone had to be lifted by one purchase, not above 30 or 40 tons. The principle of suspension also was not quite new, but had previously been exemplified in structures of considerable magnitude; still this was considered, and justly, an astonishing effort of skill, and remains a monument of the genius of Telford. What must we think, then, of the structure now in progress, and already seen partly spanning the same Straits, which is not only new in principle, and untried before the great experiment of the Conway, but where the entire bridge itself, nearly 2,000 tons in weight, requires not only to be floated on the water from the place of its construction, but then raised more than 100 feet in perpendicular altitude in one mass, and by one mighty purchase, to its seat on the top of the towers prepared for it. What extraordinary strength of materials—of chains, bolts, bars, and connections, does not this imply! What amazing resources of mechanical power and combination in the lifting machinery! What consummate arrangements, in launching the gigantic mass into the troubled waters of these Straits, and steering it with safety to its destination! All these circumstances tend to raise a singular degree of interest in this structure, and the operations connected with it, and the result fully realised his anticipations, of which, however, he could only give but a faint idea by description.

The first view which the traveller obtains is in crossing the Straits by the present Suspension Bridge. Looking about a mile to the westward, the towers of the Britannia Bridge are seen rising with imposing effect—the centre one, as it were, from out of the water—the two exterior ones from the edge of the waters, and the terminal pillars or abutments on the top of the high ground on each side. But the object to which the attention above all becomes riveted, is the appearance of an extended wall or roadway spanning the 460 feet opening between the Britannia tower and the Anglesea shore. This is the first of the four tubes which has been raised to its elevation of 103 feet above the waters. This is, in fact, *The Bridge*, standing without any appearance of support, and totally unlike any of the great works of this kind which have hitherto formed the pride of the architect and engineer. No more the noble arch rising, as we often see, so magnificently from the level of the opposite shores—nor the light and elegant curve of suspension hanging with such regular and airy proportions between the lofty towers on each side, but a figure perfectly horizontal and nearly rectilineal, spanning the opening and resting on the opposite towers—a figure certainly unequal to the others in beauty, but yet raising in the mind a sensation irresistibly striking, as exhibiting on such a magnificent scale the successful development of a new, grand, and simple idea in mechanical science.

Mr. Buchanan then proceeded to give an interesting description of the situation of the bridge, the romantic shores of the estuary, the extraordinary phenomena of its tides rushing in from the great sea at either extremity, and producing, by the concurrence of waters and other circumstances, peculiar anomalies, and, above all, currents, running often at the rate of seven and eight miles an hour; and lastly, the extraordinary and exciting operations connected with the launching of the first great tube, and floating it through those waters and currents; the difficulties, the dangers, and the singular incidents which occurred during the brief and trying moments of this extraordinary enterprise, but which, by the long-matured and perfect arrangements previously made, all ended in depositing it safely on its site between the piers.

The next great operation to be described was that of the lifting of the tube, but the description of which, owing to the important business before the Society this evening, of distributing the annual prizes to the successful competitors for Inventions and Communications, was necessarily deferred to another evening. In conclusion, particular reference was made to the great work which is now preparing by Mr. Edwin Clarke, with Mr. Stephenson's sanction and advice, being a history and description of the Conway and Britannia Tubular Bridges, with all the operations, and illustrated by very numerous drawings, on a large scale, of the details of the work, and also an account of the various experiments on the strength of iron, rivetted joints, &c., some of the results of which, as communicated to him by Mr. Clarke, he would state at the next meeting.

INSTITUTION OF CIVIL ENGINEERS.

Nov. 13 and 20.—**Joshua Field**, Esq., President, in the Chair.

In accordance with the resolution of a special meeting of Members, the Session of the Institution commenced on the 13th ult., instead of, as heretofore, in the middle of January. This is a great improvement, as it assimilates the routine of this useful Society to that of other scientific bodies; it will also prove very convenient to the country members, give a greater number of meetings, and enable the Session to terminate brilliantly with the President's conversazione. The annual general meeting for the election of President, Council, and Officers, is appointed to take place on Tuesday, December 18th.

The paper read was a "*Description of the Cofferdam at the Grimsby Docks.* By Mr. **Charles Neate**, A. Inst. C.E.

The author commenced by briefly noticing the importance of preliminary structures in all works of hydraulic engineering, and the difficulties generally attending their execution. The position of Grimsby, on the south shore of the Humber, was then described; its proximity to the sea; the natural shelter afforded by the opposite shore of Spurn Head; and the various advantages it presented for the construction of extensive docks. A general description followed of the enclosure made for the purpose of the dock-works, which comprised an area of 138 acres, and projected five-eighths of a mile beyond the margin of the high-water line of the shore. It was explained that the flatness of the coast necessitated this great projection, as it was requisite to found the new entrance locks in the low-water channel of the river, in order to secure, at all times, a sufficient depth of water for large vessels. These conditions regulated the position of the cofferdam, which stood in a very exposed situation, and was entirely self-supported; its principal features were stated to be its extent, and the form of its construction. The length of the cofferdam was 1500 feet, supporting at high water a head of water of 25 feet, whilst the excavation behind it was carried to 11 feet below low water. The form of the dam was that of a circular curve, with a versed sine of 300 feet, or nearly one-fifth of the span.

Several of the constructive arrangements were peculiar; the work consisted of a triple row of whole timber sheet-piling, which derived interior support from counterforts or buttresses of solid sheet-piling, driven at intervals of 20 feet throughout its length. The long or through-bolts were made to break joint and terminate at the middle row of piling, so that no water could pass along them through the dam. In the middle row of piling, wrought iron plating was substituted for timber walings, which formed excellent longitudinal ties, and left an uninterrupted surface on the piling, against which the puddle would lie compactly. It was stated that these [illegible] had imparted an extraordinary degree of stability and tightness [illegible] structure, which had resisted the effects of storms, and the pressure of the tides, in the most perfect manner, during a period of fourteen [illegible]. A portion of the ground between the works and the shore was [illegible] of a soft silty clay, probably the site of an old channel; [illegible], after all precautions, impossible to raise any solid structure [illegible] alternative was adopted of displacing it completely, by [illegible] chalk stone rubble, which sunk down to the hard bed of [illegible] method was successful in forming a very fine embank-[illegible]

[illegible] supply of water from Artesian wells in Grimsby was ad-[illegible] in the vicinity of the chalk hills.

[illegible] paper drew attention to the magnitude of the ma-[illegible] of Grimsby, and for the formation of which the [illegible] which, when completed, from the designs of Mr. [illegible], and under the superintendence of Mr. Adam Smith, the resident engineer, will form perhaps one of the most useful, as well as the most important, maritime works of modern times.

The **Dean of Westminster** made some remarks on the advantages that would result, from engineers possessing a more accurate knowledge of geology, and being able to discriminate between strata by an examination of the component parts, and to decide upon their origin, as a guide in judging of their capability of supporting the weights likely to be placed upon them in the construction of works. He gave many instances where, in his opinion, more accurate geological knowledge would have secured greater success, or have prevented casualties. He quoted particularly the borings and the report said to have been made previous to the commencement of the Thames Tunnel, and the recent statement, that the projected tunnel for receiving and conveying the sewage of London down to the Essex marshes, would, throughout its entire length, have been in the London clay. He showed, however, that no London clay was to be found eastward of St. Paul's, and that the plastic clay was constantly mistaken for it, in consequence of the observers not possessing a sufficiently accurate knowledge of the difference in the constituent features of the two clays.

Mr. **Rendel** and Mr. **Brunel**, although they admitted that an accurate knowledge of geology was most valuable to the profession, contended that engineers were not so ill-informed on the subject as had been assumed; they did appreciate the necessity of that knowledge, and although they might not be able to discourse upon it with the eloquence of a Buckland, a Lyell, or a Sedgwick, or to speculate so plausibly upon the events of past ages, no careful engineer ever decided upon the position, or mode of construction of his works, without a series of trial borings, a careful examination of the specimens, and experiments on them, chiefly with the view of ascertaining their strength, or capability for sustaining weights. Instead, therefore, of accusing engineers, of knowing so little, it was rather a subject of surprise that they knew so much; for no profession demanded such varied acquirements, or the exercise of such general common-sense and judgment. It was shown, that the position of the Thames Tunnel was not determined by the report, or the results of the borings, but with a view to establishing a connection between particular localities. The borings were perhaps inefficiently made, as compared with those of the present day, with the improved apparatus now in use; but Mr. I. K. Brunel had made a very complete series of borings across the Thames, showing most accurately the strata of the bed, and no errors could have been induced by them.—The statement of the proposed sewer tunnel being in the London clay, never had been accepted by eminent men, who understood their profession, however it might have been argued upon, as an assumed fact, by Commissioners and Boards of Sewers.

The discussion was closed by the Dean of Westminster giving an example of the urgency for engineers becoming geologists; and on Mr. Rendel stating that the clay at Leith was so hard as to require to be blasted, and yet that, when exposed to a small current of water, was completely dissolved within a fortnight, the rev. Dean at once explained it, as arising from the presence of a multitude of minute particles of mica, whose non-adhesive properties produced the speedy disintegration of the mass. This was admitted to be the fact, and had been observed and allowed for by the engineer in the construction of the works.

Nov. 27.—**Joshua Field**, Esq., President, in the Chair.

The paper read was a "*Description of the Old Southend Pier-head, and the extension of the pier; with an inquiry into the nature and ravages of the 'Teredo Navalis,' and the means hitherto adopted for preventing its attacks.*" By Mr. **John Paton**.

After describing the form of construction f the old pier-head, and showing the adoption of copper sheathing for protecting it from decay, and the important considerations involved in the attempt to preserve marine structures, the paper explained the ravages committed by marine worms (*Teredo Navalis*, *Lymnoria Terebrans*, and others) on the piles, both above and below the copper sheathing. This sheathing extended from the top of the mud to three feet above low water-mark; the worm destroyed the timber from two feet below the surface of the mud, to eight feet above low water spring tides, and, in fact, out of thirty-eight fir timber piles, and various oak piles, not one remained perfect, after being up only three years indeed, some were entirely eaten through.

A general outline of the extension of the pier, and a minute description; of the pier-head, were then given, showing the means adopted by the us of iron piles, and by scupper-nailing the inner piles, to preserve the structure from decay. The greater portion of the extension of the pier, the length of which was one mile, as well as the whole of the pier-head, we constructed of square, hollow, iron piles, and scupper-nailed fender piles; the iron piles being forced to a depth of from eight feet to sixteen feet, by pulling them backwards and forwards with ropes attached to them, and not by driving in the usual manner; they were then filled with gravel and concrete to within five feet of the top, and the fir piles to sustain the superstructure were fitted into them. The pier-head was constructed with forty cast-iron piles, and twenty fender piles, nailed from five feet below the bed of the sea to eight feet above low water; its greatest height was twenty-five feet above low water spring tides.

The paper then entered into an investigation of the nature and operations of the *Teredo Navalis*, and showed, as a remarkable peculiarity, that no chemical means had hitherto prevented wood from being destroyed by these animals and the *Lymnoria Terebrans*, whose destructive powers were likewise noticed, and as having penetrated between the copper sheathing and the wood at Southend. The operations of the *Teredo*, although most destructive in warm climates, extended themselves to all places, having been found almost in the Polar seas.

The chief peculiarities which distinguished the *Teredo* were stated to have been ascertained by minute microscopical investigation, and that woody fibres of an extremely minute nature had been discovered in the body, thus setting at rest the question as to whether the *Teredo* did actually feed upon the wood. It was stated, that the failure of chemical means to preserve timber from destruction by the marine worm was believed to proceed from two causes—namely, of poisonous compounds having no seriously injurious effect upon them, and the sea-water, and other things, decomposing the poisonous ingredients contained in the wood. In corroboration of the first of these views, accounts of experiments made by Mr. Paton were adduced; and physiological facts, quoted from the *British and Foreign Medical Review*, were brought forward to show, that cold-blooded animals were much more tenacious of life, than those of a higher temperament; and hence it was argued, that, as it required a very large quantity of poison of the most virulent nature, to destroy animals of a much higher order than the *Teredo Navalis*, it would take a still greater quantity to affect those animals as they existed in their own element; and it was questioned, under these circumstances, whether wood could ever be so completely and thoroughly saturated, as in any degree to affect them. The corrosive action of the sea-water, its extended influence and constant variableness in different parts of the globe, were then commented on, and some of the various salts held in solution mentioned. It was believed to be impossible to form any general notion of the precise action of sea-water on timber, whether chemically saturated, or not, without a series of most minute experiments, and a large body of facts, carefully collected in different parts of the globe—as that which might be advantageously used in the Thames, might not be of the slightest avail in the Tropics, and *vice versa*; it was thus questioned, whether any generally applicable principle could be found for the counteracting of that universal solvent of soluble matter. The conclusions arrived at were, that the ravages of the marine worm were not prevented by any chemical application, and that nothing but mechanical means could ever prove completely successful: studding with broad-headed nails was considered to be the most effectual remedy, and various authorities were quoted, proving its success. The paper concluded with a list of places where wood, prepared with various chemical ingredients, had been destroyed from various causes.

The discussion was commenced by the DEAN of WESTMINSTER who descanted very lengthily on the analogous action of the *Pholas* on stone, and on other topics, until, as the evening was so far advanced, it was announced that the discussion on the paper would be continued at the next meeting, December 4, when the first monthly ballot would take place.

NOTES OF THE MONTH.

The Royal Yacht.—The *Victoria and Albert* is ordered to be docked at Portsmouth to have an entire refit, and to have new boilers planned for her. This will be the third set of new boilers within five years, although she is only employed about a month each year. When this vessel was launched we estimated the cost at 100,000*l.* The idea was then scouted, but it is nevertheless the fact that she has cost the country altogether nearer 200,000*l.* We are quite sure that the public would not begrudge the expenditure of the larger sum in procuring for her Majesty a suitable yacht, if the accommodation could not be obtained for a less amount, but they will object to paying for one most inefficient vessel what ought to purchase at least half a dozen. The Ruler of Egypt has degraded and banished the naval architect and captain of his yacht—a good and efficient ship many hundred tons larger than the *Victoria and Albert*—because the cost exceeded the estimate; but our liberal and enlightened government has given the naval architect of the Royal yacht a retirement of 500*l.* a year, whilst his assistant has had his salary increased from 650*l.* to 800*l.* a year, and the shipwright, builder, and his progeny have received all sorts of promotions. People of common sense will easily determine which government is most wise and just.—*United Service Gazette.*

Parachute Lights.—Some experiments were recently made at the Woolwich Mortar Battery, to test the efficiency of a new light invented by Capt. Boxer, for lighting the atmosphere. General Lacy, Col. Dundas, C.B., Lieut.-Col. Chalmer, Lieut.-Col. Bell, Lieut.-Col. Brereton, C.B., Lieut.-Col. Hardinge, K.H., Lieut.-Col. Anderson, Lieut.-Col. Pester, Lieut.-Col. Maxwell, Brigade-Major Bingham, and Major Dupins, with a great number of officers of the garrison, and Lord James Hay, assembled at the Mortar Battery, when quite dark, to witness experiments with the common 8 inch carcases of the service, used for firing so as to give light to show the position of an enemy in dark nights, and to compare them with an invention to answer the same purpose more effectually, invented by Capt. Boxer, Royal Artillery. The first fired was one of the carcases from an 8-inch mortar, and it fell to the ground at a distance of between 200 and 300 yards, and continued burning about 10 minutes. One of the cases containing Capt. Boxer's plan was then fired. It consists of two tin cases, each being half-a sphere; the one containing the composition, which burns like a brilliant blue light, and the other, the parachute, formed of a light description of closely-woven bunting. The diameter of the cases appeared to be about five inches, and when fired they attained a considerable altitude, but the parachute did not in the first instance open out sufficiently, and the lighted composition soon fell to the ground. The second fired on Capt. Boxer's plan was a beautiful spectacle, the shells ascending to a great altitude, and when at the highest point an explosion took place, similar to the bursting of a rocket in the air, and out came a parachute fully 6 feet in diameter and about 3 feet in depth, suspending the brilliant blue light and gradually descending, illuminating the part of the common on which it descended with a very brilliant light. The third and fourth—all that were fired on Capt. Boxer's principle—were equally successful, and all appeared much gratified with the result. Three other carcases were fired from the 8-inch mortar with a similar effect to the first; but although they gave out flame for a considerable time, they appeared to burn dim compared with Capt. Boxer's. It may be mentioned that the parachute which supports the burning composition, on Capt. Boxer's plan, is about from 7 to 8 feet above the burning matter; six cords descending from it are attached to a small chain about a foot long, fixed to the composition shell.

Poor rates in the Metropolis.—It appears from an ingenious work recently published by Mr. G. L. Hutchinson, that the following inequalities exist in the rating of the metropolis, which is by no means the worst instance to be adduced:—The annual value of property in East and West London is 211,150*l.*, rated at 2*s.* 10*d.* in the pound. The annual value assessed in the City is 613,883*l.*, rated at 1*s.* 7*d.*; Whitechapel, 197,522*l.*, rated at 1*s.* 9*d.*; St. James's, Westminster, 250,160*l.*, rated at 10*d.*; Bethnal-green, 95,549*l.*, rated at 2*s.* 9*d.*; St. George's, Hanover-square, 604,105*l.*, rated at 6*d.* The amount received by the poor of the city is equal to 18*s.* 10*d.* per head on the population within the walls, and the amount of relief given to the population without the walls is equal to 8*s.* 6*d.* per head. The amount of relief extended to the poor of the different districts per 1*l.* value of rated property is—Bermondsey, 3*s.* 3*d.*; East and West London, 2*s.* 10*d.*; Bethnal-green, 2*s.* 9*d.*; St. George's, Southwark, 2*s.* 8*d.*; Shoreditch, 2*s.* 4*d.*; Greenwich, 2*s.* 4*d.*; Newington, 2*s.* 3*d.*; Stepney, 2*s.*; Rotherhithe, 1*s.* 11*d.*; Whitechapel, 1*s.* 9*d.*; Camberwell, 1*s.* 8*d.*; Holborn, 1*s.* 8*d.*; St. Luke's, 1*s.* 7*d.*: City of London, 1*s.* 7*d.*; Hackney, 1*s.* 5*d.*; Strand, 1*s.* 5*d.*; Clerkenwell, 1*s.* 4*d.*; Poplar, 1*s.* 3*d.*; St. Giles, 1*s.* 3*d.*; Kensington, 1*s.* 1*d.*; St. Pancras, 1*s.* 1*d.*; Westminster, 11*d.*; Marylebone, 11*d.*; St. Martin's-in-the-Fields, 11*d.*; St. James's, Westminster, 10*d.*; Islington, 8*d.*; and St. George's, Hanover-square, 6*d.* These disproportions have rather increased than diminished since this return was made.

Chlorure of Silver.—Herr Poggendorf has succeeded in decomposing chlorure of silver by the galvanic battery, which is useful when it is wanted to prepare pure silver to re-dissolve it. The way is, to take chlorure of silver in the wet state, put it in a crucible, pouring over diluted sulphuric acid (1 acid, 9-water), and introducinga porous cylinder filled with the same liquid, and in this a plate of amalgamated zinc, brought into communicaiton by a copper wire with platinum or silver.

Profits on Gas Manufacture.—A statistical return of the outlay and profits of the Durham Gas Company shows that their gains for the year 1848 were at the rate of 27½ per cent.

On the Duration of Wood, and Means of Prolonging it.—The following are the results of experiments made with great care and patience by Mr. G. S. Hartig:—Pieces of wood of various kinds, 25-8th inches square, were buried about an inch below the surface of the ground, and they decayed in the following order:—The lime, American birch, alder, and the trembling-leaved poplar, in three years; the common willow, horse-chesnut, and plane, in four years; the maple, red beech, and common birch, in five years; the elm, ash, hornbeam, and Lombardy poplar, in six years; the robinia, oak, Scotch fir, Weymouth pine, and silver fir, were only decayed to the depth of half-an-inch in seven years; the larch, common juniper, red cedar *(Juniperus virginiana)*, and arbor-vitæ, at the end of the last-mentioned period remained uninjured. The duration of the respective woods depends greatly on their age and quality; specimens from young trees decaying much quicker than those from sound old trees; and, when well seasoned, they last much longer than when buried in an unseasoned state. In experiments with the woods cut into thin boards decay proceeded in the following order, commencing with the most perishable order: The plane, horse chesnut, poplar, American birch, red beech, hornbeam, alder, ash, maple, silver fir, Scotch fir, elm, Weymouth pine, larch, robinia or locust oak. It has been proved, by repeated experiments, that the best mode of prolonging the duration of wood is to char it, and then paint it over with three or four coats of pitch. But simply charring the wood was of very little utility, as were also saturations with various salts, acids, &c.—*Revue Horticole.*

Expansive Steam-Engines.—Mr. J. C. Pearce, of Salford, has made an improvement in the expansive steam-engine, the advantages contemplated by which are stated to consist in the application of two self-acting valves, in addition to the expansion regulator, one to each end of the steam cylinder—fixed in suitable passages, which communicate with the waste steam or exhaust pipe. Mr. Pearce states that the use of these valves is to prevent the pressure upon the working side of the piston from falling below the resistance or back pressure upon the opposite side—a very common occurrence in carrying out the expansive principle, although attended with very considerable loss of power; and that the proposed improvement is chiefly adapted to locomotives and other non-condensing expansive engines, and the power is extremely variable.

Government Steamers.—A very large armament has been ordered for the Valerius steam frigate, now being built at Pembroke. On the upper deck she will carry one 68-pounder of 95 cwt.; one 10-inch gun of 85 cwt.; and four 32-pounders of 56 cwt. each, all of which are to be mounted on pivots. In addition she will be prepared to carry eight 32-pounders of 56 cwt. each.

The Vulcan.—A large spare screw-propeller, furnished by Messrs. Rennie, has been landed at Woolwich Dockyard, to be put on board this vessel. It is 14 feet in diameter, and 5½ tons in weight, and being made of the best brass, or mixture nearly approaching to gun-metal, is calculated to be worth 1,200*l*.

Screw Propellers.—It has hitherto been usual to fit screw-propellers in the rough shape in which they are cast, simply filing and smoothing the narrow edge of the blade; but one of the machines in the factory at Woolwich dockyard has been fitted in such a manner as to plane the whole of one side of the blades, and on its being tried in the factory for the first time on a screw-propeller 9 feet in diameter, cast of brass, for the Archer, it appears to perform the work in great perfection. The difficulty of obtaining a motion which would suit itself to the curve of the blade of a screw-propeller must be evident to every one who has witnessed its form, and yet it has been perfectly accomplished in this instance.

The Termagant, 24, screw-frigate, by White, of Cowes, built in Deptford dockyard, 1,556 tons, 620-horse power, by Seaward, was again tried at Portsmouth, Nov. 19, at the measured mile in Stokes Bay, with light airs and a smooth sea, to endeavour to obtain a more creditable result than on the former occasion. Captain Horatio Austen, C.B., of the Blenheim, commanded the ship on this occasion. Mr. White, her designer, was on board; as also Rear-Admirals Prescott, C.B., and Sir Charles Napier, K.C.B., with Mr. Murray, the chief engineer of the dockyard, and a host of naval officers from the college, and elsewhere ashore, the trial having attracted much attention in the service. She went out of the harbour about 11 o'clock, trimmed to a draught of 17 ft. 10 in. aft and 16 ft. 1 in. forward, her midship portsill being then 6 ft. 9 in. from the water. Her former draught was 16 ft. 9 in. forward, and 17 ft. 3 in. abaft. She was considered at her load draught for sea service, being all complete for officers and men, topgallant masts struck, and yards an end and pointed, all her guns and shot on board. The following is the result of each run at the measured mile:—

	Knots.	
First run	8·391	Giving a mean speed of 8·544 knots per hour.
Second run	8·551	
Third run	8·612	
Fourth run	8·295	
Fifth run	9·137	
Sixth run	7·627	

Revolutions (mean), 32; mean revolutions of propeller, 64; pressure of steam, 12 lb.; thermometer in engine-room, 85°; stokehole, 108°; temperature on the upper deck, 62°; mean barometer, 27½ inches. She turned a whole circle to port, with the engines in full play, in 6 min. 9 sec. in a space the mean of which was about four times the ship's length. This result is certainly more respectable than that obtained on her trial a few days since, with rough wind and weather; but is, after all, but a beggarly account of service to be expected in return for an expenditure of 70,000*l*., especially when placed in comparison with the performances of the Arrogant screw-frigate, which achieves, under all circumstances, more speed, although 306 tons more burden, with 260-horse power less.

The Conflict.—On Tuesday, the 13th ult., Her Majesty's steam-sloop Conflict, 8, of 400-horse power, Commander T. G. Drake, made an experimental trip to the Eddystone, to test the power of her screw. From Plymouth she started from abreast of the Breakwater Lighthouse, and reached the Eddystone Lighthouse, a distance of rather more than 10 miles, in 1 hour and 57½ minutes, to cover the ground, being an amount of time for such a distance which 'per se' is not satisfactory.

Steam Screw-Propeller, Minx.—This vessel went down the river from Woolwich dockyard on the 14th ult., to test the disc-engine of 10 horse power with which she has been fitted. The engine, at starting, made 130 revolutions per minute, but the average during the trial in Long Reach was 120 revolutions per minute. The speed attained was 5·271 knots with the tide, and 2·0 knots against the tide, giving an average of 3·625 knots per hour. The engine worked during the trial with a pressure of 60 lb. to the square inch. The speed was comparatively so little, that she was towed back to Woolwich by the Monkey steam-vessel, at the rate of 8·45 knots per hour.

Launch of the Propontis.—A fine screw steamship, built of iron by Messrs. Mare and Co., Blackwall, from a design by Mr. T. Waterman, jun., has been launched. The Propontis will be the third constructed for the General Screw Shipping Company, and of the same class as their two vessels the Bosphorus and Hellespont. Her dimensions are—length, 175 feet; breadth, 25 ft. 6 in.; depth, 17 ft. 6 in.; and tonnage, 531 86·94. She is to be fitted with auxiliary engines of 80-horse power, by Messrs. Maudslay, Sons, and Field, and will be commanded by Captain Brenan.

French Steamers.—Monsieur Cavé, the great French engineer, has, according to the 'Moniteur Industriel,' supplied a fourth steam tow-boat for the Rhine, which is held forth as a great feat, and a triumph over the English, likewise that he is the great champion of the oscillating engine.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM OCTOBER 18, TO NOVEMBER 22, 1849.

Six Months allowed for Enrolment, unless otherwise expressed.

John Cowley, of Walsall, Stafford, manufacturer, and John Hickman, of Aston, Warwick, clerk, for improvements in the manufacture of bedsteads, chairs, tables, couches, and tubular or hollow articles.—Sealed November 2.

George Park Macindoe, of Mountblow, Scotland, for certain improvements in machinery or apparatus applicable to the preparation, spinning, doubling, and twisting of cotton, wool, silk, flax, and other fibrous substances.—November 2.

Adam Cottom, of the firm of John Elce and Co., of Manchester, machine makers, for improvements in machinery to be used in preparing and spinning cotton and other fibrous substances. (A communication.)—November 2.

John Jordan, of Liverpool, engineer, for certain improvements in the construction of ships and other vessels navigating on water.—November 2.

Lucien Vidie, formerly of Paris, but now of South-street, Finsbury, French advocate, for certain improvements in conveyances on land and water.—November 2.

Frederick Octavius Palmer, of Great Sutton-street, Middlesex, gentleman, for certain improvements in the manufacture of candles, and also in the machinery for the manufacture of such matters.—November 2.

Charles Cowper, of Southampton-buildings, Chancery-lane, for improvements in the treatment of coal, and in separating coal and other substances from foreign matters, and in the manufacture of artificial fuel and coke, and in the distillation and treatment of tar and other products from coal; together with improvements in the machinery and apparatus employed for the said purposes. (A communication.)—November 2.

Michael John Haines, of Lucas-street, Commercial-road East, Middlesex, leather-pipe maker, for improvements in the manufacture of bands for driving machinery, in hose, or pipes, and buffers for railway purposes.—November 2.

Hiram Tucker, of Roxbury, Massachusetts, United States of America, for a certain new or improved manufacture of mantel-pieces.—November 2.

William Buckwell, of the Artificial Granite Works, Battersea, Surrey, civil engineer, and Joseph Apsey, of Blackfriars, Surrey, engineer, for improvements in steam-engines, and in propelling vessels.—November 2.

William Morris, of Coldbath-square, Middlesex, civil engineer, for improvements in the preparing of clay, and in the manufacture of bricks, tiles, and other articles made of clay or brick-earth.—November 2.

James Combe, of Belfast, Ireland, engineer and machinist, for improvements in machinery for hackling flax and hemp, and in machinery for producing flax yarns.—November 2.

Alfred Barlow, of Friday-street, London, warehouseman, for certain improvements in weaving.—November 2.

William Edward Newton, of Chancery-lane, civil engineer, for improvements in machinery for dressing, shaping, cutting, and drilling or boring rocks or stone; part of which improvements are, with certain modifications, applicable to machinery or apparatus for driving piles. (A communication.)—November 6.

James Buck Wilson, of St. Helens, Lancaster, ropemaker, for certain improvements in wire ropes.—November 8.

Charles Edwards Amos, of the Grove, Southwark, Surrey, engineer, and Moses Clark, of St. Mary Cray, Kent, engineer, for improvements in the manufacture of paper, and in the apparatus and machinery used therein; part of which apparatus or machinery is applicable for regulating the pressure of fluids for various purposes.—November 10.

Charles Matthew Barker, of Lower Kennington-lane, Surrey, engineer, for improvements in sawing or cutting wood and metals.—November 10.

Richard Ford Sturges, and Jonathan Harlow, both of Birmingham, for improvements in bedsteads.—November 10.

Enoch Chambers, of Birmingham, smith, for improvements in the manufacture of wheels.—November 10.

Thomas Keely, of Nottingham, manufacturer, and William Wilkinson, of the same place, framework knitter, for certain improvements in looped or elastic fabrics, and in articles made therefrom; also certain machinery for producing the said improvements, which is applicable in whole or in part to the manufacture of looped fabrics generally.—November 10.

Samuel Brown Oliver, of Woodford, Essex, gentleman, for improvements in dyeing and dyeing materials. (A communication.)—November 10.

Henry Henson Henson, of Hampstead, Middlesex, gentlemen, for certain improvements in railways and railway carriages.—November 10. To be dated June 14, 1849.

Rowland Brotherhood, of Chippenham, Wilts, railway contractor, for an apparatus or mode for covering trucks and wagons on railways, road wagons, and canal boats, so as effectually to protect goods in the course of public transit from theft or damage, and at the same time to allow of such trucks and wagons being loaded and unloaded with equal facility.—November 10. To be dated July 18, 1849.

[The two last patents being opposed by caveat at the Great Seal, were not sealed until the 10th November, 1849; but bear respectively the date they would have been sealed had no such opposition been entered.]

Robert Parnall, of the city of London, clothier, for a new instrument for facilitating the stitching or sewing of woven fabrics.—November 13.

James Chesterman, of the firm of Messrs. Cutts and Co., of Sheffield, machinist, for improvements in carpenters' braces and other tools and instruments used for drilling and boring purposes.—November 18.

Charles Cowper, of Southampton-buildings, Chancery-lane, Middlesex, for improvements in the manufacture of sugar. (A communication.)—November 14.

Louis Adolphe Duperrey, of 112, Faubourg du Temple, Paris, engineer, for certain improvements in machinery for producing figures in relievo.—November 17.

Alfred Vincent Newton, of Chancery-lane, mechanical draughtsman, for improvements in manufacturing leather. (A communication.)—November 17.

Charles Ludovic Augustin Meinig, of Hamburgh, now residing in London, merchant, for certain improved modes or methods of applying galvanism and magnetism to curative and sanitary puposes. (A communication.)—November 17.

Charles James Pownall, of Kensington, Middlesex, esquire, for a certain mode or method, or certain modes or methods, of ascertaining or registering the number of persons entering in or upon passenger conveyances and passage ways, and the instruments and apparatus for effecting the same.—November 17.

George Edmond Donisthorpe, of Leeds, manufacturer, and James Milnes, of Bradford, York, for improvements in apparatus used for stopping steam-engines and other first movers.—November 17.

William Brindley, of Nelson-terrace, Twickenham, Middlesex, papier-mache manufacturer, for improvements in producing ornamental designs on papier-mache, and in preserving vegetable matters.—November 17.

William Buckwell, of the Artificial Granite Works, Battersea, Surrey, engineer, for improvements in manufacturing pipes and other structures artificially in moulds when using stone and other matters.—November 17.

Samuel Stocker, of High Holborn, Middlesex, hydraulic engineer, for certain improvements in the beer-engines, beer measures, and tobacco-boxes used by publicans.—November 17.

Thomas Worsdell, of Birmingham, Warwick, manufacturer, for certain improvements in the manufacture of envelopes and cases, and in the tools and machinery used therein.—November 17.

John Webster Hancock, of Melbourne, Derby, manufacturer, for improvements in the manufacture of hosiery goods, or articles composed of knitted fabrics.—November 17.

Charles Edouard Françis Constant Prospere De Changy, of Brussels, now residing in Tavistock-street, Westminster, civil engineer, for improvements in the preparation and manufacture of flax, hemp, and other like fibrous substances.—November 20.

Charles Cowper, of Southampton-buildings, Chancery-lane, for certain improvements in the manufacture of sugar. (A communication.)—November 20.

Francis Justin Duburguet, of Cahors, in the republic of France, for certain improvements in hydro-pneumatic engines.—November 22

Joseph Pierre Gillard, of Paris, gentleman, for certain improvements in the production of heat and light in general.—November 22.

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END OF VOLUME XII