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THE incidents connected with the building of the city and county buildings at Chicago have been so various and, from a professional point of view, so suggestive and entertaining from the beginning that we have been compelled to refer to them in these columns much more frequently than perhaps is warranted by the intrinsic importance of the buildings themselves. The jealous and active unofficial supervision of disappointed bidders is still bearing fruit. The latest phase is the report of the expert committee appointed to consider the charges preferred against the material and construction of the city-hall. General McDowell was chairman of this committee. As regards the ashlar of the building they find that an average of every sixth stone is in some respect imperfect and at variance with the requirements of the contract, and that one in every twenty-one stones is marked by some distinctly bad defect. The committee, however, state their belief that these defects will not cause the destruction of the building in the near future, but that none of them are "excusable in good building nor warranted by any terms or any fair construction of the contracts and specifications." They find that the brickwork, though not according to contract in all respects, is fair; that the granite course is deficient in width of bed; and that the bond-stones required by the drawings, and distinguished by color thereon, do not exist in the wall; that these deficiencies in the stone-work, amounting to 6,666 cubic feet, have necessitated extra brickwork, in the backing amounting to one hundred and fifty thousand brick, which stand as a claim against the city; that the superintendent, instead of being the director and arbiter of the work, has had his plans changed and his orders countermanded by "some higher power." The building committee of the city council, after a discussion of this report, determined to call in additional evidence before reporting to the council, and have summoned a large number of people who have been immediately or remotely connected with the work from the beginning. Apparently, therefore, it will be long before we discover what power it was through which the stone which the builders should have rejected has become the head-stone of the corner.

MEANWHILE, making due allowance for the tendency among all experts to justify their employment in any case by over-scrupulous exactions, and by interpretations of contracts more literal than is found expedient or practicable in the actual fulfilment thereof, there seems to be sufficient ground to believe that the work has not been carried out in accordance with the obvious stipulations of the contract in some particulars. Thus a point in defence is unofficially made with regard to the absence of bond-stones by stating that although the drawings distinctly set forth their number, position, and dimensions, due mention of them was accidentally omitted in the specifications, and that as the "specifications are made out last," they are to govern in preference to plans. This may possibly be true in cases where plans and specifications differ, but it certainly is a new interpretation of common building agreements that a stipulation which is required by the drawings but not by the specifications is not to be considered binding by the party of the second part. In prac-

tice the specifications are in no sense bills of quantities, and their function is never to take the place of drawings or to supersede them, but to state the obligations which cannot, from the nature of the case, be defined by drawings. No building contract can be intelligible and binding in which the plans and specifications, having been duly identified by signatures, are not equally essential parts thereof.

THE main building of the Centennial Exhibition has for some time been held by the Permanent Exhibition Company of Philadelphia, under a license granted by the Commissioners of Fairmount Park. In the midst of innumerable discouragements, moral and pecuniary, this company, by various means, has succeeded in gathering together and maintaining what promises to be a very large and important collection of objects illustrating the progress of the industrial and mechanic arts. Among their devices for raising money they have seen fit to hold in the building exhibitions and entertainments of various kinds in order to attract the public. But the Commissioners, impelled either by a want of confidence in the success or usefulness of the undertaking, or in its management, or by a desire to restore the park to its more legitimate uses, have from time to time had consultations with the officers of the society with a view to the removal of their enterprise to some other locality. Notwithstanding these warnings the notice served last week upon the society to quit the premises, remove the building, and restore the site within two years, according to a provision reserved in the license, has come with a certain suddenness and surprise. This removal will have the effect of opening the park and giving due prominence to the Memorial Hall, which is now destined to remain the only visible record of the great international event of 1876. As for the Permanent Exhibition we cannot but think that, if it was really on a fair road to success and is in good hands, a great and wealthy community like Philadelphia will scarcely permit it to die. Certainly Fairmount Park is too distant from the city for the location of a great museum the object of which is to educate and encourage a popular taste for the mechanic and higher arts, and to illustrate by visible signs the great social movements of the day. If the building itself is to be re-erected elsewhere it is to be hoped that its temporary and shed-like character, which was only condoned by its enormous extent and by a certain agreeable architectural effect obtained by repetition of parts, may be modified so that an institution designed to do service in the cause of civilization may be more monumentally and safely housed.

Two weeks ago we had occasion to refer to the fact that the demolition of the water-front of the Ducal Palace at Venice, preparatory to the rebuilding of it, had actually begun, and that London Bridge was in imminent danger of such alterations as would materially change its familiar aspect. Now we have to record the fact that a still greater historical monument has been doomed to absolute destruction. A short time since a committee of the French Chamber of Deputies, charged with considering the plans for the rebuilding of the Tuileries, approved the restoration of the central palace in its original exterior form "out of respect to the genius of two great French architects, Philibert Delorme and Jean Bullant." But a few days afterwards — on the 29th of July — the Assembly, terrified by the spectre of a monarchical restoration, determined to sacrifice art to politics, and, by a vote of 249 to 166, adopted the proposal of M. Proust, to destroy the ruins of the famous pile and turn the site, which it has occupied for more than three centuries, into a garden. We cannot contemplate the final demolition of the palace of the Tuileries, with all its thronging historical and artistic associations, without a pang of regret. Doubtless this monument has exercised over the civic architecture of the Renaissance in Western Europe and America an influence more potent than any other single structure of the style. Without the inspiration and suggestions furnished by this fruitful source the aspect of modern cities, especially in this country, would have been essentially different. Jean Bullant, Pierre Lescot, Claude Perrault, Percier and Fontaine, Visconti and Lefuel, extended the order of the Tuileries and developed their capacities in the façades of the Louvre, which are the type of the modern French Renaissance; and this form of art is the basis of design in the great majority of modern architectural façades. If the central

monument of this great style is indeed to be removed from its site, and is to share the fate of De Lorme's other works, — the Château Gaillon and the Château Anet, demolished in the revolution, with all their sculptures of Jean Goujon and Germain Pilon, — may we not hope that at least some characteristic portion of it may somewhere be preserved, as, in the court-yard of the School of Fine Arts at Paris, Gaillon and Anet have been preserved to keep alive an affectionate respect for the work of the great master, and the knowledge of a beautiful phase in the development of art.

THE old churches of London which gradually have been left stranded upon an alien shore of shops and warehouses, deserted of worshippers, but supporting each a clergyman and a clerk and still maintaining an empty form of ecclesiastical existence without any practical service of religion, are daily falling under the operations of an act called the Union of Benefices Act. Under this act the ecclesiastical commissioners are empowered at their discretion to destroy these old and disused buildings and to sell their valuable sites for as much money as they can get for them, equitably apportioning the charitable endowments of the disestablished churches to neighboring and deserving charities, and making large grants for church-building purposes in outlying districts, where the potential congregations are large and the existing church accommodations insufficient. All this seems as unsentimental and, from an archaeological point of view, barbarous, as from a practical point of view it is judicious and expedient. The architects who are fortunate enough to build new churches with these spoils of the old churches have no reason to complain; but the destruction of the ancient landmarks is deplorable, and the Society for the Protection of Ancient Buildings is kept in a continual state of vigilant expectation and vigorous protest by the thorough manner in which the work of spoliation is done. Among those lately destroyed are St. Mary Somerset, established in the reign of Edward III., and rebuilt with a tower by Wren, after the great fire; St. Dionis Backchurch, dedicated to St. Dionysius the Areopagite, the St. Denis of France, dating from the thirteenth century, and rebuilt with a tower by Wren, after the fire in 1674; St. Benet's or Benedict's, in Grace Church Street, another of poor Wren's churches, with a cupola and spire 140 feet high; St. Mildred's, another of Wren's monuments; St. Martin's Outwich, a fourteenth century building in mediæval style, rebuilt by Cockerell; St. Antholin, a church of the twelfth century, rebuilt by Wren in 1684, with an oval dome supported by eight columns, a miracle of carpentry, and with a tower 154 feet high; St. Michaels, Queenhithe, built by Wren in 1677, with a spire; All Hallows, Bread Street, where Milton was baptized; All Hallows Staining in Mark Lane, where Queen Bess, before she was queen, performed her devotions after her liberation from the Tower; and now there is a struggle between the society and the commissioners over St. Mary-at-Hill, Eastcheap, with the chances in favor ultimately of the latter. The old steeples cannot stand in the midst of the modern torrent of business, and hereafter those who would be instructed by their example must content themselves with the counterfeit presentment in books. But if the work of Queen Anne's time is destroyed in one part of London it is rebuilt in another part in a fashion more archaeological than architectural.

In view of the rapid disappearance of these old London churches built upon mediæval foundations and replacing mediæval forms after the sharp line of demarcation between the historical eras afforded by the great fire of London, it is well for us to pause and reflect upon the really important part which they have played in the development of the characteristic forms of English Renaissance. Perhaps the unequalled opportunity enjoyed by Sir Christopher in the fifty or more city churches which he built conferred upon this style an undue share of his own personality in the beginning; but in the hands of Hawksmoor, the Adamsons, Sir William Chambers, Sir John Vanbrugh, and the rest of his successors, it became acclimated and distinctly representative of English genius. A scientific analysis of these forms, as distinguished from those which were developed on the other side of the Channel after Delorme, Bullant, Lescot, and the other French masters, would betray an elasticity in the five orders of architecture which it has been the fashion distinctly to deny during the prevalence of the late Gothic revival. The elements of the orders are so simple, and their proportions and details so arbitrary, that at first sight it would seem but little scope is left in them for expressions of characteristic individuality. But the comparison which we have suggested seems to be

capable of proving pretty distinctly that in due course of time, out of the accumulation and succession of minute and more or less indistinguishable traits of personality, which may be expressed through this apparently inelastic medium of arbitrary signs, there was presently developed an expression of national genius which, if it is difficult to define, is easy to recognize. We cannot but think that a study of the use of the orders and of the classical details in these old London steeples, because of the absence of embarrassing practical conditions in such merely ornamented features, would go far to show how this national genius unconsciously, modified the accepted types of form, until, if not a new language, certainly a new dialect was developed. We know that even now, so powerful is the influence of national genius, notwithstanding the cosmopolitan nature of architectural education in these days, it is impossible for an English architect to produce a work in French Renaissance without betraying his foreign accent. In like manner the French Renaissance, as quoted in our own state-houses and city-halls, though often grammatically correct, is after all only broken French, or rather a French modification of our own vernacular. Thus we believe these old steeples have a lesson to teach, and the architectural philologist who shall be able to point out in them the characteristic and national modifications of detail and combination may also be able to show how these modifications are expressions of essential traits of national genius. The distinction between the use of the orders by the Greeks and by the Romans has been traced to its sources and found to have clear relations to the national genius in each case. Doubtless the more complicated civilization of more modern times will not prevent a similar analysis.

MR. JAMES JACKSON JARVES, in his last letter to the *New York Times* from Florence, explains the conditions under which the proposed "Retrospective Art Exhibition" is to be held in that city. This is to include all those objects which are generally understood to be proper in "loan exhibitions." A scheme, therefore, to bring together the household treasures of such a province as Tuscany, with such untold and unknown stores of wealth in every department of art, and of art manufacture, hitherto hidden away and inaccessible, must be of no little promise. It has been sanctioned and assisted by the Italian king, who has placed the Pitti Palace at the disposal of the committee for this purpose, and the date of opening is dependent solely upon the promptness with which the necessary funds can be gathered and the preliminary arrangements made. As regards the application of art to manufactures of every kind in stuffs, glass, furniture, bronzes, and metallic work of all sorts, in pottery, porcelain, ivories, terra-cotta, jewelry, etc., this exhibition must needs be of the utmost interest and importance. But while we are congratulating ourselves upon this intelligent enterprise, by which the ancient Tuscan households and galleries are for a time to give up their precious heirlooms for the delight and instruction of the world, most inconsistently there exists under the auspices of the very Italian government which fosters this undertaking a system of barbarous and arbitrary destruction of works of art and archaeology which seems incredible. It is said to be the fixed policy of this government, in disposing of the results of the excavations which it is now carrying on in various parts of Italy, to retain only two or three specimens of any class of objects recovered, for the enrichment of its museums, and to destroy all duplicates. Thus it is known that in the excavations at Pompeii there are imperative orders from Rome, enforced by heavy penalties, to melt down all bronzes and metallic objects, and to break up all terra-cottas and sculpture, however beautiful and valuable, after selecting two or three specimens of each for the museum at Naples. One witness states that he saw more than four hundred bronzes melted under this official vandalism, so that Naples might have a more unique collection and be more attractive for students of archaeology. Such a policy of barbarism surely seems more Turkish than Italian.

AMERICAN DRAMATIC THEATRES. IV.

THE practical difficulties of the Greek type of auditorium, as given in the last article, have led to the adoption of a second class of forms, varying in plan from the segment of a circle, or the flat curve of an ellipse, to an elongated horseshoe shape. In these the main floor, commonly known as the pit, orchestra-stalls, or parquet, has a rise to each seat of from two and one half to six inches; and there are added one or more galleries, the upper one often extending back over the entrances, and not unusually having a seating capacity equal to a third of the house. In most cases the galleries extend at the sides

to the proscenium wall. In foreign theatres they are often shallow and divided into small boxes, seating six or more each, but this disposition has not found favor with American audiences, who prefer a more open and democratic arrangement. This preference has led to making the galleries unusually and inconveniently deep, eleven or twelve rows of seats often being placed across the rear, the number being reduced to three or four at the ends. In order to get sight lines for this awkward arrangement the gallery front often has a fall or slope towards the proscenium, which not only gives a bad combination of lines in the house, but makes the seats nearest the stage extremely uncomfortable by causing them to slope from side to side. However much Americans may incline to abuse their own spines they do not relish an enforced twist, especially when they are bent on pleasure. Of course this tilting of the seats may be avoided by stepping the gallery in its length as well as width; but this interferes with the use of the ordinary connected tilting-seats, causes stumbling places, and much increases the expense. To obviate the bad effect of the sloping lines of the gallery front, the ceiling and dome have sometimes been built on the same pitch, but the effect is not agreeable, and the work of construction is complicated and the cost increased. How this form came into vogue in America is uncertain; but it is not unlikely that it may have been a makeshift of the carpenter-architect, who saw no other way to crowd the required number of seats demanded by the manager into the limited space allowed. There are a few foreign examples of this arrangement, — the Alexandra Theatre of St. Petersburg being one of the most important, — but it certainly has little to encourage imitation.

The desire for undue seating capacity in the hall has been one prolific source of controversy between owner or manager and architect. The limits of safety and comfort being determined, there is almost invariably a demand for extra seats and more standing-room. To what extremes the architect should be made the antagonist of his employer, and constitute himself a martyr for the benefit of the many, is still an open question. It would seem reasonable, if he is to be considered the natural guardian of public safety, that he should be paid something for such service out of the public purse, or at least should be reimbursed for the sacrifice of his commission, and attendant law expenses, when forced to such loss for the good of the community.

As is well known, the law, as made for and applied to the safe building of theatres, is very defective. Even were the restrictions of the buildings acts more perfect, the administration of them has generally been incapable and ineffective. It is within the knowledge of any one who cares to investigate, that a prominent and important building of this class, in Boston, was passed as safe, after daily supervision by the department of survey and inspection of buildings, and was subsequently made somewhat safer at the demand of the public and through the intervention of other authority; and that, in less than a year, under the pressure of public opinion, stimulated by the lesson of a great disaster, it was pronounced by the same department *unsafe*, and the owner forced into an additional expenditure of many thousand dollars in order to make it safe. The record of other cities seems to be no better.

The limit of the seating capacity of a theatre, in its relation to size of site, and width, and disposition of exits, should be established by law. And the law should be sufficiently comprehensive, and administered with an amount of recognized and experienced ability, to meet the constantly varying conditions of arrangement of parts in relation to stairways, lobbies, character of audience, and other modifying circumstances, and on such matters the administration should have the weight of competent judgment.

The building act of Boston provides no special and exact rules for theatres. They are classed in general with churches and other public buildings, from which they differ very materially. The act does not even prescribe that all doors shall open outward. Certain discretionary powers are delegated to the inspector of buildings, an official whose tenure of office is uncertain, and whose compensation is entirely inadequate to insure the requisite experience and ability for the exercise of large discretion in matters so technical and important. The clause of the act requiring plans and specifications to be submitted to the inspector insures safety only so far as the examining authority shall be fully conversant with the questions at issue.

On the width of exits, a prominent English theatre architect, presumed to represent a somewhat advanced standard at the time, wrote some eight years ago that staircases of exit should be four feet in width for any number not exceeding one hundred persons, with an additional foot in width for each additional hundred, and good landings every ten steps and no winders.

A still later authority requires one foot to every one hundred people. These measurements to be at the narrowest points, which govern the whole. The proposed building act for the city of Providence, R. I. (which failed of adoption by the legislature chiefly on account of the opposition of mechanics and others interested in speculative building, although earnestly advocated by the able architects who prepared it), prescribed, with other good rules for safety, that no egress or exit stairway of such a building should be "less than five feet wide, nor aggregate a less proportion than eighteen inches for each one hundred of its inmates or spectators that such room may at any time contain." This would give twenty-two feet six inches width of exit for fifteen hundred persons, which might answer if all other conditions of safety were fulfilled, but is too narrow a limit to cover all

cases. The wording of the restriction is wise, in that it includes the audience that the room may at any time contain, which would comprise the occupants of standing-room, an additional number very closely figured by the manager, but often disregarded by the authorities.

With fifteen hundred people seated, many halls are made to hold one thousand more standing, and it is on special and holiday nights, when this jam is most likely to occur, that there is the greatest danger of panic from various causes.

There should be as strict a law against overcrowding a place of public assembly as against overcrowding a steamboat. In a conspicuous place in each division of a theatre there should be placarded the exact number it is allowed to contain, and to sell tickets in excess of this limit should be a serious offence against the law.

It should not be permitted anywhere to build a theatre on the second floor above the street, and no ordinary hall for public assemblies should be permitted more than one flight above the street.

It has been previously noted that the open gallery is more popular here than any arrangement of boxes, although proscenium-boxes, which are comparatively worthless as positions from which to view the stage, are often introduced for the convenience of the management, for the use of those who care more to be seen than to see, and as decorative features of the proscenium.

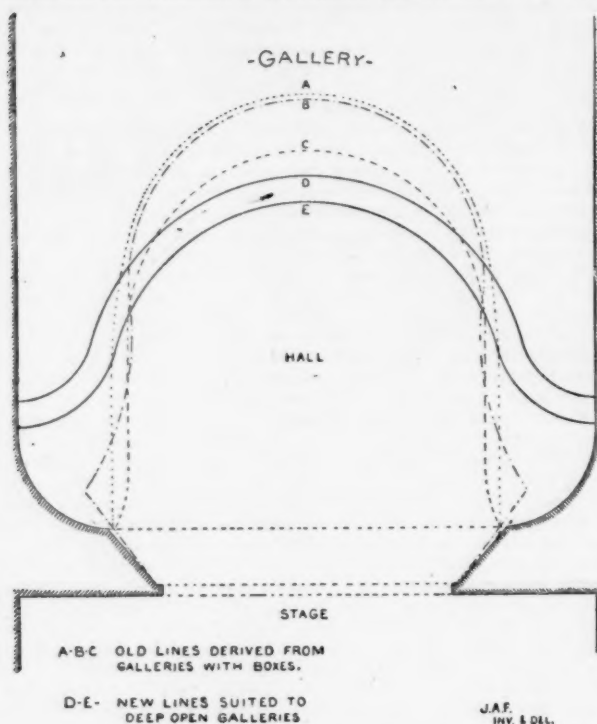
The curves of the gallery or parquet circle fronts are important matters of appearance and use, but changing so continually with the varying conditions of the size and shape of the hall, that it is difficult to lay down any rules for them. The old, elongated, horseshoe form has nearly fallen into disuse, it being serviceable only in very large auditoriums or where boxes are substituted for open galleries. The division of parts is another uncertain and variable factor. In the new English theatres the front of the parquet is occupied by very roomy seats, called the orchestra-stalls, the rest of the space being seated more closely and named the pit. The seats in the stalls sell for ten shillings and in the pit for two, although the front ones of the latter are in as good position as the rear ones of the former. The stalls are reached by going up stairs to the balcony and then down two stairways, three feet wide each, located next the proscenium. These must prove dangerous exits. There is in addition a gate through the pit railing, to be used in case of emergency; such special exits are of little avail. People naturally seek to get out where they came in, and all exits to be serviceable should be in constant use as entrances, or at least open and in full view of such entrances.

The favorite division in most American theatres is into orchestra-stalls, or parquet, which includes the space formerly known as the pit, but now considered the choicest part of the house; the parquet circle, that is, the portion of first floor under the gallery; the first gallery, divided into balcony seats, which usually include the front two rows; and the family or dress circle, which includes the rest. If there is a second gallery it generally goes by that name. The present tendency is to abandon the second gallery or to reduce its capacity to a minimum. It is the experience in small cities and large towns that the "gallery gods," when corralled by themselves, are a source of greater disturbance than when in closer proximity to the better part of the audience. Good manners are contagious as well as bad. In some of the smaller buildings the parquet circle is omitted altogether, in order to sell more seats at a higher price under the name of orchestra-stalls.

In arranging the seating of galleries there is little difficulty in the central portions opposite the stage. The less depth there is to the hall and the more there is to the galleries the sharper the pitch must be to obtain good sight lines. Too steep a pitch to the gallery seats is both awkward to look at and disagreeable to the occupants. In some cases this has been carried to such an extent as to be dangerous to the persons going to their seats. But the chief trouble lies in reconciling the back corner seats with those of the ends of the rows towards the stage. In the horseshoe form this is very difficult, and led doubtless to sloping the lines of the gallery front towards the stage. In the flatter, segmental, or elliptical curves it becomes of less importance. Perfect sight lines for all gallery seats are almost impracticable where the rows are extended to the proscenium. By perfect sight lines is meant a full view of the entire stage floor, and of the scene for its whole height, from any seat in the hall, assuming the spectators to be of average height when seated (of course exceptional cases can be provided for only in the Greek form of sitting); this standard would require that from any rear corner in the gallery a view of the full width of stage at the footlights should be had over the heads of all persons in the front row coming between such sight point and the footlight line. Such perfect provision for seeing is very rare in theatres. It can be had by stopping the galleries short of the proscenium and flattening the curve considerably, as done by the writer in the new Lewiston Music Hall. Such a change is a move in the direction of freedom from precedent that promises good practical results.

The objection to it has been the supposed architectural necessity for breaking the side walls by the lines of gallery fronts and supporting columns. The old style (adopted from the French, where it had the boxes for an excuse) introduces a circular screen of columns surmounted by a dome within the hall, and interposes this screen between a part of the audience and the stage, shutting them out also from a view of a large portion of the decorative features. The new disposition starts dome or ceiling from the side walls, throwing the

audience together and in full view of all parts of the house, and adopts the best treatment of the exposed walls consistent with their



real use. Following out the same idea, the proscenium wall, or the wing walls which cut off the useless corners next the stage, are treated as screens, and, where they are not required, without boxes.

J. A. F.

THE ILLUSTRATIONS.

THE NEW NATURAL HISTORY MUSEUM, SOUTH KENSINGTON, LONDON, ENGLAND. MR. ALFRED WATERHOUSE, ARCHITECT.

THE Index Museum, of which we copy from the *Builder* the interior, is the great entrance-hall of the new Natural History Museum in Cromwell-road, South Kensington. It occupies the centre of the building, and runs north and south. At the south end is the principal entrance, and at the north end the grand stair up to the first floor. Along the sides are deep bays, to be used as exhibition spaces, and above these are galleries which lead from the staircase at the north end to the foot of what is practically its continuation at the south end. Here the hall is spanned by a gigantic elliptical arch, carrying the staircase, which rises right and left until it reaches the summit of the arch, whence a single flight leads to the second-floor level. At each break of the balustrade, both here and at the north end of the hall, is a pedestal to carry a statue. The hall is entirely faced with buff terra-cotta, relieved by bands of gray. The mouldings of the arches, string-courses, etc., are enriched with a profusion of foliage, and much interest is awakened by the introduction of flowers, birds, and monkeys, which can be seen in the view we present to our readers. The floor is of marble mosaic. The roof is carried by wrought-iron semicircular lattice-girders, with conventional foliage inserted into the triangular spaces between the struts. A range of roof-lights runs on either side from end to end of the hall, while the flat centre of the ceiling has been decorated with a series of illustrations of plant-life on a blue ground. A general view of the new Natural History Museum was given in the *Builder* for the 4th of January, 1873, and a plan in the number for the 11th of January of the same year, together with a descriptive account. Additional particulars were given in its volumes for 1876 (p. 120) and 1878 (pp. 83 and 635). The building has been erected from the designs and under the superintendence of Mr. Waterhouse, A. R. A. Messrs. G. Baker & Sons are the general contractors. The terra-cotta has been supplied by Messrs. Gibbs & Canning of Tamworth.

THE HARVARD CHURCH, BROOKLINE, MASS. MR. E. T. POTTER, ARCHITECT, NEW YORK.

The stone-work of this church, which was completed several years ago, is Longmeadow-stone, relieved with a finish of a lighter stone.

COMPETITIVE DESIGN FOR THE FEARING LIBRARY, HINGHAM, MASS. MR. C. S. LUCE, ARCHITECT, BOSTON.

THE CONSTRUCTION OF MILL ROOFS. — A VIEW OF A ONE-STORY WEAVING MILL.

Our correspondent E. A. kindly furnishes us with these illustrations of the method of mill-building which he advocates. Of the diagram showing the construction of the roof he says: —

"The most common failure to meet the requirements of the Boston Manufacturers' Mutual Fire Insurance Company happens in respect to roofs. In our judgment the best and safest roof is one constructed of two and one half or three inch plank, covered outside with any of the approved compounds or with metal. The apparently excessive thickness of the plank is essential to safety, as there is always a better chance to save property before a roof is burned through than after; it is also essential to the stability of the covering, whatever it may be; it serves to keep the upper room warm in winter and cool in summer, and it checks or prevents the condensation of moisture on the inside. It may also be added that there is more reason for strength in roof construction as the weight of wet snow one foot deep is about double the weight per square foot of surface of the looms, stock, and operatives, as usually placed on a weaving-room floor. Attention is called to the open cornice with the ends of the beams constituting the brackets. A boxed cornice of wood is a common, unsightly, and useless cause of danger. No gutters are required."

Of the one story mill, to which he refers in another column, he says: —

"The mill is rather more expensive than a mill having an equal amount of floor space built in three stories. Such a mill would be about 28 feet by 52 feet on each floor. The difference in expense of the building, however, would be more than made up in the advantages gained in the one-story mill. The first cost of the one story mill would be a little more, on account of the amount of roofing and foundations. The difference in cost, however, would probably be made up in a large mill, because in a one-story building all the labor of raising materials to the upper stories would be saved. The great advantage of the one-story mill is in having a more solid floor than can be had in any other mill above the first floor. Some of the machines weighing four or five tons have their greatest motion some distance above the floor, thus causing great vibration of the floor, so that the floor must be very solid. The advantage in the greater amount of light in the one-story mill is especially to be noticed in this mill, as the parts of the machines which used to be lighted are somewhat underneath and shaded from the light by the upper parts of the machine, so that the light ought to be stronger than can be got from side windows above. In the knitting-machines a strong light is necessary for arranging the needles. The handling of the work in the one-story mill can be much more conveniently done. In the old mill the work is done in passing the material from below to the top. The work is begun in the basement and the goods are finished at the top, then they all must be sent down again. In the new mill all this may be saved. This mill was built for a particular purpose, the parts of the stockings being made in the old mill, and put together in the new one. The overseeing is less necessary in the new mill. In the old form of mill an overseer is needed for each floor; in the new one only one overseer is needed. The heating of the building is made much easier, as the amount of window space being larger, the sun has more effect in heating the room. In this mill only three steam pipes are necessary, around the walls; the number which would usually be put in is four. The gain in light is so much that the gas is lighted one half hour later every day."

The mill here shown is 85 feet by 52. The flooring is supported on transverse girders 12 inches by 14, ten feet on centres, and between each pair of girders is a joist 6 inches by 14, running parallel with them. Girders and joists are supported on dwarf walls. The roof is framed as shown in the diagram, the rafters being also 12 inches by 14 and ten feet on centres, — their upper ends being supported by columns rising from the floor below.

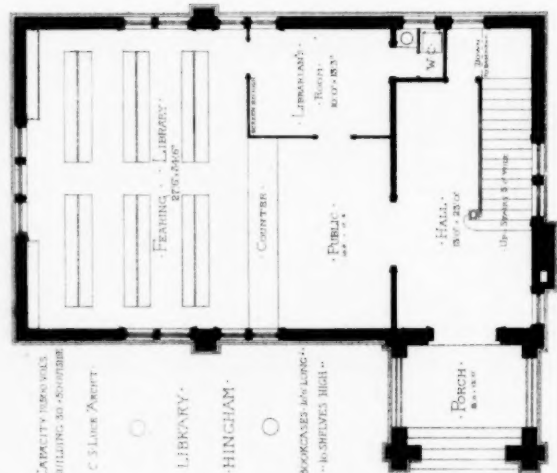
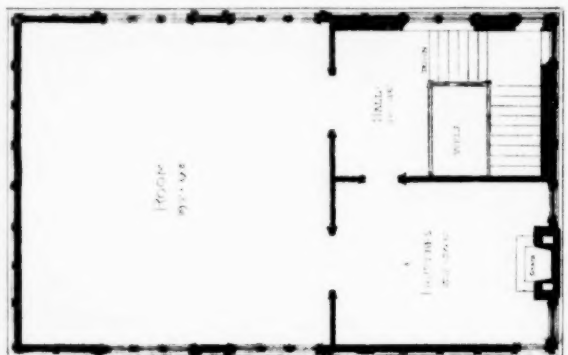
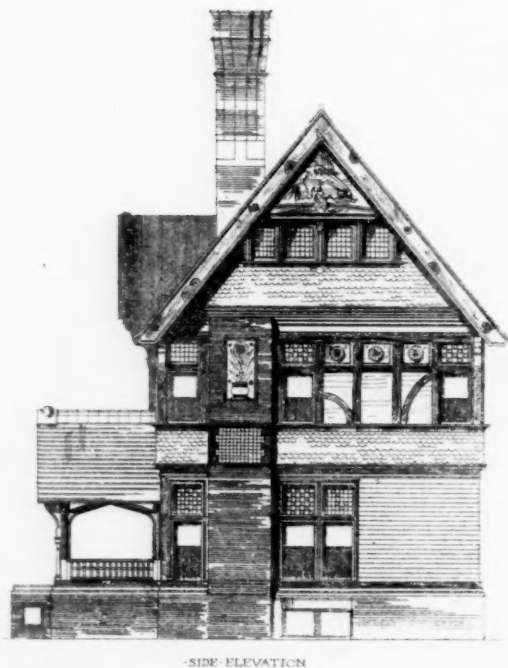
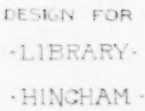
CORRESPONDENCE.

THE CHICAGO CITY-HALL INVESTIGATION.

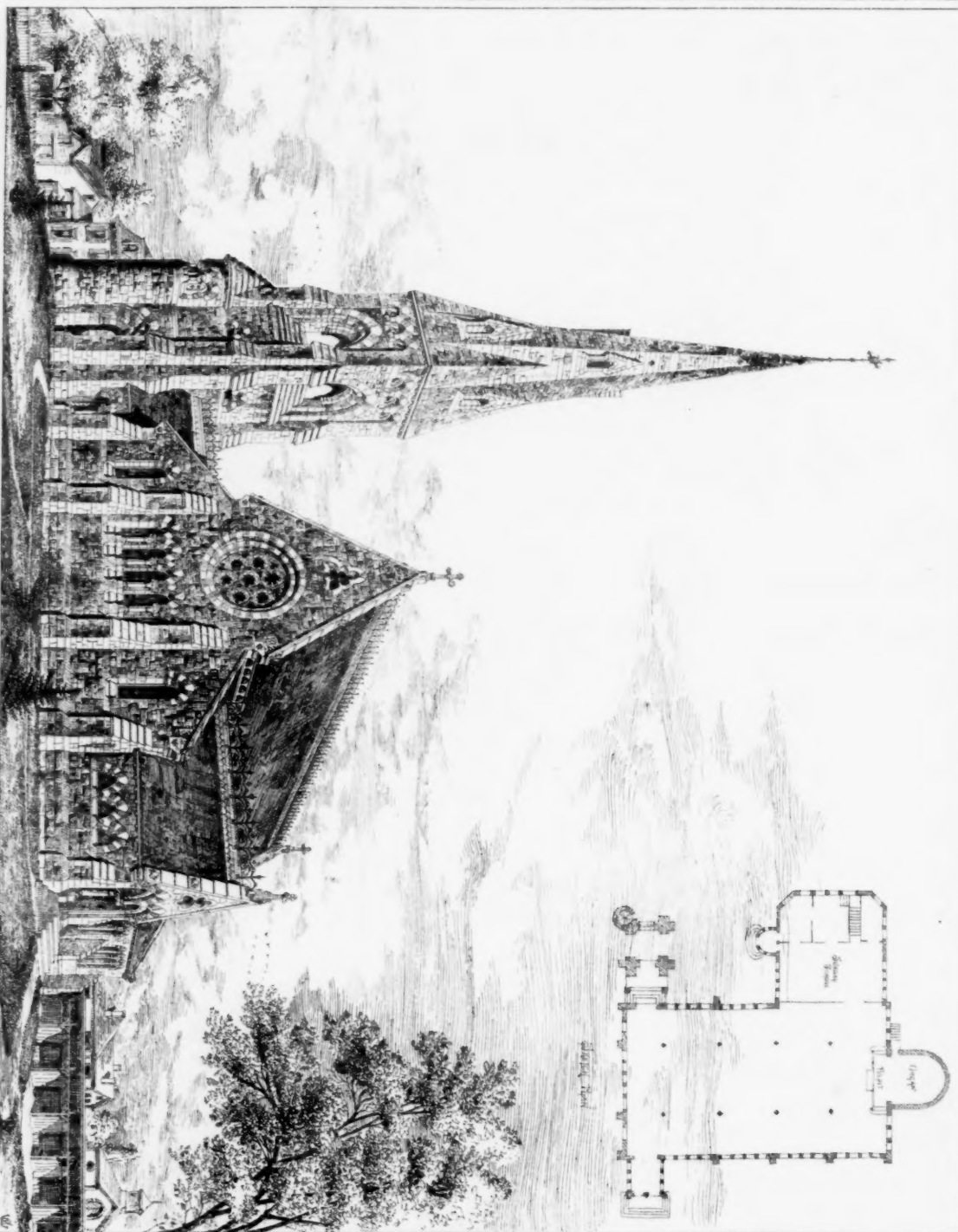
CHICAGO, July, 1879.

The construction of the new city-hall is now the subject of an "investigation," the occasion for which is twofold. In the first place it must be borne in mind that last spring witnessed a political change in the government of the city. A Democratic mayor and council succeeded a Republican mayor and council. A Democratic building committee succeeded a Republican building committee. Mr. Chesbrough, Republican Commissioner of Public Works, was succeeded by Mr. Waller, a Democrat. Mr. L. D. Cleaveland, who has been three years Superintendent of Buildings, was succeeded by Mr. Kirkland. Both of the latter are architects by profession. Mr. Cleaveland, by virtue of a clause in the ordinance creating a department of buildings, which required the superintendent to "perform such other services as might be required," had been compelled by the last mayor to virtually become the architect of the city-hall without additional compensation. Mr. Kirkland also succeeds him in the performance of these functions.

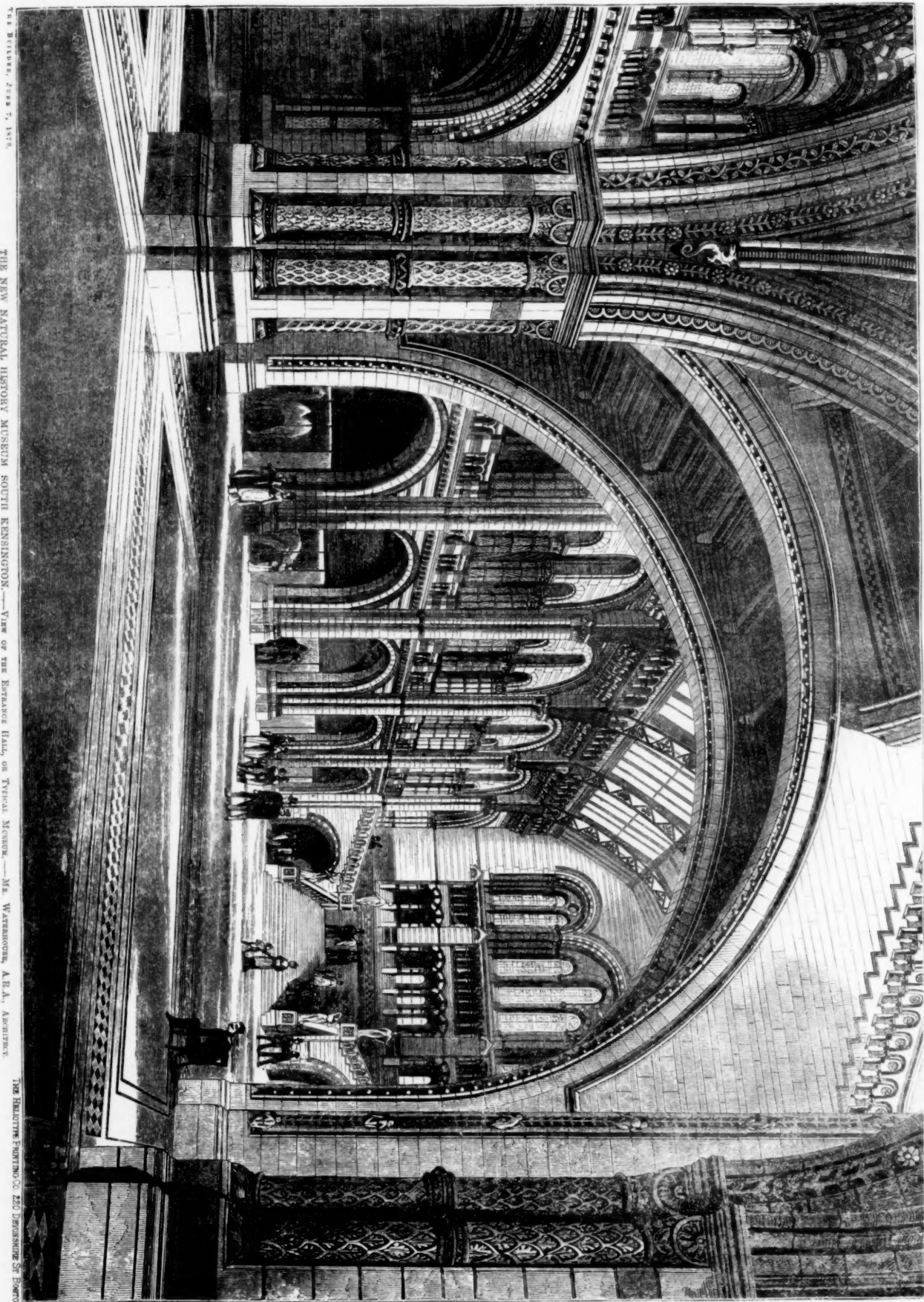
Beside the usual new broom business there is a labor trouble. The Stone-Cutters' Union of this city is an eight-hour league. The contractors for stone-work refused to accede to the eight-hour plan, and employed outside parties to work ten hours. The Union struck. The contractors then employed men to cut the stone at Bedford, in addition to such as they might obtain in the city. The striking stone-cutters had plenty of leisure to look about the building, and this sug-



— HARVARD —
— CHURCH —
— BROOKLINE — MASS —
— E. T. POTTER ARCHT —



THE ILLUSTRATION PRINTED BY THE NEW YORK OFFICE OF THE ARCHITECT



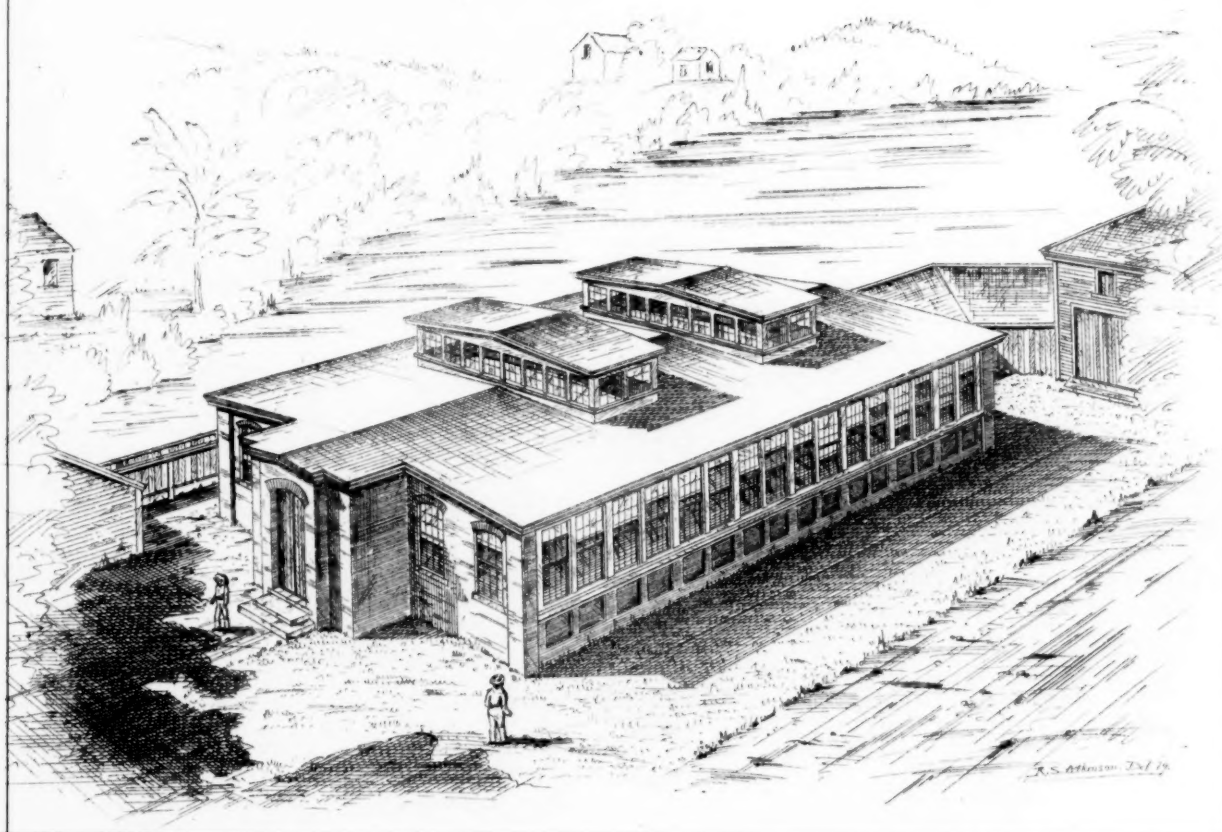
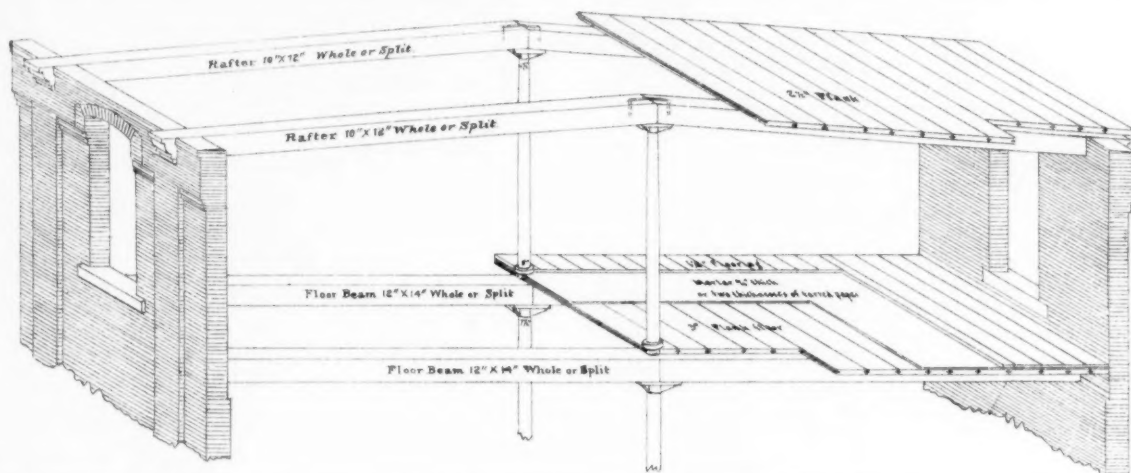
THE BUILDING, 1858-59.

THE NEW NATURAL HISTORY MUSEUM SOUTH KENSINGTON.—VIEW OF THE ESPANADE HALL, OR TYPICAL MUSEUM.—MR. WATERHOUSE, A.R.A., ARCHITECT.

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ONE STORY MILL, DESIGNED BY W.H.H. WHITING, ESQ.

gested to them that they might use new tactics to bring their employers to terms. This was some time in the latter part of June. So they constituted themselves volunteer superintendents, or rather critics of the work.

They told the reporters of the daily papers that the work was badly done, the stone poor and uneven, full of holes, which had been stopped with cement, and full of frost cracks which had occurred during the winter. This led to a public agitation and considerable discussion. But not satisfied with this, the stone-cutters, through their spokesman, Alderman Lawler, brought the matter up in the City Council, and the result was that the board requested the mayor to appoint an investigating committee of experts.

The new mayor, Carter Harrison, appointed as such committee John Adair McDowell, superintendent of the new custom-house; O. L. Wheelock, architect; L. B. Dixon, architect; John M. Dwyer, mason; and James Batchen, stone-cutter. It is said that all the experts are Democrats except the first-named.

After spending considerable time in examination and consultation, the committee reported on the 28th of July to the mayor. They state the charges made against the building to have been as follows:—

First. That the stones are inferior to sample, not being of uniform color, and being rougher in texture, having cavities filled with stopping, and deficiencies of size and shape supplied by patches.

Second. That the stones are not always laid on their natural beds, and have not the bonds and joints required by the specifications.

Third. That the anchors specified in the contract are not used.

Fourth. That all the stone-cutting is not done in the city of Chicago as required by the contract.

Fifth. That the stone-work is carried up too far in advance of the brickwork, contrary to the requirements of the specifications.

The following extract will show their conclusions on these points.

In support of the first charge, your committee finds, besides these patched, cracked, or filled stones, 257 inferior or defective stones now in place in the building. One hundred and twenty-five of these should have been rejected. Of the fifty-two patches, thirteen are bad patches. Either should not exist, and are not workmanlike.

Of the 457 cavities and deficiencies in faces of stones filled with "stoppings," the larger proportion are small spots, half an inch square or more of surface, and forty-six are four square inches of surface or more, and varying from that size to forty inches of surface.

Of the twenty-three cracks, eight are deemed bad, and of these eight three are very bad.

In support of the second charge, your committee finds ten stones not on their natural bed that should have been so set; these of the blue cast stones, which show rift or cleavage; also forty bad joints, resulting from unevenness of the stone in thickness or length; and five stones that should be reset.

Under the third charge, "That the anchors are not according to the specifications," your committee finds the anchors are not galvanized, but covered with coal-tar varnish, nor are these of the dimensions shown or required by the plans.

The fourth charge, "That all stones have not been cut in the city of Chicago," is not denied.

Under the fifth charge, your committee finds that the stone-work has been carried up in advance of the brickwork from six to fourteen feet, and the varying courses of stone protrude inwards for the brickwork bond from six inches to thirty inches.

Besides the stone in the building, your committee examined the stone on the ground.

Of the 376 delivered up to July 9, ten had been condemned by the inspector. Five of them were inferior. One was cracked. Seven were patched and thirty-three were filled in places with "stopping."

These facts substantially sustain the charges made as herein summarized.

These statements are not very clearly made, and therefore I make no attempt to summarize them. But by way of explanation the committee has made a tabulated list of the defects and deficiencies; and, comparing them with the superintendent's list of stones delivered and set, shows that there are 844 defective stones out of 4,638. They say that there are 50,000 cubic feet of stone in the building, and make the not very clear statement, "Defects to cubic feet therefore stand about one to sixty-one, or one to every sixth stone." They then say, "This represents the proportion of total defects, large and small, to the whole number of cubic feet in the building. But, as before stated, some of these defects are small. Hence, to give as fair a showing as possible, if we take those defects considered bad, we have the following showing:" the summing up of the table shows 241 "bad" defects, which is quite a considerable reduction, little more than a quarter of the whole. "These," they say, "make the proportion of bad defects one to every 208 cubic feet, or nearly one to every twenty-one stones now in the building." What can be demonstrated by showing the proportion of defective stones of a building, many of which contain from 50 to 100 feet, to the total number of cubic feet, is more than I can understand, but which perhaps the committee can explain.

The committee adds that "none of the defects enumerated above are excusable in good building" (but do not say whether they refer to the "small" or "bad" defects). "Nor are they warranted by any terms or any fair construction of the contract and specifications. They do not believe that these defects will be the cause of the destruction of the building in the near future. Yet they are not consistent with good building of any kind, and far less with one of the magnitude and character of a city-hall of Chicago."

The brickwork is rather gently handled. Still the committee say that the bricks are not all "sewer" bricks as specified; that they have not been laid with "sufficient wetting or slushing," and that the brickwork is far behind the stone-work. But they add that the defects in this department "are not so alarming as they have been stated to be."

The committee makes the charge that Mr. Cleaveland used two sets of plans for the exterior stone-work, the one more elaborate than the other, and that the work is done according to the least elaborate plans. This is a serious charge to make against the architect in charge; but it is so vaguely and clumsily stated, being capable of construction as an admission that a large amount of money was saved thereby instead of being lost, that in justice to the committee I will not quote it, but let Mr. Cleaveland explain the matter himself, which he and Ex-Mayor Heath did subsequently in the course of interviews published in the *Chicago Tribune*.

The committee report a deviation from the plans in a reduced thickness of the granite water-table. But this water-table was all set and covered up six months ago. At that time attention was called to its deficiency in thickness by the Lemont stone-men, who had not succeeded in getting the contract, and many stones which were not of the thickness required were taken out and replaced.

The main charge which seems to have been sustained is that the bond-stones, which were marked on the elevations of the basement and first story in the smaller piers, were not used, but that these stones were only made a little wider on the beds than the contiguous ones. It is claimed that these stones were to have gone entirely through the walls, though there seems to have been some discussion between the contractors for stone-work and brickwork, on the question whether or not the bond-stones were to be continuations of the facing-stone or separate bond-stones in the brick backing. In the latter case they would have been included in the contract for brickwork. The walls in these places are about five feet thick in the basement, and require about three and a half feet of brick backing. The experts say that 150,000 extra bricks were required to fill the places which should have been occupied by bond-stones, the number of cubic feet of stone omitted being 6,666.

The experts say in general terms that "the orders of the superintendent and condemnation of the inspector are not observed; and instead of the superintendent having been what the contract said he was to be—the director of the work and arbiter in all cases of dispute—it seems that some higher power has interfered with his work, and changed his plans and countermanded his orders." But no facts are adduced in proof of this, it seeming to be an inference from the fact that the plans in relation to bond-stones were not adhered to. They say also that they found it difficult at first to get at the facts now covered up by the progress of the work, except for the aid given by some citizens who had been looking over the work. These "citizens" seem to have been the striking stone-cutters; but Mr. Walker, the contractor for Lemont stone on the county building, who also bid for the work on the city-hall, has since publicly stated at a meeting of the building committee that he has continuously, "in his capacity as citizen and tax-payer," watched the progress of all the stone-work on this building.

The *Tribune* has published a long interview with Mr. Cleaveland. He says that the bond-stones were not left out, but that they do not go through the wall; that the plans were not altered. After the city purchased copies of Egan and Hill's design for the exterior of the county building, a new set of elevations was made, in which the stone-work was simplified and much expensive detail work left off; that all the stone-cutters figured on these plans, and that the contract is being executed under them. He admits that there are sand-pockets in the stone, and that they were filled up, but that they were very small holes, which might as well have been left unfilled. He admits that a few stones were patched, which had been mutilated after they were cut. He says that the anchors are generally longer than the specifications call for, and that in consideration of the contractors furnishing larger ones, they were allowed to cover them with coal tar in place of galvanizing them. He admits that the brickwork was carried up slower than the stone-work, as the brick contractor was not working up to time and the stone-contractor was, and therefore he did not want to delay the building by stopping the stone-work, which would give the stone-contractor a claim for damages against the city. He thinks the average thickness of stone-work is greater than that called for, all of which decreases the amount of brickwork required, sufficiently off-setting any claim for extra brickwork, due to the omission of bond-stones. He also admits that sewer-brick were called for, and that the bricks used are not all of that grade, but most of them are. Mr. Cleaveland thinks that the report contains misrepresentations and exaggerations intended to prejudice the public against the building unjustly. He says that it contains nothing to the credit of the building at all. He considers that the investigation is inspired by the stone-cutters, because the contractors would not accede to their demand of eight hours for a day's work; that an influence had been brought to bear all through the progress of the work to substitute something else for Bedford stone. He says, "Judging from what I see in the newspapers, there has been a great influence to substitute Lemont stone for Bedford."

The same paper publishes interviews with Mr. Jordan, the assistant superintendent, and others, who were on the building committee when the contracts were made. They are similar in tenor to Mr. Cleaveland's.

The report was read in the Common Council and referred to the present building committee, with order to report on the 4th of August.

Meanwhile the mayor has called on the experts for more light, and they have replied with commendable alacrity. The following are his questions:—

First. Whether, in your opinion, the sand-holes in the stone will materially weaken the building or not?

Second. Whether the failure to lay a number of the stones on their natural bed will weaken the building or not?

Third. Whether the neglect of the contractors to furnish the anchors according to the specifications will have a tendency to impair the stability of the building or not, and, if so, how far?

Fourth. Whether the failure to carry the brickwork up along with the stone-work has caused such damage as to weaken the building materially or not?

Fifth. Whether you believe that the defects will ultimately cause the destruction of the building or not, and, if not, what is meant by the "near future"?

Sixth. Whether the failure of the contractor to supply all the sewer-bricks, and to wet and slush those used sufficiently, will endanger the building or not?

Seventh. Whether the failure to have the stone have a width of bed less than one half its build or height endangers the building or not?

Eighth. Whether the piers in which no bond-stones have been used should be torn down or not, and, if not torn down, should they be strengthened: or is the building safe without these bond-stones?

Ninth. Whether with all the defects and omissions noted by you, it will be safe to finish the building, provided hereafter the work and materials be good.

Yours respectfully,

CARTER H. HARRISON, Mayor.

The reply of the experts is as follows: —

First. They will not materially weaken the building, and were noticed by your committee because they were blemishes that placed such stones far below the requirements of the contract, and were inferior to the samples.

Second. Not necessarily. Where such stones are to sustain great weight, or are material to the supporting principles of the building, they do. Where they are only ornamental facings they do not.

Third. To the building as now constructed anchors as shown on the plans are important, and in event of uneven settlements positively essential. If the stones in the wall were of sufficient width of bed, and length of bond, and built up with the backing, no anchors would be needed. In reply to the latter part of the question, "If so, how far," your committee feel that to give a definite reply to this question would be assuming a knowledge impossible to acquire save by destroying, dissecting, and analyzing the entire structure, its foundations and their underlyings. The superficial view of the walls taken by your committee and the partial knowledge of their internal deficiencies, as discovered by them and reported to your Honor, is entirely too partial a basis for calculating the problem your Honor's question proposes. Even with all the knowledge possible, any answer to such a question would be only an approximation.

Fourth. This failure is not now a cause of damage, but is a deficiency in what was intended as a compound wall of brick and stone, and which wall, as now constructed (with anchors as proposed), is mainly dependent upon the brickwork for its strength. Hence an inherent weakness.

Fifth. Your committee are of the opinion that if this building is not destroyed by some convulsion of nature, or torn down for its site upon which to erect some better building, that these defects will "ultimately" cause its destruction. Simply this: a building properly and carefully constructed, of good material, will outwear one poorly put up and of inferior materials. The plans and specifications of, and the contract for, a building, either mean something or they are useless papers.

Sixth. The insufficiency is not so much in the brick as in the mode of laying them, and the wall is not as good in this respect as it should be; every defect more or less endangers the permanence of a building.

Seventh. The last clause of the answer to question No. 6 applies here.

Eighth. Your committee are of the opinion that the lesser piers, or piers between windows where there are no projecting piers, should be torn down and the bond-stones supplied as per plans, or rebuilt of dimension stone entirely.

Ninth. Your committee feel that more time would be required to answer this question fully, than can now be taken. Your Honor will see that it is a very broad and sweeping one, and that it is hardly fair to your committee to expect of them a reply so comprehensive in so brief a time. Still we do say that an independent, responsible, and fully empowered superintendent could make such additions and alterations besides the ones before spoken of, the bond-stones and small piers, and the filling up of the spaces or flues with concrete, as proposed by Mr. Kirkland, as would make it safe to continue the construction.

Very respectfully,

JOHN A. McDOWELL.
JOHN M. DUNPHY.
O. L. WHELOCK.
L. B. DIXON.
JAMES BATCHELOR.

The concluding remarks in the answer refer to a private report made to the mayor by Superintendent of Buildings Kirkland, which has not been printed. I infer from the wording that he has recommended filling the hollow spaces in the external piers of basement and first story with concrete. These piers are like buttresses and support the coupled columns commencing at the second story, which carry practically nothing, as they are outside of the wall line. Mr. Cleveland made them hollow to save unnecessary weight on the foundations and about 1,000,000 bricks.

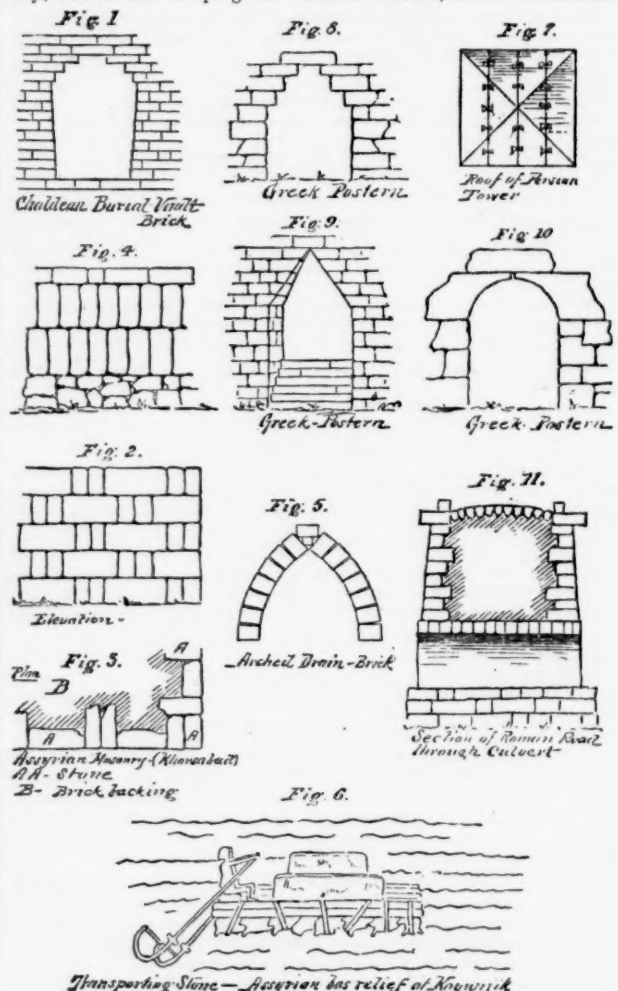
It may be added by way of explanation that the lawful and responsible head of all building operations conducted by the city is Mr. Waller, Commissioner of Public Works. The duties of this office devolved upon Mayor Heath at the time the building was commenced. Subsequently Mr. Chesbrough, city engineer, assumed the duties of commissioner, and he was succeeded by Mr. Waller, the present incumbent, about two months ago. The Common Council can only act in an advisory capacity.

The dome "foundation" which the county had erected has now been razed to the ground, and a contract has just been made for the construction of the connecting rotunda between the two buildings.

SOME FEATURES OF ANCIENT ENGINEERING.¹

MODERN research among the ruins of antiquity is steadily relegating to the old civilization many things that we formerly thought belonged only to modern times. Almost all the *materies* of our present civilization originated among the ancients, the peculiar distinction of modern times being the wider and more rapid diffusion of our inher-

itance from the past and the working it over into new forms. The various textile fabrics of cotton, linen, silk, and wool that we now use, for example, were perfectly well known to the Egyptians of 4000 years ago; but the cotton-gin, the power-loom, and the steam-engine have increased their forms and variety, and put them into the hands of every one. We find the same thing true of engineering science. Canals, artificial harbors, stone bridges, aqueducts, drainage systems, high class roads, involving cuttings, embankments, and tunnels, and stone, brick, and wooden building construction of all varieties existed then as now; but the modern engineering methods differ widely from those employed by the ancients. The ancient harbor of Ostia, a magnificent work, protected from the sea triremes and craft well adapted only for navigation in the Mediterranean, while the stone docks of Liverpool harbor the ocean steamer and the enormous iron-clad man-of-war. The substructure of the modern railroad is very much the same as the old Roman military road, but in our hands its scope and efficiency have been vastly increased. A recent engineering achievement, the transport of an Egyptian obelisk from Alexandria to London, and its erection on the Thames embankment, illustrates very well, I think, our indebtedness to antiquity, and not less our progress. That we should, in this nineteenth



century, reërect, with pomp and ceremony, a monument set up in Egypt ages ago, is the strongest kind of a compliment to the ancients. It may well be doubted whether our successors of twenty-five centuries hence will think any of our efforts of this kind worth carrying 4000 miles and reërecting. Of the manner in which it was accomplished — the iron caisson-like boat, so admirably designed; the ease with which it was swung on its iron trunions and placed on its pedestal — we may justly feel proud; still the fact remains that the *fait accompli* the end reached, was the same as that of its original designer. How the Egyptians raised their obelisks we do not yet know, beyond the fact that they were familiar with the simple machines, the inclined plane, etc.; understood the use of cordage, and had command of unlimited manual labor in the shape of captives taken in war.

We should naturally expect to find the constructive uses of the simpler building materials, stone, brick, and wood, highly developed among the ancients, and this we find to be the case. In this direction I shall consider, first, the structures found in Western Asia.

The earliest civilization in this region of which we have any records was the Chaldean, and was central in the lower part of the Tigris-Euphrates valley. This region is alluvial in character, with no stone, but abundance of clay, and was subject to frequent inunda-

¹ Portions of a paper by George Burnham, Jr., C. E., read February 15, 1879, before the Engineers' Club of Philadelphia.

tion. The building material, consequently, was mainly brick, and the important structures were built on platforms raised above the general level of the plain. The temple at Mughier was built with parallel sides of 98 feet and 133 feet in length, and about forty feet high. The material used was small sun-dried brick, laid in bitumen, faced with kiln-dried brick. The bricks of the upper story were laid in a cement of lime and ashes. The bricks used in this and similar structures were stamped with the name of the king. In the uppermost story glazed tiles and copper nails have been discovered. The temple of Abu Shahrein (these, of course, are modern names) rests on a platform of beaten clay, cased with a massive wall of sandstone and limestone, 20 feet thick in places. From the platform to the summit of the first story extends a marble staircase, composed of small polished blocks, 22 in. $\times$ 13 in. $\times$ 4½ in., fastened by copper bolts to the bed of sun-dried bricks, on which the staircase rests.

Of these edifices Rawlinson says: "No buildings in the world, not even the Pyramids, are more deficient in external ornament. The buttresses and air-holes, that alone break the uniformity of the walls, are intended for utility only." A brick burial vault at Mughier is interesting, as exhibiting what we may call a rudimentary arch. The vault is of sun-dried brick, laid in mud, seven feet long, three feet seven inches wide, and five feet high. The sides slope gently outwards as they ascend, until the springing line is reached, when the successive layers of brick are pushed towards each other until they meet.¹

The Chaldean ascendancy in the East lasted from about 2200 to 1500 B. C., after which time the Assyrians became masters of the situation, remaining so until about 650 B. C. The centre of activity now advanced to the upper portion of the Tigris-Euphrates valley. At Nineveh, according to Diodorus, the wall surrounding the city was 100 feet high, and so broad that three chariots might drive around side by side. Xenophon, who passed close by on his famous retreat with the ten thousand, puts the height at 150 feet and the width at 50 feet. The actual greatest height of the ruins at present is 46 feet, and, from the immense mass of debris, the computation of Diodorus is probably not far from the truth. The width of the crumbled mass is from 100 to 200 feet. The construction seems to have been as follows: up to a certain height (50 feet, according to Xenophon) the walls were composed of neatly hewn blocks of fossiliferous limestone, smoothed and polished on the outside. Above this the material was sun-dried bricks. The grand halls of the Assyrian palaces constituted their principal feature. In the palace of Esarhaddon, the son of Sennacherib, the hall was intended to surpass all its predecessors. Its length was to be 165 feet, its breadth 62 feet, making an area of over 10,000 square feet. The builder appears to have been unable to roof the hall, and was obliged to divide it by a wall down the middle, which, though he broke it in an unusual way, and kept it some distance from the ends of the apartment, still had the actual effect of subdividing the room. The method of roofing these palaces is not certainly known; some investigators holding that brick vaulting was used, while others think that wooden beams were employed. Others, again, imagine that the portions near the walls, only, were covered, leaving the centre open for light and air.

The masonry at Khorsabad was of three kinds: That of the palace mound, forming a portion of the outer defence, was composed entirely of stone, square hewn, of great size, laid dry and backed with brick. Figs. 2 and 3 show an elevation and horizontal section of this wall. The bond is made up of stretchers, alternating with double-headers; the reinforced corner and the bonding of the stone into the brick backing are points worthy of notice. The stones measure from two to three yards in length, three feet in width, and five to six feet in height.

The rest of the defences were of inferior character. The material was stone, but not so carefully hewn. The third kind, illustrated in Fig. 4, was found outside the main wall. Stone only was used, the lowest course being rough rubble-work; above this were two courses of carefully squared stones, about one foot long and six inches wide, placed on end, care being taken to break joints.

Although the ancient architectural construction was mainly trabeate in its nature, the old notion that the round arch was of Roman and the pointed arch of Gothic origin has been dissipated by the spade of the Eastern archaeologist. I have already spoken of the elementary arch of the Chaldeans, but the Assyrians used the true arch. All the Assyrian arches hitherto unearthed are of brick. Round arches are found both in crude and kiln-dried material, the bricks, in every case, having the proper wedge-shape section, with curved extrados and intrados. These arches are almost wholly found in underground construction, as drains, etc., the greatest span hitherto discovered being fifteen feet. They are mostly semicircular. The only pointed arch found by Mr. Layard is in a drain under the N. W. Palace of Nimrud, and is very peculiar in its construction. The bricks used are ordinary rectangular brick, laid as in Fig. 5. The arch is keyed with two layers of brick with their beds horizontal. The mortar joints are, of course, slightly wedge-shaped.

The faults of Assyrian construction are not less interesting than its merits. Although there was plenty of stone at hand, they used sun-dried brick, merely faced with stone, because they had learned a certain style in the alluvial Babylonia, and having brought it with

them to a country far less fitted for it, they raised in comparatively hilly Assyria the type of building that was the natural outgrowth of the flat, stoneless plain that was their primitive abode. The earthen platforms upon which they built must inevitably have bulged and settled sooner or later; the problem of the retaining-wall that still troubles the engineer proved fatal to many an Assyrian constructor.

Hence, while the massive buildings of Egypt stand to-day, the Assyrian palaces are almost shapeless ruins. That the Assyrian king so frequently destroyed the palace of his predecessor, and built afresh, is probably due to the rapid decay of the edifice rather than a mere desire to excel his forerunner. That they found no difficulty in transporting large stones is evidenced by their bas-reliefs. Fig. 6, taken from a bas-relief at Koyunjik, shows a boat loaded with such freight proceeding down a river. The lower part of the craft is made of inflated skins, to which are lashed logs for the flooring.

The colossal human-headed bulls, of such frequent occurrence in Assyrian art, and which weighed many tons, were placed on the top of artificial platforms, from thirty to eighty feet high. The fact that they finished the detail of the statue before transportation shows that they were perfectly confident of their ability to move it without mishap. An Egyptian sculpture near El Bersheh shows a colossal statue in process of transport. On the knees of the figure stands a man, probably beating time and giving out the words of a song. At the prow of the sledge a man is pouring something from a vase, perhaps grease. Platoons of soldiers accompany the march. A number of men are delineated carrying water (or possibly grease) and unknown implements. Task masters and reliefs of men follow. We have seen that the Assyrians, who came into power 1150 B. C., knew the brick arch, but we find that it existed in Egypt as early as 1540 B. C. The stone arch is found there, constructed about 600 B. C.

The last rulers of Western Asia, before the advent of Alexander, were the Persians, from 553 B. C. to 333 B. C. These Aryan Persians did not follow their Semitic predecessors in all their architectural forms, but originated a style that is suggestive of the Greek, using the column very largely.

A curious edifice, belonging probably to the later Archæmænian times, is a square tower, composed of large blocks of marble cut with great exactness and joined together without any mortar or cement of any kind. The building is thirty-six feet high and twenty-four feet square. The doorway is not at the bottom, but half-way up, and must have been reached by a flight of steps. The most interesting feature, however, from our point of view, is the roof, which consists of four large slabs of stone, reaching entirely across from side to side and measuring about twenty-four feet in length, six feet in width, and from eighteen inches to three feet in thickness. The slabs are cut to slope each way from the diagonal lines, and were originally clamped together in a very careful manner by iron clamps. This construction is shown in plan by Fig. 7.

I shall pass by Egyptian stone-work, not because it is less worthy of notice than that of Western Asia, being, on the contrary, much more remarkable, but because for that very reason it has been more generally discussed, and you are doubtless familiar with its general character. As to the mechanical methods used, however, a few words may be of interest. In blocks of very great length, as the columns at Fateeh, which are about sixty feet long and eight and one half feet in diameter, certain pieces of stone were left projecting from the sides, like the trunnions of a gun, to which the ropes were attached. The largest of the obelisks, which is at the temple of Karnak, weighs about two hundred and ninety-seven tons, and was brought about one hundred and thirty-eight miles from the quarry to where it now stands, and those taken to Heliopolis passed over a space of about eight hundred miles. The method employed was the same as that already described in the case of the colossus. The skill of the Egyptians was not confined to the mere moving of great weights. Their knowledge of mechanism is shown in the erection of the obelisks and in the position of large stones raised to a considerable height and adjusted with the utmost precision; sometimes in places where the space will not admit of the use of the inclined plane. Some of the most remarkable are the lintels and roofing stones of the large temples, the lofty doorway leading into the great hall at Karnak being covered with sandstone blocks forty feet ten inches long and five feet two inches square. In one of the quarries at Syene is a granite obelisk which, having been broken in the centre after it was finished, was left in the exact spot where it was separated from the rock. From the dimensions of the quarry, and the situation of the stone, it must have been lifted bodily, as was the case also with the other stones taken from the same quarry.

Among the most famous feats of ancient military engineering were the canal and bridge of Xerxes. On account of a former disaster to his fleet in rounding Mt. Athos (a stormy promontory resembling our Cape Hatteras in this particular, and which Greek sailors still dread to pass), Xerxes determined to cut through the peninsula by a canal twelve furlongs across, the neck of the peninsula being comparatively level. The work was done by the neighboring peoples, each nationality doing a certain portion. Herodotus, who seems to have been a historian with considerable engineering sense, says: "The sides fell in continually, as could not but happen, since they made the width no greater at the top than it was required to be at the bottom. The Phenicians, however, showed their usual skill by making the part assigned to them twice as wide at the top as it was required to be at the bottom." The other work that I have mentioned was a pontoon

¹ Compare Figs. 8, 9, 10, representing early Greek construction.

bridge across the Hellespont from Abydos to Sestos, for the transport of his enormous army. The channel at this point is about one and a half miles broad. A storm having destroyed the first bridge, Xerxes gave orders that the Hellespont should receive three hundred lashes, and that a pair of fetters should be cast into it. Herodotus says that the lashers uttered these words while scourging the Hellespont: "Thou bitter water, thy lord lays on thee this punishment because thou hast wronged him without a cause, having suffered no evil at thy hands; verily, King Xerxes will cross thee whether thou wilt or no. Well dost thou deserve that no man should honor thee with sacrifice, for thou art in truth a treacherous and unsavory river." While this interesting ceremony was in progress, he likewise commanded that the overseers (engineers?) should lose their heads—a fate that should reconcile the engineer of to-day to his lot.

I shall treat very briefly of the Roman works, as these are well known. The Cloaca Maxima or great sewer of Rome, ascribed to the last three kings, i. e., about 520 B. C., is still preserved for a distance of one thousand feet, and still conducts the drainage from the Capitoline and Palatine hills to the Tiber. It is probable that the Etruscans were the designers of this and other early Roman works, as this remarkable nation was already far advanced in civilization when the Romans were ignorant rustics. An arched vault of tufa, with arches of travertine inserted into it at intervals of ten feet, covers the canal, which is about twenty feet wide. The original height was twelve feet, now reduced to from six to seven feet by silting, in spite of frequent cleanings. To prevent inundations or reclaim arable lands, lakes and marshes were drained by works called emissaria. These were either open or covered, and involved, in some instances, a considerable amount of tunnel work.

The drainage of Lacus Fucinas, which was subject to dangerous inundations, was planned by Cæsar but not executed until the time of Claudius (9 B. C.—54 A. D.). The whole basin was laid dry; this being effected by a shaft cut through the solid rock from the lake to the river Liris (now Garigliano), which discharges into the Mediterranean. The tunnel was 15,000 Roman feet in length, 9 feet wide, and 14 feet high. Vertical shafts were sunk for the removal of the debris, and inclined shafts for the ascent or descent of the workmen. The solidarity of the Roman Empire allowed the construction of roads that would not have been possible in disconnected Greece. The nature of the ground was almost wholly disregarded as influencing the alignment of the road. Mountains were cut or tunnelled, depressions filled, deep valleys or rapid streams spanned by bridges of bold design.

Of tunnels I will mention the so-called Grotto of Posilippo, near Naples, which is still used. It is 2,300 feet long by 20 $\frac{1}{2}$ wide, arched at both ends, with spans of 81 and 84 feet. The material pierced is solid rock.

ONE-STORY MILLS.

TO THE EDITOR OF THE AMERICAN ARCHITECT:

Dear Sir,—I send you herewith a picture of a one-story knitting mill, for which the plans were made by our Mr. W. H. H. Whiting. It meets the necessary conditions of the work in the best manner.

It would be interesting to have some of your contributors give "architectural effect" to this building without impairing its use or making it dangerous. A good example of such work would enable us to direct the owners to whom to apply in order to relieve themselves of the charge of contributing to the "dreariness" of the factory towns.

Some observations have been made during the heated term as to the comparative heat in a one-story weaving mill, one acre in area, and the second floor of a four-story mill, from which the looms were removed. The heat was the same in the one-story mill where 1,000 looms were in operation as in the old room in which no work was in process.

I beg leave to call your attention to the work of C. Lang, a pupil of Pettenkofer, upon "Natural Ventilation" (Stuttgart, 1877), in which you may find reason to change your opinion that a covering of plastering upon a timber will exclude air sufficiently to cause rot. This work gives the facts, based upon exhaustive experiments, as to the porosity of mortar, brick, stone, and other materials used in building, and the circulation of air through such substances.

The beams in the Mason & Hamlin Co.'s building are cut off from all circulation of air except that which passes through the plaster or the floor above, the furring on which the wire-lath is fastened being only sufficient to give the plaster room to lock inside the interstices of the lathing.

P. S.—Losses by fire in the United States, in June, \$6,361,500. Hotels as usual head the list; fires twenty-seven in number. Losses by fire in the United States for six months ending June 30, 1879, \$47,026,800.

THE ARCHITECTURAL EXPRESSION OF THE PLAN.

TO THE EDITOR OF THE AMERICAN ARCHITECT:

Sir,—Your contributor, J. A. F., in his interesting paper on "American Dramatic Theatres," speaks of the New Opera in Paris as if the expression in its façades of the essential features of the plan were a novelty in theatre architecture. In the Brooklyn Academy of Music, built twenty years ago after the designs of Mr.

Eidlitz, the three great divisions of the building—the foyer, auditorium, and stage—are separately roofed, and their several purposes quite as distinctly expressed as in the recent French example. M.

NOTES OF EXPERIENCE AND INEXPERIENCE.

31. SEWAGE IN THE IRRIGATION SYSTEM.—The undersigned will be happy to furnish M. P. with particulars of several cases of subsoil irrigation on the Moule or Waring system, wherein there has never been the slightest obstruction from freezing in winter, although the pipes are less than twelve inches below the top of the ground. Mr. J. C. Bayles, of New York, the town authorities of Lenox, Mass., several parties in Philadelphia, in Orange, N. J., and elsewhere, besides Colonel Waring himself, can give all needed information. I have myself never heard of a case where the working of the system was injuriously affected by frost.

T. M. CLARK.

32. BOND-STONES IN PIERS.—Could you, in your valuable paper, inform me how and in what relation to crushing strength do bond-stones act in disconnected piers (brick), and in what proportion do they strengthen the piers?

YOUNG ARCHITECT.

33. BOOKS ON CONSTRUCTION.—Could you give me the name, and when published, of the latest work on building construction, either English or German publication, one that is detailed, and is authority?

J. H. H.

NOTES AND CLIPPINGS.

THE ROUND-HOUSE ACCIDENT AT BUFFALO.—The coroner's jury impanelled to determine the cause of the death of the workman who was killed by the falling of a roof-truss of the round-house of the N. Y., L. E. & W. Railroad has returned the following verdict: "The said Irving Hall came to his death on the 19th day of July, 1879, through injuries sustained by the falling of the trusses used in the construction of the roof at the Erie round-house at Buffalo; that said trusses were not safely and properly secured in their places; that the labor employed by the Leighton Bridge and Iron Company, and the supervision at the time of the accident, were inexperienced and incompetent, and that the Leighton Bridge and Iron Company are responsible for the accident."

We have received a communication from the Leighton Bridge and Iron Company disclaiming the responsibility in the following terms: "The decision was contrary to the testimony, and the blame no doubt was attached to us as we were the only ones doing work except Buffalo parties. The roof fell after we had completed our contract, and with every bar of iron in its proper place, and while it was in the hands of the carpenters."

A PNEUMATIC DESPATCH TUBE.—Shavings from a planing-mill in Chicago are, by an air-blast, blown seven hundred feet through a fifteen-inch sheet-iron pipe, to a distillery, where they are burned for fuel.

THE WASHINGTON SCHOOL-HOUSE.—We are not surprised to learn that the commissioners of the District of Columbia have so altered the design which was accepted in the competition of a school-house for the city of Washington, upon which we commented some time ago, that its architect, Mr. Lautritzens, disclaims all authorship of them.

AIR CUSHION FOR FALLING ELEVATORS.—Some time since we published a description of a patent just issued for using an air cushion to break the jar of a falling elevator car in case of accident. An apparatus based on, perhaps, similar principles, has been put into practical use in Chicago by the inventor, Colonel A. C. Ellithorpe, and subjected to serious tests in the Chamber of Commerce, where the elevator car, which itself weighed two tons, was loaded with five thousand pounds of iron, and, to test the real merits of the invention, a basket of eggs and some glass globes; the car was then dropped from a height of forty feet, and was checked so gradually by the air at the bottom of the shaft that neither an egg nor a globe was broken. This encouraged two men to drop with the car, and they reached the bottom not only in safety, but almost unshaken.

TENEMENT-HOUSE REFORM IN LONDON.—Tenement-house reform is as complex a problem in London as it is in New York. The *Pall Mall Gazette* shows how heavy is the loss which the metropolitan rate-payers are likely to sustain from the operation of the Artisans' and Laborers' Dwellings Act. The main object of the act was to clear away the over-crowded dens of the metropolis, and to provide for the erection of healthier dwellings in their place. When it was passed it was thought that there would be little difficulty in disposing of the sites at their cost price at least, but experience is against that expectation. The Metropolitan Board of Works, indeed, has recently accepted an offer made by the Peabody trustees for the purchase, at the rate of \$50,000 an acre, of certain vacant spaces for which the Board paid \$400,000 an acre. The gross loss to the rate-payers on this transaction alone is estimated at \$3,215,000. It is said that if no better terms can be obtained for the land to be cleared under other schemes now before the Board, the total loss will be between \$10,000,000 and \$15,000,000.

THE DUKE OF BRUNSWICK'S MAUSOLEUM.—The six marble statues of his ancestors, which, under the late Duke of Brunswick's will, are to be placed around the sarcophagus containing his body, have been mounted on their red granite pedestals about the mausoleum in the Place des Alpes, Geneva, Switzerland, which was begun three years ago. This magnificent memorial of a most generous benefactor is expected to be finished before the end of September, and will probably form one of the most striking monuments on the Continent. A full description of the monument was published in the *American Architect* for July 7, 1877.

COLOGNE CATHEDRAL.—The scaffold which surrounds the southern tower of the Cathedral of Cologne has been raised another stage, and it now appears certain that the cathedral will be finished next year.