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CONTENTS.

THE AMERICAN ARCHITECT AND BUILDING NEWS.

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CONTENTS

THE Metropolitan Museum of Art, in New York, is rapidly adding to its precious resources for the study of sculpture and painting. The north hall of the new wing, which will be opened this season for the first time, is to be devoted to Classical sculpture. Of the three sections into which the hall is divided, the first will be filled with casts of Parthenon sculpture. The second section will contain casts of other Greek sculpture, and the third will be filled with Roman work. If the lighting of these rooms is as good as that of the other sculpture galleries in the Museum, the new wing should be a very Mecca for American art-students. Many other casts are in store, waiting for space in which to display them, and another wing is, it is said, soon to be added to the Museum for this purpose. According to the accounts in the New York *Tribune*, the thing now most to be desired for the Museum, after a liberal supply of money with which to carry on its noble work, is some sort of reform in the methods of handling freight at the wharves of the foreign steamship lines. Of the casts which have been so carefully selected, and so generously furnished by the great European Museums, hardly one, we are told, reaches its destination whole, although they are all carefully packed, in cases marked with the warning "Fragile." Of course, the skilful plaster-workers at the Museum can put together the fragments, but a restoration of this kind is not quite the same thing as a cast that has never been broken, and there is absolutely no reason why these precious objects should be so brutally treated. No doubt, they only suffer the fate of all the fragile objects which Fortune delivers to the tender mercies of American freight-handlers, but the abuse of delicate merchandise in our seaports has long been a scandal in the mercantile world. We have ourselves seen an open crate of earthenware, the contents of which could easily be seen, packed in hay, through the interstices of the crate, landed on the pier after a long railway journey, a voyage of three thousand miles, and three handlings, under English auspices, in perfect condition, only to have its contents reduced to a mass of fragments before it had been transported half a mile on American soil; and nearly every importer has similar stories to tell. We know a man who, like many other tourists, fell in love with the German porcelain stoves. He bought two, had them packed with extreme care, and shipped to this country. He might have sent them all around the world, to English or French or German ports, in safety; but it is different in America; and, when they reached him, both the stoves were broken into pieces so small that he could not find a fragment of either, as large as the palm of his hand, to keep for a memento of the American system of transportation. Where nothing but an importer's pocket is concerned, the rest of the world can, perhaps, look with complacency on these peculiarities of the American mercantile system; but where works of art, bought by charitable people for the benefit of poor students, are destroyed by the hundred, through being rolled end-over-end around the streets and piers, simply because that is the American custom, it is time for the friends of civilization to see if something cannot be done to ameliorate that custom.

A CURIOUS case, involving the still more curious question of the ownership of the space under the sidewalk in front of buildings, came up in New York a few days ago. It seems that Mr. Oscar Hammerstein bought, about six months ago, the old Seventy-first Regiment Armory, intending to build a theatre on its site. Attached to the armory was a long vault, under the sidewalk, which was used by the corps as a shooting-gallery. In the course of construction of the theatre, it was found that the vault, in which it was intended to place the engine and boilers, was not quite large enough, and that more room would be needed. Mr. Hammerstein thereupon petitioned the Board of Public Works for additional vault room, offering at the same time eighteen hundred dollars, which was the price, at the regular rate of seventy-five cents a foot, which the city exacts for the use of the ground below the sidewalks, for the additional space that he needed. The Board of Public Works refused to give the space asked for, on the ground that there was no record to show that the old vault was a part of the armory property purchased by Mr. Hammerstein, and that, if he wanted to use it, or make additions to it, he must pay the city for the whole of it. This Mr. Hammerstein refused to do. He had paid a million dollars for the armory property as a whole; the regiment had used the vault under the sidewalk for twenty-five years, and he thought that it was fairly included in his purchase. In order to test the question as quickly as possible, he sent his son to dig a hole in the sidewalk over the vault. The City authorities were on the lookout, and promptly arrested the young man, on the charge of having violated the City ordinance which holds the sidewalk, and the ground under them, to be the property of the City, unless the ownership has been duly transferred. Of course, the youth was immediately paroled by the judge before whom he was brought, and a decision is soon to be rendered. A special complication is introduced into the case, apparently, by the fact that the armory must have been State property, and the dealings between the State and the City would naturally be on a different footing from those between individuals.

THE *Review of Reviews* contains an article, by Louis Windmüller, on "The Careless Construction and Wilful Destruction of Buildings," which, apparently to suit it to the popular taste, is seasoned with so much careless misstatement that it ought not to go uncorrected. It is the misfortune of the time that the swarm of monthly magazines, which have, not perhaps entirely without advantage, superseded to a considerable extent more solid publications, find it necessary to compete with each other for making sales, by taking advantage of every occurrence which occupies the attention of the daily papers for a few days to produce disquisitions appropriate to the circumstances, made as startling as possible by reckless assertions made with an air of authority intended to impress the reader with their importance. Such an occurrence as the fall of the Ireland Building was sure to call out some of these dissertations, and Mr. Windmüller's is, perhaps, only more deserving of reputation because it appears in what is generally a considerate and honorable periodical.

MR. WINDMULLER begins by saying that "Our consular reports demonstrate that loss of life and property is far less abroad than it is here, although American firemen are considered superior. A chief cause is the hasty and reckless construction of dwellings"; and, farther on, he says that "In Germany, a special police watches over their erection, and examines the material placed in them; a Board, representing the Fire Department and local Government, has absolute power to order changes while the house is in course of erection, and it must not be utilized until it has been judicially approved as a whole when completed." Most people, after reading this, would suppose that building in Germany, under all this inspection and judicial approval, must be very well done, and it would probably surprise the subscribers to the *Review of Reviews* to learn that the fall of buildings, or parts of buildings, not as a result of fire, but from bad construction, pure and simple, is perhaps more common in Germany than in any other civilized country. It is true that German buildings, like Continental buildings generally, do not often burn down, the law making house-owners responsible for the consequences of the spread of fire beyond their own premises, which has been enforced on the Continent for centuries, having made uninflammable construction a fixed habit in all Continental cities; but in the matter of over-balanced cornices, or rotten masonry, or bad brick, or defective stone, the German builders can give lessons to almost any in the world. A superstition is prevalent here, similar to that received in regard to German building, that house construction in Paris is exceedingly solid and safe; yet the very worst building-work that we ever saw done anywhere was in Paris. We know something of what "skin" builders in New York can do when they try; but nothing that we have ever seen in New York was quite so bad as the masonry done under the strict laws and supposedly efficient supervision, of the Parisian Government. The fact is that it is utterly impossible to supervise building-work officially in such a way as to prevent defective construction. Even a clerk-of-works, constantly on the ground, cannot superintend more than ten men in such a way as to be able to say with confidence that a fault has not been committed which may cause the destruction of a building. It is so easy to leave out a few bolts in a truss or girder; or to make a fatal joint in a concrete foundation by allowing a little clay to work into it; or to increase the strain on a column to a dangerous extent by allowing a pebble to get into the cement in which it is bedded, that the wonder is not that supervision should be unable always to prevent accidents so much as that most buildings, notwithstanding the impossibility of detecting faults committed in their construction, are sound and strong. That they are sound and strong, and quite as much so in New York as in police-ridden Berlin, is simply because most building workmen are conscientious and intelligent, and, of their own accord, try to guard against possible dangers. Drunken and vicious workmen would build a bad and dangerous building though inspectors by the score stood by and watched them; and the best safeguard against bad construction is not, as Mr. Windmüller thinks, increase of inspection, but development of the conscience and sense of responsibility of the individual workman. How that development is to be brought about, we will not attempt to say, but it is certainly not by increase in the rigor of the building-laws.

ONE of our correspondents sends us a curious document, from the Superintendent of an Insane Asylum in the West, inviting the persons to whom it is addressed to "describe fully anything believed to be original, new in use, or in your opinion specially desirable," with a list of forty-six points, relating to arrangement, materials and equipment, and to details of hospital management, on which information is desired. In itself, the circular is innocent enough, and, if sent about among hospital superintendents, as was probably intended, it should bring valuable information; but the idea of addressing copies of it to architects was certainly not a happy one. An architect who had been particularly successful in planning such establishments would, with reason, think himself entitled to employment in designing the two new asylums which, as the circular informs us, the State is about to build; and would be very unlikely to expend his special knowledge gratuitously, for the benefit, possibly, of some ignorant professional rival; and, it is safe to say that the only information that will be obtained from architects on the subject of planning and materials will be furnished by people who know little or nothing, either of sound architecture or of hospital planning, and who simply seize the opportunity to make themselves conspicuous by a display of pretended science, invented for the occasion, with which they hope to impose upon the State authorities. The Superintendent who signs the circular apparently has much the same idea in regard to it, for he expressly says that the information is asked for at the desire of the Governor of the State.

IF we might offer a suggestion as to the best manner of securing what, as we are told, the Governor wishes — that embodiment in the new building of "whatever has been found best as to plans and construction," we should say that this end could be best attained by procuring, say, a copy of Burdett's "*Hospitals and Asylums of the World*," which contains plans of all the principal hospitals for the insane, adding, perhaps, other plans, from Trustees' Reports and similar documents. In this way might easily be accumulated a collection, containing plans of nearly every asylum in the civilized world. These plans should first be submitted to the medical authority which is to have charge of the administration of the new hospitals, for study, comparison and criticism. Architects do not need to be told that in asylum administration the medical world is divided into at least two camps. One of these favors what is known as the Dutch, or cottage system, in which the patients are divided into little separate households, on the ground that the comparative quiet and freedom from exciting conditions of these cottage sanitariums are so favorable to the cure of mental disorder that the great additional cost of attendance and administration should not be considered. The physicians of the other school, while recognizing the merits of the cottage system, think that large pavilions, accommodating from one to two hundred patients in each, are so much more economically carried on, and so much more easily kept under efficient supervision, that they are to be preferred. It is certainly not for the architect to say which of the two systems of planning is to be chosen. After the medical authority has made its choice, which it can do with a far greater knowledge of local circumstances, the character of the patients to be received, and the medical direction available, than any architect could possibly possess, it is time to call in a good and experienced architect, and discuss the details of the plans with him. Any architect who understands his business will know a good deal about the details of planning for the insane, as there are few architects who have not had something to do with asylum-building; so that, at this stage, the two professional men together will be in a position to make a satisfactory combination of the information which they both possess; and the construction of the buildings can follow in due course, with the certainty that they will "embody," as Governor Altgeld says, all the advantages that two competent experts can select from a comprehensive examination of all the best that has been done previously; and that they will not present, as is too often the case with hospitals for the insane, only the realization of a whim of some self-willed and half-instructed official, seconded by an ignorant and irresponsible architect.

THOSE of our readers who are fond of experiments in chemistry may like to pursue the investigation begun by Herr Strindberg, a Swedish chemist, who claims that iodine can be made synthetically from certain coal-tar products. He was led to this conclusion by noticing, during some photographic operations, that when he mixed pyrogallol and hydroquinone, for a developer, the hydroquinone gave out the characteristic odor of iodine. This circumstance led him to calculate the molecular weight of oxyhydroquinone, that is, hydroquinone with an atom of oxygen added. As a molecule of hydroquinone weighs one hundred and ten times as much as a molecule of hydrogen, and one of oxygen weighs sixteen times as much, an arithmetical operation of no great difficulty convinced him that a combination of the two would give a molecule weighing one hundred and twenty-six units. The atomic weight of iodine is one hundred and twenty-seven, according to the ordinary authorities, but this is so near to one hundred and twenty-six that the coincidence, together with the iodine-like smell, convinced Herr Strindberg that he had really succeeded in compounding a halogen out of carbon and water. That he will succeed in isolating the iodine so produced we hardly venture to hope; but, unless the smell that he took to be that of iodine was due to the escape of bromine from the sensitive film, which usually accompanies the action of the developer, it is certainly curious that a chemical action which might possibly lead to the formation of an organic compound with a molecular weight of one hundred and twenty-six should be accompanied by a smell resembling that of the vapor of a mineral element with an atomic weight of one hundred and twenty-seven.

ELECTRICAL SCIENCE FOR ARCHITECTS.[1] — XV.

THE NATIONAL CODE OF RULES FOR ELECTRIC WIRING. — VIII.

Class D.

ALTERNATING SYSTEMS. — CONVERTERS OR TRANSFORMERS.

33. CONVERTERS: —

a. Must not be placed inside of any building, except the Central Station, unless by special permission of the Underwriters having jurisdiction.

b. Must not be placed in any but metallic or other non-combustible cases.

c. Must not be attached to the outside walls of the buildings, unless separated therefrom by substantial insulating supports.

34. IN THOSE CASES WHERE IT MAY NOT BE POSSIBLE TO EXCLUDE THE CONVERTERS AND PRIMARY WIRES ENTIRELY FROM THE BUILDING, THE FOLLOWING PRECAUTIONS MUST BE STRICTLY OBSERVED: —

Converters must be located at a point as near as possible to that at which the primary wires enter the building, and must be placed in a room or vault constructed of, or lined with, fire-resisting material, and used only for the purpose. They must be effectually insulated from the ground, and the room in which they are placed be practically air-tight, except that it shall be thoroughly ventilated to the out-door air, if possible through a chimney or flue.

An explanation of alternating currents and of the laws regulating their action requires so technical a discussion that a simple statement of important facts will probably leave clearer ideas than would an attempt at an exposition.

With the alternating system the dynamo ordinarily generates a pressure of 1,000 or 2,000 volts. *Transformers* or *converters* are then used to change this pressure, at the place where the current is to be used, into a lower pressure of 50 or 100 volts. The pressure is high before the transformation is made and the current comparatively small; after the transformation the pressure is low and the current comparatively large. The available amount of energy is but little changed by this transformation or conversion; the current multiplied by the pressure (the number of watts) is virtually the same before as after.

This transformation is possible with alternating currents because of the principal called *induction.* Suppose (Fig. 72) a coil of wire B to be lying near, but not touching, another coil A in which a current may be started either in the direction of the arrows c, c, or in the direction of the arrows d, d. Without discussing the hypotheses made to account for the phenomena, it may simply be stated that if a current be started in coil A, a current will also flow momentarily in coil B if its ends be joined; if they be not joined there will be only a momentary electrical pressure between the ends of the coil. If the current in coil A be now changed in direction, there will be a momentary current in coil B in the direction opposite to that in which it flowed in the first instance. These currents in B are what are called *induced currents.* They last but a very short time, and if the current started in A be continued in the same direction, there is only the short rush of current in B at the starting of the current in A. To keep a current flowing in B it is consequently necessary to keep the current in A constantly alternating in direction. An alternating dynamo is so constructed that it will do this.

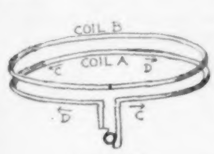


Fig. 72. Illustrating Induced Currents.

The coil A which is connected with the dynamo, and in which the current first flows is called the *primary coil,* and the coil B in which the induced current flows is called the *secondary coil.* The coils in Figure 72 have each but one turn of wire. The relation between the number of turns in the primary coil to the number of turns in the secondary coil determines the relative electrical pressures and the relative currents in the two coils. Thus, if there are 1,000 turns in the primary coil and 100 turns in the secondary, the ratio between the number of turns is 10 to 1 and the electrical pressure in the secondary coil will be one-tenth of that in the primary coil while the current in the secondary coil will be 10 times that in the primary coil. If, for instance, the pressure at the terminals of the primary in the case supposed is 1,000 volts and the current flowing is 10 ampères, then in the secondary the pressure will be 100 volts and the current will be 100 ampères. The rate of work in the two coils (the watts) will be the same; in the primary coil the number of watts will be 1,000 x 10 = 10,000 and in the secondary the number of watts will be 100 x 100 = 10,000. There is simply a transformation from high-pressure and small current to low-pressure and large current. The transformer has somewhat the effect that a reducing-valve has with gas when it allows a larger flow of gas at a lower pressure. It should be remembered, however, that with the electrical transformer there is no electrical connection between the two coils; there is a space between them and the current in the primary coil with its high-pressure is not free to pass to the secondary coil.

In practice the terminals of the primary coil are connected to the wires from the alternating dynamo, as in Figure 73, and the lamps are then connected in between the wires leading from the terminals of the secondary coil just as they would be on any other low-potential circuit. The two coils are surrounded by soft iron, since this greatly increases the effect and makes it possible to transform a large amount of energy in a comparatively small piece of apparatus. The two coils are compactly wound, thoroughly insulated, and placed near together, while iron plates are so formed that they will fill the space within and about the coils. The whole is then enclosed in a cast-iron case for protection against the weather and against mechanical injury.

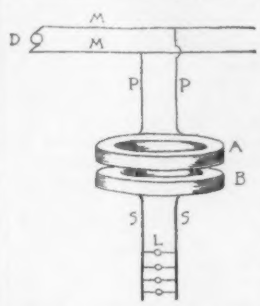


Fig. 73. Illustrating Transformer Connections: *D.* Dynamo; *M.* Mains; *P.* Primary Wires; *A.* Primary Coil; *B.* Secondary Coil; *S.* Secondary Wires; *L.* Lamp.

The great advantage of the alternating system is in the saving of copper in the street conductors. If, for instance, the rate of output of a station be 100,000 watts, by using the alternating current the voltage may be 1,000 and the current 100 (1,000 x 100 = 100,000), while if the direct current (one flowing constantly in one direction) were used and the pressure were everywhere the same as at the lamps, say 100 volts, there would have to be 1,000 ampères at 100 volts (1,000 x 100 = 100,000). But the amount of current that is forced through a given resistance is what determines the loss. For a given loss a smaller wire may be used for a small current at a high-pressure than for a large current at a low-pressure, although the energy in the two cases, as in the example cited, may be the same.

When passing through a resistance, alternating currents under certain conditions do not follow the law that holds with direct currents. The property of induction has an important effect and on account of it sometimes a very small alternating current will flow, where with a direct current there would be a short-circuit. Thus in the transformer (Fig. 73) when there are no lamps turned on and the secondary coil is consequently "open" almost no current will flow in the primary coil although it is "closed." If a few lamps be turned on so that the secondary coil is partly "closed" more current will flow in the primary and this current will increase or diminish in almost exact proportion to the number of lamps turned on in the secondary circuit.

Transformers or converters become somewhat heated even under ordinary conditions and it is possible, when a short-circuit occurs in the secondary circuit or when there is a defect in the transformer itself, for the temperature to become dangerously high. When a transformer "burns out" the smudge from the burning insulation will not infrequently cause considerable smoke damage. The primary wires may become a source of danger because they are connected to a generator of high electrical pressure so designed that it will furnish a heavy current at a constant pressure. There is some likelihood that lightning discharges will break through the insulation of the primary wires in the transformer and if this were to occur it would be better to have the transformer out of doors and mounted so that overheating could do no damage. For the foregoing reasons the underwriters have thought it best to exclude transformers from buildings wherever possible.

35. PRIMARY CONDUCTORS: —

a. Must each be heavily insulated with a coating of moisture-proof material from the point of entrance to the transformer, and, in addition, must be so covered and protected that mechanical injury to them, or contact with them, shall be practically impossible.

b. Must each be furnished, if within a building, with a switch and a fusible cut-out where the wires enter the building, or where they leave the main line, on the pole or in the conduit. These switches should be inclosed in secure and fireproof boxes, preferably outside the building.

c. Must be kept apart at least ten inches, and at the same distance from all other conducting bodies when inside a building.

36. SECONDARY CONDUCTORS: —

Must be installed according to the rules for "Low-potential Systems."

The construction of the primary circuit must be in accordance with the rule for high-potential circuits (Sections 10, 11, 12,) except that Rule 35 (*c*) requires even greater distance between wires.

All the reasons for the use of service switches with arc-light circuits, and for the use of service switches and main fuses with low-potential circuits, apply with even greater force to their use with alternating circuits, for the electrical pressure is high and the current is not limited by the regulation of the dynamo as it is with constant-current series circuits.

Class E.

ELECTRIC RAILWAYS.

37. ALL RULES PERTAINING TO ARC-LIGHT WIRES AND STATIONS SHALL APPLY (SO FAR AS POSSIBLE) TO STREET RAILWAY POWER-STATIONS AND THEIR CONDUCTORS IN CONNECTION WITH THEM.

[1] Continued from No. 1026, page 76.

38. Power Stations: —

Must be equipped in each circuit as it leaves the station with an *approved* automatic "breaker," or other device that will immediately cut off the current in case the trolley-wires become grounded. This device must be mounted on a fireproof base, and in full view and reach of the attendant.

[Section *a*. Automatic circuit-breakers should be submitted for *approval* before being used.]

Electric railways are ordinarily operated at an electrical pressure of 500 volts, which the rules classify as a "high-potential"; the generators are designed to maintain this pressure constant and as they are usually of great power, a tremendous current will flow when a short-circuit occurs. For these reasons the same construction is required as that specified for arc-light purposes.

An *automatic circuit-breaker* is a device for breaking connection between the generators and the outside lines. It performs the same service as a fuse, but operates instantly when there is an excessive current, while a fuse requires time to heat sufficiently to melt. The automatic breaker is operated by the current that flows out to the lines. The current passes through the wire on an electro-magnet and this magnet becomes stronger as a larger current passes. The breaker is so adjusted that when the magnet reaches a certain strength a piece of iron is pulled toward it, and this iron piece is so attached to a sort of trigger that a spring will be released and left free to force open a switch. Figure 74 shows the principle of an automatic breaker. In a practical form it must be so arranged that the arc formed upon opening the circuit cannot continue, and precaution must be taken that the parts to be moved will not stick. This arc has a great heating-power and the whole piece of apparatus should be mounted on a non-combustible base.

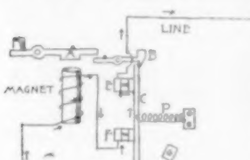


Fig. 74. Showing Principle of Automatic Circuit Breaker. An excessive current makes the magnet attract *A*. *A* strikes *B* thus releasing *C*, which is pulled out by the spring *D*. A gap is then left in the circuit between *E* and *F*.

39. Trolley Wires: —

a. Must be no smaller than No. 0, B. & S. copper or No. 4, B. & S. silicon bronze, and must readily stand the strain put upon them when in use.

b. Must be well insulated from their supports, and in case of the side or double-pole construction, the supports shall also be insulated from the poles immediately outside of the trolley-wire.

c. Must be capable of being disconnected at the power-house, or of being divided into sections, so that in case of fire on the railway route the current may be shut off from the particular section and not interfere with the work of the firemen. This rule also applies to *feeders*.

d. Must be safely protected against contact with all other conductors.

40. Car Wiring: —

Must be always run out of reach of the passengers, and must be insulated with a waterproof insulation.

41. Lighting and Power from Railway Wires: —

Must not be permitted, under any pretence, in the same circuit with trolley-wires with a ground return, nor shall the same dynamo be used for both purposes, except in street railway-cars, electric-car houses, and their power-stations.

42. Car-houses: —

Must have special cut-outs located at a proper distance outside, so that all circuits within any car-house can be cut out at one point.

43. Ground Return Wires: —

Where ground return is used it must be so arranged that no difference of potential shall exist greater than five volts to 50 feet, or 50 volts to the mile between any two points in the earth or pipes therein.

Feeders are the wires that lead from the station to points where current is taken off by the different branches. If all the current

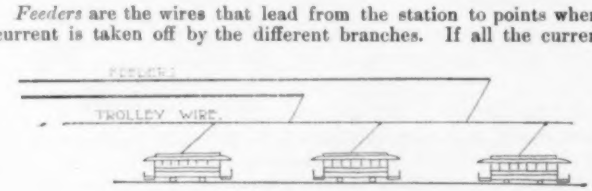


Fig. 75.

required to operate a large street-railway had to be conducted from the station through the trolly-wires, either these wires would have to be of tremendous size, or else there would be great loss in forcing a large current through a small wire. If the wires were small they would greatly overheat, and the pressure would be different at different parts of the system. After a large current had been forced through the trolley-wire there would not be so much energy left to operate the cars. Where much current is needed it is consequently the practice to use the trolley-wire only as a sort of local conductor to carry current from the ends of the feeders to the cars (Fig. 75).

Street-railways that use a trolley running along a wire overhead almost invariably make the rails and the earth serve as return conductors to the station. Figure 76 shows the connections and also indicates a motor being operated from the trolley line. Quite aside from any danger, it is unsatisfactory to take current for power and light from a street-railway trolley-wire, because the electrical pressure varies when the current taken by the cars varies, and because when for any reason the circuit-breaker at the station cuts off the current from the line, the service is interrupted. It is more dangerous to operate power or lights from a trolley line than from a regular power or light circuit, for many reasons.

One side of the circuit is always connected with the earth. With other circuits every precaution is taken to keep both wires thoroughly insulated from the earth, but with the trolley circuit one side is grounded intentionally, permanently, and as well as possible. Where both wires of a circuit are insulated from the ground, to have trouble with earth connections it is necessary to have *two* connections with the earth, one on *each wire* at the *same time*. With a trolley circuit a bad leak or short-circuit is caused by *one* connection between the one wire and the earth at *any time*. With any circuit the electrical pressure is constantly striving to force current through the insulation: there are always minute leaks. When the pressure is doubled these minute leaks double and are much more likely to become rapidly worse. With a circuit having both wires insulated, only half the total pressure is acting to break down the insulation on each wire; where one side of the circuit is grounded the total pressure is acting to break down the insulation on the single wire. With a grounded circuit there is likely to be more trouble from lightning because there is a connection to the earth through motors and lamps. The discharge in passing through these is apt to cause damage. It is difficult satisfactorily to operate motors from the trolley wire when a proper fuse is used, because the fluctuations in the pressure cause the motor often to take rushes of current that will melt the fuse unless it be too large for good protection.

The foregoing are the principal reasons why light and power from trolley lines are so strongly objected to by the underwriters. Incandescent lamps would also be prohibited by Rule 14 (*c*) because with a 500-volt circuit it is necessary to connect five lamps in series and there is thus a multiple-series system. Of course it does not make an insulated metallic circuit if two wires are run from the motor to the power-house, because the only change this makes is the connection of one wire to the earth at the dynamo instead of at the motor.

Figure 76 also illustrates the way in which the current in a trolley circuit returns to the generator. A part returns through the rails, a

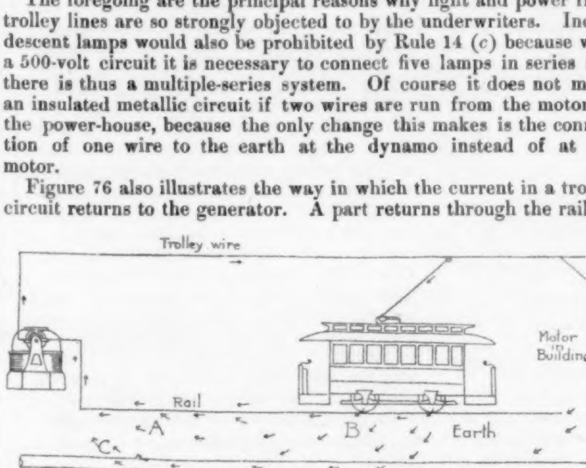


Fig. 76. Illustrating Street-railway Circuit and Paths taken by Current.

part flows into the earth and returns through buried pipes, moist earth or any other conducting substance. This return current divides according to the conductivity of the different paths. Since there is resistance it takes a part of the pressure of the dynamo to force this current from the car back to the dynamo; thus there will be a difference of pressure between any two points in the return circuit, say between *A* and *B*. If a gas-pipe should run near the point *A* and a water-pipe should run near the point *B*, and if these two pipes should touch each other somewhere, there might be dangerous arcing due to the current finding its way back through the pipes. This is one of the reasons for Rule 43. The other and greater reason is that if there are considerable differences of potential there is destructive action called *electrolysis* wherever the current leaves the pipe for the earth, as at *C*, Figure 76. The iron of the pipe is carried away into the earth toward the negative pole of the generator just as in a silver-plating battery the silver is carried away from a silver plate toward the article to be plated which is attached to the negative pole of the battery.

Class F.

44. Storage or Primary Batteries: —

a. When current for light and power is taken from primary or secondary batteries, the same general regulations must be observed as applied to similar apparatus fed from dynamo generators developing the same difference of potential.

b. All secondary batteries must be mounted on *approved* insulators.

[Section *b*. Insulators for mounting secondary batteries to be *approved* must be non-combustible, such as glass, or thoroughly vitrified and glazed porcelain.]

c. Special attention is directed to the rules (Rule 21) for rooms where acid fumes exist.

d. The use of any metal liable to corrosion must be avoided in connections of secondary batteries.

In a *primary battery* an electric current is produced by chemical action. If, for instance, a copper plate and a zinc plate are placed in a jar containing dilute sulphuric acid, chemical action produces an electrical pressure between the two plates and if they be connected by a wire or other conductor forming a circuit, a current will flow. Batteries for operating the telegraph, call-bells, burglar-alarms, etc., are primary batteries.

One form of *secondary* or *storage battery* is made by placing lead plates and sulphuric acid in a suitable jar and then forcing a current through the lead plates and acid. When the current passes, the lead plates are chemically changed, so that if after a time the battery be disconnected from the circuit by which current is furnished, it will act like a primary battery and will produce an electric current when connected to a circuit of wires or other conductors.

Batteries may be connected so that they will give a high electrical pressure or a large current, or both, and the same precautions are to be taken with the wiring that would be taken if the current were coming from a dynamo. With primary batteries the pressure is ordinarily very low and the current very small, so that as far as danger from fire is concerned, little care need be taken.

Secondary batteries are mounted on insulators because salts formed by the chemical action frequently creep over the surface of the jars and there would be leakage of electricity if the jar were not properly insulated.

Acid fumes are often produced by batteries and care must be taken that such action will not destroy the insulation or injure apparatus.

If the metal used about secondary batteries were to corrode and waste away, the carrying-capacity of the conductors would be lessened and excessive heating might occur.

45. MISCELLANEOUS: —

a. The wiring in any building must test free from grounds; *i. e.*, each main supply-line and every branch circuit shall have an insulation resistance of at least 25,000 ohms, and should have an insulation resistance between conductors and between all conductors and the ground (not including attachments, sockets, receptacles, etc.), of not less than the following: —

Up to	10	ampères	4,000,000
" "	25	"	1,600,000
" "	50	"	800,000
" "	100	"	300,000
" "	200	"	160,000
" "	400	"	80,000
" "	800	"	22,000
" "	1,600	"	11,000

All cut-outs and safety devices in place in the above.
Where lamp-sockets, receptacles, and electroliers, etc., are connected, one-half of the above will be required.

This testing can, of course, be done satisfactorily only by those familiar with electrical instruments. All insulation allows minute leakage; that is, the resistance of the insulation is never infinite. It is not safe to allow more than a certain small amount of leakage to a given length of conductor. An installation requiring only 10 ampères of current will presumably be a small one and the circuit a short one. For this reason a higher insulation resistance is required for a wiring system where the maximum normal current used is 10 ampères, than for one where it takes 1,000 or 2,000 ampères to supply all lamps. This insulation test is useful as an indication, but it has principally a negative value. A low resistance indicates a fault, but a high resistance does not necessarily show perfect construction. There might be an air space of a thousandth of an inch between a wire and a pipe and this would prevent an indication of low resistance, but a jarring of the building might afterward bring the wire and the pipe into contact and cause a disastrous short-circuit.

b. Ground-wires for lightning-arresters of all classes, and ground-detectors, must not be attached to gas-pipes within the building.

c. Where telephone, telegraph or other wires connected with outside circuits are bunched together within any building, or where inside wires are laid in conduit or duct with electric light or power wires, the covering of such wires must be fire-resisting, or else the wires must be enclosed in an air-tight tube or duct.

d. All conductors connecting with telephone, district-messenger, burglar-alarm, watch-clock, electric-time, and other similar instruments, must be provided near the point of entrance to the building with some protective device which will operate to shunt the instruments in case of a dangerous rise of potential, and will open the circuit and arrest an abnormal current flow. Any conductor normally forming an innocuous circuit may become a source of fire-hazard if crossed with another conductor, through which it may become charged with a relatively high pressure.

WIRE-PROTECTORS.

[Protectors must have a non-combustible, insulating base, and the cover be provided with a lock similar to the lock now placed on telephone apparatus or some equally secure fastening, and be installed under the following requirements: —

1. The protector to be located at the point where the wires enter the building, either immediately inside or outside of the same. If outside, the protector to be inclosed in a metallic waterproof case.

2. If the protector is placed inside of building, the wires of the circuit from the support outside to the binding posts of the protector to be of such insulation as is approved for service wires of electric light and power, and the holes through the outer wall to be protected by bushing, the same as required for electric light and power service wires.

3. The wire from the point of entrance to the protector to be run in accordance with rules for high-potential wires; *i. e.*, free of contact with building, and supported on non-combustible insulators.

4. The ground-wire shall be insulated, not smaller than No. 16 B. & S. gauge. This ground-wire shall be kept at least three (3) inches from all conductors, and shall never be secured by uninsulated double-pointed tacks.

5. The ground-wire shall be attached to a water-pipe, if possible; otherwise may be attached to a gas-pipe. The ground-wire shall be carried to and attached to the pipe outside of the first joint or coupling inside the foundation walls, and the connection shall be made by soldering, if possible. In the absence of other good ground, the ground shall be made by means of a metallic plate or a bunch of wires buried in a permanently moist earth.]

Ground-wires for lightning-arresters and ground-detectors are not to be attached to gas-pipes within a building, because if there were heating or arcing at the point where the wires are joined to the pipe, the gas-pipe might be burned through and the gas ignited.

Where wires are bunched together there is liability that they may become connected accidentally or on account of moisture. If there were bad leakage from one wire to another, the insulating covering might catch fire and carry it to the building. Rule 45 (*c*), consequently, requires that such wires be covered with fire-resisting material, or else that they be enclosed in an air-tight duct so that if a fire do occur it cannot have air to support combustion and cannot extend to the building.

An instrument is "shunted" when a by-path is formed round it so that the current will have a path other than that through the instrument. A high electrical pressure on telephone, burglar-alarm, or similar circuits, which do not have to be particularly well insulated, is likely to break down the insulation and cause heating at the break. Protective devices lead these high-potential currents to the ground before they get to the wiring in the building. The rules for installing protectors are given in detail in the note under 45 (*d*). Since the protector is to carry off a current forced by a relatively high pressure, all the wiring from the protector to the ground is done with the same care that would be used to install a high-potential circuit, so there will be no leakage to the building and no burning of gas-pipes.

e. The following formula for soldering-fluid is suggested: —

Saturated solution of zinc	5 parts.
Alcohol	4 parts.
Glycerine	1 part.

MATERIALS: —

The following are given as a list of non-combustible, non-absorptive, insulating materials, and are listed here for the benefit of those who might consider hard-rubber, fiber, wood, and the like, as fulfilling the above requirements. Any other substance which it is claimed should be accepted, must be forwarded for testing before being put on the market: —

1. Thoroughly vitrified and glazed porcelain.
2. Glass.
3. Slate without metal veins.
4. Pure sheet mica.
5. Marble (filled).
6. Lava (certain kinds of).
7. Alberene stone.

RUSSELL ROBB.

[The end.]

AN ARCHITECTURAL SCHOOL FOR SAN FRANCISCO. — Arrangements have been made for a practically free architectural school at the Mark Hopkins Institute in San Francisco. It will be under the direction of Prof. B. R. Maybeck of the University of California. A class in Free-hand Drawing has been organized under H. T. Bestor, another in Architectural History under G. H. Sanders, while G. W. Percy will have one in Construction. The teachers give their services free. The proposed course will extend over three or four years. — *N. Y. Times.*

A SYLLABUS OF EARLY CHRISTIAN, ROMANESQUE AND GOTHIC ARCHITECTURE.[1] — III.

THE EVOLUTION OF VAULTING.

THE only satisfactory kind of roofing is naturally the vault, beginning in the crypt, the narrow passages and the aisles, the apse being already vaulted. This changes the whole character of the building, makes it more dependent upon calculation, less upon chance, and the vaulted church is therefore by far a more complete, a more rational product than the one with wooden ceiling. The vaulting of the nave was the accomplishment most sought for, but represented the greatest, and as it seemed for a long time an almost insurmountable, difficulty.

The great danger of fire and moisture to which the wooden ceiling is exposed called for preventives. Besides, the interest for perfection and beauty in an edifice is closely related to the desire for its preservation. The art of vaulting was probably never quite forgotten. Vaulted buildings were still existing, mostly as ruins, in the old Roman provinces. In France Nîmes and Arles, and in Germany Trier, still possess a goodly number of monuments. The aqueducts and bridges all over the territory gave lessons in vaulting for practical purposes; most frequent among these were the *tunnel* and the *groin vault.* Nothing, however, was so effective in bringing about an improvement in this respect as the example of satisfactory vaulting presented in the *concentric* structures, such as the imperial chapel Charlemagne himself built at Aix-la-Chapelle. This chapel was looked upon as a wonder and a model of constructive ingenuity. Besides being the necessary consequence and conclusion of the concentric principle, the vaulting preserved the edifice uninjured by time and weather through centuries. Even in the Carolingian period there was serious thought of vaulting the basilica.

The vault is composed of arches. The arch almost exclusively used in vaulting during the Romanesque period was the *semicircular*, but in cases where a great constructive efficiency was demanded, *e. g.*, in vaults of great span, the *pointed* arch was, sometimes and in some places, introduced to increase the stability of the vault. The pointed arch, compared with the semicircular, has this peculiarity, that its surface nowhere presents horizontal or almost horizontal lines where the arch may prove inefficient to carry loads and break down.

DIFFERENT KINDS OF VAULTING ARE:

1. The *tunnel* or *barrel vault*, being either semicircular or pointed, used sometimes in a transverse position — the so-called *bridge-vault* — semi-tunnels over aisles.
2. *Groin* or *cross vault* (the groins crossing diagonally), constructed upon the principle of two intersecting tunnel-vaults, the edges where they meet being termed the groins. These groins in the later part of the period, especially in Northern France, are marked out by ribs. The groin-vault can be either:
   a. Quadripartite over square, rectangular or trapezoidal bays, or
   b. Sexpartite, one bay of centre aisle corresponding to two bays of side aisles.
3. Another kind of intersecting vault is the so-called *cloister-vault* differing from the cross-vault by the angles receding, while in the latter they project.
4. The *pendentive dome* over square bays, *e. g.*,

Dome over rectangular bay in the Cathedral at Pisa.

The pendentive dome is semicircular or polygonal. The octagonal cloister-vault and the polygonal dome are hardly different from one another. A peculiar kind of dome is the so-called Angevin vault, a combination of the cupola with the system of ribs.

5. *Half dome* over apse.

Vaulting is made difficult not only by its construction, which has to provide against the falling-in of the vault, but also because of its exercise of a powerful vertical and lateral thrust which has to be counteracted by sufficient strength in the wall or pier, or whatever member of the construction forms the chief support. In the tunnel-vault the thrust is exercised equally along the whole line, while in the groined vault it is mainly reduced to four chief points where it has to be efficiently met.

The *tunnel-vault* being the simpler and for the inexperienced builder the more comprehensible of the two, it is the first one to be commonly used, especially in *Southern France*, where vaulting was really settled upon as a necessity before the horizontally-ceiled basilica had time to be developed to any degree of perfection. The difficulty, however, of giving it any great span without endangering its stability, put the tunnel-vault decidedly at a disadvantage and taxed the inventiveness of the constructors. It is in these *early cruciform structures of one nave and small proportions*, that the first attempts at a rational abutment are met with. The vault is supported by heavy walls and standing buttresses to which in the interior correspond pilasters and transverse arches, a construction perfectly logical and influenced by Roman models. In some cases the abutment is even confined to the interior, forming side chapels within the nave, a peculiar refinement interesting to observe in that age. In this style of building and to heighten its effect, the application of *a pendentive dome* over the intersection of nave and transept is not uncommon.

This attempt is superseded in some provinces by the erection of *large edifices of the same type crowned with a row of pendentive domes*, one over each compartment. These form another peculiar group of buildings, half Byzantine in conception, still truly Romanesque in execution and, nevertheless, in their *ensemble* pointing towards another ideal to be reached, almost a renaissance before the Renaissance.

The constructive axiom, that the side thrust of a structure increases with its height, made it a matter of serious study in the case of the tunnel-vault how to erect basilicas. If there was to be more than one nave and the central one of any considerable height, the *aisles had to be raised* above the ordinary, or if this was not easily accomplished a *second story* could be added to the aisles to give the nave sufficient support. In both cases the aisles would be carried so high as to leave no space for admission of light. The power of the *galleries* thus introduced in the second story of the aisles in lighting the upper part of the nave was very small and the nave remained, accordingly, dark and gloomy.

In all structures, abutment is to some extent performed by the aisles. These are natural supporters of the nave as are transept and towers of the whole edifice. In this particular instance the aisles proved very effective, especially if the semi-tunnels could be made to spring from a point high enough to bring all their force to bear upon the nave.

Less heavy to handle, but possessing peculiarities that also called for ingenuity, was *the groined* or *cross vault.* The difficulty connected with this was in its way serious enough, but at the same time it satisfied better the demands of the time and became the more popular. Here the elements were heterogeneous and presented conflicting forces to be subjugated.

The groined or cross vault was probably first used in vaulting the crypts. In France the aisles were cross-vaulted at a time when the horizontal ceiling still prevailed for the nave. The problems to be solved by the Romanesque builders were (1) the stability and satisfactory character of the vault employed at a considerable height and span, such as in the middle nave, and (2) its application in spaces of different and irregular size.

In a *square* compartment vaulted by semicircular arches the intersecting lines or groins will naturally form — not a semicircle, but an ellipse, and thus offer grave weaknesses that may result in disaster. In order to prevent this, the groins had to be made semicircular by raising the apex of the vault and bulging the cells, a process which is said to "dome" the vault. The vaulting of an irregular space proved another problem. The semicircular arch has no capacity for adapting itself to spaces of different size. In a *rectangular* compartment, such as may easily be found even in the nave, the arches spanning the longer side differ in height and width from those spanning the narrower. In rising toward the apex the latter will in no wise compete successfully with the broader ones, but make the vault most uneven and unsightly. To remedy this it was decided to raise the level of the smaller arches either by making them elliptical or by stilting them, the latter to be preferred. The same problem occurs in the vaulting of *trapezoidal* compartments. This was met in various ways, the difference between the arches being equalized by making the larger one segmental, or by stilting the small one, or by letting the broader arch spring from a lower level, etc. The results may be deemed interesting in many cases although neither ideal, nor easily accomplished.

In spite of the fact that the builders of Southern France at last succeeded in making a basilica of the tunnel-vaulted structure, the only kind of vaulting which as a matter of course admitted light through the windows in the nave, and thus solved one great difficulty, was the cross-vault. Therein consists its chief and conquering quality which enables it to supersede all others, the basilica being the time-honored and universally preferred type of church-building.

Besides, from the point-of-view of final development, the use of the cross-vaults throughout the structure is almost a necessity. The tendency of all style hitherto had been towards a clear, although moderate, expression of the constructive agencies. In Romanesque art this is already done in the regulation of the ground-plan, the definition and grouping of supports, the vertical memberment that more or less supersedes and outshines the horizontal. The sense for logical disposition and exchange of forces demands a stricter calling into service of the truly constructive parts and reliance upon them. In the structures with wooden ceiling the absence of organism calls for an articulation of the constructive activity of the wall, in the structures with vaulting (except the cross-vault) the vertical memberment is more urgently pronounced, but horizontalism — by the very nature of these vaults — is still supreme.

In the application of the cross-vault, however, the vertical element is pronounced superior and the constructive struggle temporarily brought to a close. With the cross-vault it is the task to abut the points where the thrust consolidates. In the *interior* this is done by the large piers which are either raised to the point where the vault springs or from where strong shafts (in cluster or in a single body) rise to meet the arches of the vault. In the case of the larger squares of the ground-plan when the sexpartite vault is mostly employed, an intermediate shaft corresponds at once to the more slender support below and the intermediate arch above. The intersecting lines of the vault are the final interaction of the forces that separately

[1] Continued from No. 1027, page 88.

and still not disconnectedly undertake the support below. In the *exterior* the abutment is not performed with so much consistency. For the lower stories the standing buttress occurs frequently, but as far as the clerestory wall is concerned, no other abutment is used but that contained in the vaulting of the galleries. A single strip of vault, such as an isolated arch fixing upon the real point of thrust and leading the latter to the wall of the aisle, occurs only rarely and hidden under the roof. The time for these forces to become detached from their original element has not yet come. That they are still somewhat latent in their action is due to the reluctance Romanesque style shares with many other styles towards accentuating the particular at the expense of the general, and its preference for the wall and the vault as the main and safest support and quiet background for the active life of architectural memberment.

M. WERGELAND.

[To be continued.]

MATHEMATICS AND CONSTRUCTION IN "THE ÉCOLE DES BEAUX-ARTS."[1]

THE reputation of the Architectural Department of the École des Beaux-Arts of Paris is based almost wholly on its strength in design. The curriculum, however, necessarily includes a fairly thorough course in mathematics and construction, because graduates of the school are granted diplomas permitting them to practise architecture. Nominally they are also required to have had two years of office practise, but in reality a few weeks suffice.

The students are divided into two classes, known as first and second, and to pass from the second to the first fifteen "mentions" are necessary. They are one each in mathematics, descriptive geometry, stereotomy, construction, perspective, modelling and archæology, two in drawing and six in architecture. A bright student will accomplish this work in about two years, but it is possible for one who enters in March to do it in sixteen months. The first five mentions, which represent rather more than half the work, are the subject of this paper.

The instruction is given entirely by lectures which are an hour in length and usually come no oftener than twice a week in any subject. A French lecturer includes much more in a lecture than do our professors and the result is that the subject is less thoroughly grasped by the pupil. It is hoped that the reader will be able to form some conception from the number of lectures in a course and from the problems and drawings required during it and on examination of how carefully the ground is covered. The examinations will serve as the best criterion of the thoroughness attained. Merely outlines of the problems are given and without the details the reader will be apt to conceive them as simpler than they really are.

Of course any wording offers considerable opportunity for different interpretations of the amount of work expected, but there is such a spirit of competition pervading the school that the fullest interpretation usually results. In forming an opinion of the course the reader must bear in mind that all subjects are taught from the standpoint of their application to the study or practice of architecture, and everything not having a direct bearing on the subject has been eliminated from the curriculum.

The examinations are oral, but are supplemented by problems worked "*en loge*," which means that the student is assigned to an alcove and required to work out a problem in a specified time, varying usually from six to twelve hours.

The course in mathematics comprises about thirty-six lectures and includes the subjects of algebra, trigonometry, conic sections, analytical geometry and mechanics. The algebra includes equations as far as the solution by successive approximations of numerical equations of the third degree, decreasing geometrical progression, logarithms and interest.

Trigonometry includes the solution of plane triangles in general, the calculation of triangles by logarithms and the relation between a plane in space and its projection.

Conic sections receive much more attention than the two preceding branches. Quite a careful study is made of the curves resulting from the intersection of the cone and cylinder by a plane, and of practical methods of drawing them, and tangents to them; also of methods of measuring surfaces and volumes frequently met with in construction.

Analytical geometry is only touched upon and is taught mainly for its application to the curves of flexure of beams. It includes the curves of the second degree except the hyperbola, equations of the line and circle referred to polar coördinates, and in geometry in space, the equation of the line and plane and the angle between two planes.

Mechanics includes only statics and simple machines. Under the first are considered parallel and concurrent forces, composition of forces, parallelogram of forces, couples, moments, general equations for equilibrium, centres of gravity and resolution of forces; under the second, the lever, ballance, pulley, tackle, windlass, gears, inclined planes, the wedge, screw, and various applications.

The examination on this course in mathematics and mechanics is both written and oral. The written one usually consists of two questions, one of which is almost always the solution of a triangle and the other on mechanics. The oral is about three questions chosen at random.

As a course in mathematics it is certainly very incomplete; whether as a course specially designed for students of architecture it is also incomplete is a subject affording ample opportunity for discussion. Enough is included to suffice for the courses which are to follow, and the deficiency seems to be more in drill than in subject matter. Though the French seem to have found it sufficient to answer the actual needs of an architect, the American practice of adding a little more for the sake of the mental drill is a most excellent one.

In contrast with it is the course in descriptive geometry, which is very thorough, being the principal basis of stereotomy and perspective. The course includes fifty or sixty lectures, of which about ten are a review of the part required for entrance and ten on the finding of the most common shadows.

The best conception of the course is to be obtained from the examination questions, a list of which, divided into six series, is furnished to the students. The oral examination, part of which comes at the middle of the course, is on questions from this list, one being chosen at random from each series. The first series contains about twenty-five questions on the line and plane; the second, thirty on the sphere, cone and cylinder of revolution, problems of angles, the solution of trihedral angles and regular polyhedrons; the third, thirty on cones, cylinders, pyramids and prisms; the fourth, twenty-two questions on surfaces of revolution; the fifth, twenty-five on ruled and helicoidal surfaces, and the sixth, twenty-five on shadows.

Twenty-two plates of about forty of these problems must be drawn and constitute part of the examination. The problems on the first six plates are to be chosen from the first two series, on the second six plates from series three, four and five, and the remaining ten on shadows.

One problem must be drawn "*en loge*," for which six hours is allowed. The problem given last year was: A cube stands with its diagonal vertical, a second cube of the same size has its diagonal coinciding with the first, but is turned through an angle of $22\frac{1}{2}°$. Draw in plan and elevation the intersecting cubes and find the shadows at 45° on the solid and on the plane of projection. Pillet's text-book on "Descriptive Geometry" is closely followed in the lectures.

The course in stereotomy is also a thorough one and includes all of Pillet's text except the skew-arch. Under the division of masonry the lecturer treats of the methods and instruments used in stone-cutting, the principles of jointing, and of vaults, niches, domes and cupolas; the arranging and proportioning of treads of stairs, also vaulted and suspended stairs. Under the division of woodwork, the general rules of framing are considered, the methods of assembling pieces, general principles of roofs and the special ironwork of carpentry. This course also includes the methods of finding patterns of stonework and bevels of rafters, and two problems are given, the one in wood and the other in stone construction. Of those given last year the first was a small railway station which involved the design of the building, the framing plan of the roof and the principal bevels, also the framing of the stair and the patterns for the front string; the second was a building entirely in stone, to be erected in a public market square and to contain a fountain and other sources of water-supply for the market. It was to be a vaulted structure with the vaulting visible both inside and out, and a decorative motive based upon the structural form of the vaults. In the centre was to be a large stone basin and around the walls small basins supplied with both warm and cold water for washing purposes. Outside were to be troughs for the watering of animals. The basement was to be used for storerooms and was also to contain the apparatus for heating the water; a stone stairway was to serve as a means of communication with it. Drawings were required of the plan, façade and section, showing the jointing of the stonework, besides patterns of three *voussoirs*, one of which was to be from the vaulting of the stairway. A course in surveying, consisting of six or seven lectures and three days' practical field work, is appended to the above course.

The work in construction comprises twenty lectures on theoretical and thirty on technical construction. Brun's text on "Construction" is followed in outline, but in a condensed form, and the formulas which are given are demonstrated whenever possible by means of the mathematics already enumerated. The following outline is very general and the reader is expected to supply many headings which are necessarily preparatory to some of those enumerated. The lectures include internal and external forces acting on beams, application of formulas to all usual cases, beams of equal resistance, also beams subject to inclined pressures, columns, lattice girders, roofs, calculation of strains and deformations, curved roofs, metal ribbed vaults, expansion, friction, effect of wind, stability of masses and distribution of pressures, retaining-walls, problems of stability, applications to foundations in general, reservoir walls, stability of vaults and their supports, curve of the centre of pressure and its application to vaulting.

The technical part includes a description of the materials of construction, methods of handling and transporting them, foundations, rules for masonry work, walls subject to thrust, buttressing, shoeing, piers and columns. Vaults are treated first historically, after which follow descriptions of different kinds, methods of construction, centreings, piers, abutments and buttresses, stone stairs,

[1] A paper by James M. White, Assistant Professor of Architecture, at the University of Illinois, published in the *Technograph*.

paving with flagstone, brick and asphalt, and the draining of rain-water. The lectures on wood-working include descriptions of woods, methods of preservation, general principles of wood-working, assemblages, walls, floors, scaffolding, roofs, dormers, spires, towers, effect of wind and snow, roof coverings, stairs, joinery and special ironwork. This is followed with lectures on metal work, descriptions of the useful metals, commercial shapes, iron walls and floors, masonry work of floors, roofs, trusses, arches, awnings, glazed roofs, water-pipes, gutters, iron blinds and shutters, elevators, grilles, balconies, hardware, plumbing and gas-fitting, heating and ventilating, electric-bells, and lightning conductors.

Three problems are worked *en loge* during the lectures on theory and three general problems are required during the latter part of the course. Besides these problems there is an oral examination on each of the two parts of the course of about three questions. The nature of the problem to be worked *en loge* is known beforehand, so the student may be supplied with whatever data and formulas that may be necessary. One of these problems called for the design of a lattice I-girder of equal resistance throughout and to sustain a uniformly distributed load and two concentrated loads at equal distances from the end. Given the size of the angle-irons, height of web, width and thickness of cover-plates and diameter of rivets. Calculate the number of cover-plates required at the centre and at what points they may be successively discontinued, also the spacing of the rivets for the cover-plates and the lattice bars. Another problem was the design of a six-panel triangular truss, sustaining dead load only, by both analytical and graphical methods.

The three required during the lectures on technical construction involve design as well as construction. The first usually includes the investigation of a vault, such as: Design a grand stairway leading up to a terrace, the principal landing of the stair being vaulted. Calculate the vault and its buttresses. The second in one case called for the design of one bay of a riding-school, the walls to be of half-timbered work, trusses 38 metres centres and 20 metres span. Submit plan, elevation, details of framing and the calculations of the principal parts. The third is called the general problem and includes about all the ordinary problems of construction which can be centred in one building. The following one will serve as a sample: Design a museum building, consisting of a central glass-covered court, surrounded by galleries, three stories and basement high. On the third floor is to be a library. The basement ceiling is to be vaulted, the other floors to be of iron and masonry, the roof of the court to be of iron and glass, while that of the galleries is to be of wood and metal. There are required complete general drawings, problems of the stability of the vaults and notes on the calculations. These drawings are quite elaborately worked out and rendered in color, even the construction details having the shadows all cast at 45°. The feature of design enters every problem that requires drawing, no matter what the study.

The course in perspective consists of twenty lectures and is very thorough. Three problems are required besides one *en loge*. The following may be considered as samples: Design a pedestal bearing a statue, the base to be about 1.5 metres across and either square or circular. Make a drawing of a public place, surrounded by arcades and with a monumental fountain in the centre. No side of the square is to be parallel to the picture plane.

Make a drawing from nature of an *ensemble* or architectural detail, the drawing to be at least 0.25 x 0.35 metres. The problem given to be drawn *en loge* last year was the capital, architrave and frieze of the Greek Doric Order without triglyphs. The shadows were also required.

The above is, I believe, a fair representation of the work of the school not classed under the head of design, except the diploma drawing, which is a thesis design and involves details of construction and specifications. A candidate for a diploma is also required to pass quite elementary examinations in physics, chemistry and building law.

The usual problems in design do not include any calculations of construction as no construction is expected to be shown on the drawings.

RECENT EGYPTIAN DISCOVERIES.

THE extraordinary popular interest evinced of late years in the history of ancient Egypt is evidently on the increase, writes Mr. L. E. Steele in the *Irish Times;* and the remarkable fact that no less than three distinct collections of objects from amongst the most recent "finds" in Egypt are, during part of this present month of July, on exhibition in London, is sufficient evidence that the avidity for information in this direction is stronger than ever. Egyptologists, most generous of *savants*, have always placed their marvellous collections at the service of the *dilettante* and of the expert alike, and taken immense pains to point the lessons of the diggings and discoveries; and so it comes to pass that there is now a widespread and intelligent appreciation amongst the ordinary reading public of facts, which, but a few years ago, were deemed to be the heritage alone of the high priests of the cult of hieroglyph, tomb and temple. The educated man who nowadays is unacquainted with the salient facts of the history of, let us say, the fourth and eighteenth dynasties of ancient Egypt, or who speaks of cartouche and cartonnage, of pylon and propylon, of stele or scarab, with the hesitation begotten of ignorance, is held to be but a sorry fellow, and worthy of the fate which Osiris suffered at the hands of his brother, Set.

However, the sciolist has not quite got it all his own way yet, for, from time to time, popular speculations as to the buildings and beliefs of the nation of mummies assume fantastic and amusing form. It has ever been so. From the times of the earliest writers, from Herodotus to Georgius Syncellus, the *ex Africa semper aliquid novi* has made the imagination of the unlearned run riot in theorising, and has supplied the expert with excellent opportunity for administering archæological castigation. For example, Strabo, in the early days of the Christian Era, is at great pains to demolish a popular notion prevalent in his day with regard to the pyramids at Gizeh. The great mass of these buildings is composed of huge blocks of limestone of various sizes, cut for the most part from the neighboring quarries of Turah, on the opposite Nile bank. Now this particular limestone, geologically speaking of comparatively recent formation, is mainly formed of masses of small fossils known as nummulites; they are in size and shape not unlike lentils. The weathering of these huge artificial mountains has caused considerable deposits of these little hard brown fossils to form at the bases of the buildings. Two thousand years ago these deposits were perceptible to the men of Strabo's day, and they conceived the strange theory that they were survivals of the great stores of food provided for the generations of workmen who for many a long year toiled for the great kings of the fourth dynasty. This popular fallacy the old Greek proceeds to confute, and correctly points out that the so-called lentils are but petrifactions, examples of which he was familiar with at his own home in Pontus. But the men of two thousand years ago need no apology when, at the end of the nineteenth century, there are found some who believe that the stones of the pyramids are merely blocks of concrete moulded as the old buildings required them, and as the building rose — an ingenious enough solution of the mechanical problem, if tenable. The absurdity of the theory will be apparent at a glance. The "concrete" of which they are built is a "concrete" which, as far as is known, stretches right across the northern part of Africa, which pushes its way five hundred miles up the Nile Valley until it meets with the sandstone and syenite at Assouan, and of whose thickness the gods alone know the measurements. If we are to believe that the old Egyptian made his concrete blocks as the modern jerry-builder does, we must also be prepared to admit that he laid down this vast limestone floor of North Africa as the modern workman lays down his concrete footpath. But the concrete of Egypt is no work of man's hands, but the result of one of the infinitely slow processes of Nature's alchemy. Out of this limestone, of hoary antiquity when compared with the paltry four thousand years of Egyptian rule, the men of the land built many of their grandest edifices, and into this rock they hewed their way to find a resting-place for their honored dead.

It may be interesting for us to know the nature of these London exhibitions of objects from Egypt; at least, of two of the most attractive, as some may had an opportunity of visiting them during last month.

The Egyptian Exploration Fund has been carrying on a work of paramount importance for the past three winters in the neighborhood of Thebes. M. Naville, with Mr. Newberry and other devoted explorers, have succeeded in almost completely clearing one of the most exquisite and interesting of the temples, relieving the precious edifice of a heavy superimposed mass of rubbish, in some places no less than forty feet in thickness. They have revealed in its main features, for the first time in modern days, a temple which stands unique amongst the buildings of ancient Egypt for originality of design and beauty of workmanship; and one of these exhibitions contains a remarkable selection of portable objects which have been recovered in the course of the excavations. We need not concern ourselves now with the details of the exhibition, but rather try and gain some broad facts in connection with the architecture and chronology of this building, which will enable us to appreciate the importance of M. Naville's undertaking.

Right opposite to the stupendous ruins of the Temple of Amon, at Karnak, with the River Nile between them, stands, most curiously situated, this Temple of Dêr-el-Bahri. At this point, the great gaunt limestone cliffs of the old river-bank fold back into the Western Desert, and form an almost right-angled crease. At the base of the scar, and dove-tailed into a corner of the rock, the architect has planted the temple. At the upper or sanctuary end, and along the right side, the protecting cliff rises sheer from the platform and embraces the walls of the building, and also, be it said, has proved a source of enormous trouble to the explorers from the deposit which the weathering of centuries has rolled down from its sides upon the temple platform.

Now, if we imagine that the platforms and the buildings which the explorers have exposed form the temple proper, we shall be quite in error, and herein lies the feature which stamps this building as unique amongst the sacred edifices of the land. The temples of Egypt were either great independent erections, standing freely upon the plains, or gigantic caverns hewn into the cliff side. The temple of Dêr-el-Bahri is a combination of both. The great platforms, no less than three in number, rising like three gigantic steps, one higher than the other, are merely the approach to the temple. The holy of holies, the sanctuary of Amon, to which great god of Thebes the building is dedicated, lies in the cliff side, and for no less than sixty feet the visitor penetrates the solid rock to examine its features.

And besides this temple there are many minor rock-hewn halls and shrines, to which he will find entrance from the platforms. The building is, in truth, a transition one. The architect has taken his idea of the sanctuary from the tombs in the hill-side, especially those at Beni-Hassan, and suggestions for the platforms from the temples of his predecessors, combining them with consummate skill and taste. It forms, in style and in time, a link between the pile at Karnak and the gigantic rock-cut temple of Aboe-Simbel, which Rameses II, two hundred years later, carried for three hundred feet, the length of St. Patrick's Cathedral, into the cliff's side.

High up in the face of the precipice, the architect of Dêr-el-Bahri has hewn his temple and shrines, and the height at which he has placed them has suggested to him the conception of bringing the worshipper up from the level of the plain beneath by a succession of platforms, the first two of which are some 250 feet long and 300 feet wide. The "step" from platform to platform was too lofty to scale directly, and so the approach of the worshipper was facilitated by sloping ways, springing from the centre of each platform to the level of the one above it. The faces of these steps have been utilized for inscriptions and historic pictures, and, as we shall presently see, one of their surfaces records, with full illustrations, an incident of the time which has for us just now some points of special interest.

To whom do we owe this lovely temple? Who was its architect? When was it built? The excavations of the last three winters have given complete and satisfactory answers to the questions. Its erection was due to the munificence of Queen Hatasu, or, as she is otherwise called, Queen Ramaka, wife to Thothmes II, and aunt to Thothmes III, one of whose obelisks is a familiar object on the Thames Embankment. We are all now familiar with the idiosyncrasy of this great Queen. The pictures in her temple invariably represent her dressed as a man, while the inscriptions speak loud in praise of her as a woman. After all, she did no worse than Joan of Arc, and thus anticipated by some thirty-five hundred years the aspirations of the rational dressers and lady bicyclists of our own day.

And the architect? Who was this ecclesiastical artist — this Wren of ancient Egypt? We now know much about him. A statue of him is in Berlin, and his name was Senmut. Thus he speaks of himself in the inscription on the statue in words which curiously illustrate the trouble taken by the officials to combine the actual and assumed sex of their kingly queen: "I was a great man who loved his *lord*, and I gained the favour of my *queen*. *He* exalted me before the face of the land to the rank of overseer of *his* house and purveyor of the land. I was chief over the chiefs, head of the architects; I executed *his* orders in the land. I lived under the lady of the land, Queen Ramaka living eternally." And thus some fifteen hundred years before Christ, and two hundred years before the Hebrews fled from the land, Queen Hatasu and her architect, Senmut, planned and built this lovely temple. One word about the famous sculptures on the face of the step to the upper platform. A considerable portion of this wall-surface of almost three hundred feet is occupied with pictorial representations of a commercial expedition dispatched by the Queen to a land spoken of as Punt. Five ships comprised the expedition, and they returned laden with products, such as gold, ivory and incense; with animals, such as leopards, panthers, dogs, monkeys and giraffes; and with aromatic trees, which we see at first in flower-pots, and, after their transplanting, flourishing in the soil of Egypt — commodities which point undoubtedly to an African locality; and, indeed, there is excellent ground for supposing that Punt was no other than the coast of Africa, at the lower end of the Red Sea, and now known as the Somali country. Is it more than imagination that would see in that extraordinary Somali encampment in the grounds of the Crystal Palace the direct descendants of those men of Punt with whom the sailors of Queen Hatasu traded thirty-five hundred years ago? It is an idea worth considering as we run down to the palace after a visit to the Dêr-el-Bahri relics at Burlington House.

But the collection which transcends, in sensational interest at all events, is that which Professor Petrie and Mr. Quibell have thrown open at University College to all interested in this fascinating subject. Here we have brought home to our very door evidence of the astounding discovery made by Professor Petrie last winter, that in a district, extending for some hundred miles south of Abydos, there lived, three thousand years before the Christian Era, and contemporaneously with the Egyptians, a race of men wholly unlike the people of the land in their customs and their arts, ethnologically wholly unrelated to them, and, so far as is yet known, wholly unlike any race of antiquity. And the discovery has thrown a curious light on a passage in Juvenal. That author, in his fierce denunciations of Egyptian ways in the Fifteenth Satire, relates how that there were two towns, Ombos and Tentyra, between whose inhabitants in his day there was "a long-standing feud of remote origin," and tells how on one occasion, when the people of one town were holding high festival, they were attacked by the inhabitants of the other, and how, when the defeated Tentyrites fled, the Ombites paused, like a pack of wolves, in the pursuit to devour the body of a slain Tentyrite and pick his bones (*corrosis ossibus edit*). Now, Tentyra is the modern Denderah, some forty miles north of Thebes, but Ombos (in ancient Egyptian times called Nubt) has heretofore been identified with the well-known Kum Ombo, which place, unfortunately for the coherency of Juvenal's story, is situated one hundred and twenty miles, as the crow flies, south of Tentyra, and on the opposite bank of the river. They could not, therefore, have been considered "neighbors," as Juvenal asserts they were. Professor Petrie has set the question at rest for ever, for he has found and explored the ruins of a town quite close to Tentyra, which he has also discovered to have borne the name of Nubt, and, therefore, of Ombos. Moreover, he has explained the statement of Juvenal that "the cause of the feud was chiefly that each place disliked its neighbor's religion," by the discovery of undoubted evidence that the town was a centre of the worship of the hateful god of evil, Set, who, according to the legend, had destroyed his brother, Osiris, and to which cult the orthodox Egyptian was bitterly opposed; hence the hostility of the Tentyrites.

Now we must bear in mind that these two towns were distinctly Egyptian, and the evidence adduced by Professor Petrie from the remains unearthed on this new site proves the thoroughly national character of the art and architecture of the town. But within a quarter of a mile of this newly-discovered Ombos or Nubt, another town, with a great associated cemetery, was laid bare, which proved to be as un-Egyptian in its character as the other was Egyptian. Neither in the town nor in the cemetery was there found a single article bearing any comparison with the relics of the Egyptian town. To quote the words of Professor Petrie, "Not one scarab or cartouche, not one hieroglyph, not one piece of usual funeral furniture, a head-rest or a kohl-pot, not one Egyptian bead, not one god, not one amulet, not a single piece of Egyptian pottery," was discovered within the precincts of this strange settlement. It was evidently the centre of a powerful foreign colony. Although no trace was found to indicate a knowledge of the art of writing, the fine arts generally, with the exceptions of drawing and sculpture, which were crude, were found to be quite on a par with those of the Egyptians, and, in some respects, excelled theirs. The discovery of copper adzes point to woodwork, copper needles to the fact that sewn garments were worn; in flint implements, these mysterious people surpassed the Egyptians, and of pottery and glasswork no finer specimens have been found throughout the land. Professor Petrie assures us that the stone vases, of beautiful form, were made entirely by hand, with a lathe, and that the gracefully moulded clay vases were formed without the assistance of the potter's wheel.

But the sensational discovery lay in the cemetery. No less than two thousand graves were opened by the explorers, and their contents examined with surprising result. It was found that this early man, a tall, long-legged, long-bearded, eagle-nosed human being, did not mummify his dead, as his neighbors did, nor bury them stretched at full length, but, as Andrew Lang sings, entombed them

> With their toes
> Tucked up, an original plan,
> Till their knees came right under their nose,

and in a sitting posture, with the head to the south, but the face to the west. This was, however, the case only in the minority of instances. A far more extraordinary revelation awaited the explorers in the majority of graves examined. In these, the bodies had been cut up into pieces, and the bones grouped and arranged with evident design — ribs in one place, arm-bones in another and the skull, in many cases, placed between two vases. Most curious of all, there was evidence in this condition of the remains, as well as in the fact that the bones had been broken off short and the marrow scooped out, that amongst this primitive people there prevailed the horrible custom of cannibalism, which, in some way, was connected with their funeral and possibly with their religious ceremonies. It was a gruesome discovery, but one of intense interest. It is dangerous to speculate in the face of the warnings of Egyptologists, but one cannot help thinking that those Ombites, of Juvenal's time, who devoured the slain Tentyrite, were acting in accordance with an ancient custom which their remote ancestors had adopted from these mysterious foreign settlers, and handed down through three thousand years.

All exploration work in Egypt ceases with the approach of summer, and so we must wait patiently until another spring brings back Professor Petrie again, laden with the spoils of that land, which seems to yield its treasures and its history to this Egyptian magician with miraculous facility. Meantime, this brief account of the results of last winter's campaign may prove helpful in enabling us to appreciate the lessons of the exhibitions at Burlington House and University College. — *The Architect.*

BOOKS AND PAPERS.

MR. MARSHALL'S book[1] is really remarkable. It is rare to find the evidences of so wide a knowledge brought to the treatment of this subject; and rarer still to find such attainment used in so philosophical and open-minded a spirit. Each re-reading of the little volume removes earlier misconceptions and objections, until a feeling little short of unqualified admiration remains. The author's logical development of his theme, his wide range of intellectual sympathies, his fairness of judgment and his impersonality

[1] "*Aesthetic Principles*": by Henry Rutgers Marshall, M. A., author of "*Pain, Pleasure and Æsthetics.*" Published by Macmillan & Co., London and New York. For sale by W. B. Clark & Co., Boston; $1.25.

and modesty of style — all these are elements fighting on his side, inclining the reader to a sympathetic appreciation of his views.

Mr. Marshall bases his theory of æsthetics upon the phenomena of the mind rather than upon the phenomena of the external world of art. That is to say, his point of view is the psychologist's. His hypothesis is, that "the science of æsthetics is fundamentally a branch of the science of pleasure." In the development of this hypothesis, the reader is led to consider very briefly the inadequacy of previous systems of æsthetics, and is given a succinct idea of the nature of pain and pleasure, from a psychological point-of-view. Aesthetic pleasures, Mr. Marshall then proceeds to show, are distinguished from all other pleasures by one constant trait — namely, their relative *permanency*. By pleasure, the author means that totality of agreeable impression that results from any given experience, and which can only be estimated by the mind when the impressions resulting from other experiences are re-called and compared with them. Those which longest remain agreeable in this retrospective view, Mr. Marshall identifies as the æsthetic pleasures. The demonstration of this is very pretty. All primary sensative pleasures are dependent for their intensity and duration upon physiological conditions, and rise and ebb with the natural demand of the organs which are their agents. It is impossible, therefore, that any one particular pleasure should be, in point-of-fact, a permanent and uninterrupted one; but to the mind reviewing it in memory, it will appear as a yet unexhausted and so *relatively* permanent pleasure, provided attention has been diverted from it before weariness ensues. The function of the æsthetic faculty is, then, to combine the various agencies of pleasure-giving in such way that no one claims attention to the point when attention becomes weariness, but each contributes in some measure to the value of all the rest. Thus, out of various pleasures, of themselves short-lived, is produced a group, or *pleasure-field* as it is called, which can be enjoyed during a considerable interval of time. In proportion as the combination effected retains its power of pleasing, does it take rank as an æsthetic production.

It is plain to see that in the above theory Mr. Marshall has described with justice mental conditions which might have been familiar had we but been observant enough to notice them. His theory is at once justified by common experience. Of course, the work of art is that which longest keeps its hold upon our affections, and the greatest are those which "endure to the end." The justice of his delineation in the large seems so obvious that it would hardly appear as worthy of more than a passing consideration, if it were not for the train of lesser, but more applicable conclusions which follow from it.

Perhaps the most important of all the results of the above classification of æsthetics is that, according to it, no resultant of human activity, or even any unsought effect of Nature, is excluded from the possibility of producing æsthetic effects upon the observer. No arbitrary line is drawn which must be enforced by dogma and defended by controversy. That which appears to any one as beauty is to him, for the time being, an æsthetic agent. Each person, therefore, is privileged to determine his own standard of æsthetic values. There are as many standards of what is beautiful as there are persons to hold those standards, a fact equally true of morals. From the constant clashing and comparison of these standards is evolved the fine appreciation which belongs only to the most highly cultivated of men.

Mr. Marshall lays great stress upon what he calls this "Relative Standard," partly because it seems to correspond with the actual facts as we see them commonly, and partly because it offers a premium to self-culture, and prevents an ever-enlarging field of delight to the advance of the race.

Another important conclusion is that to which the author is brought regarding the precepts which we have been accustomed to hear from youth, such as "seek truth," "get repose," "unity" and the like. He finds, as a consequence of his examination, that from a strictly æsthetic standpoint these should rather read, "avoid the appearance of untruth, instability, disruption," etc. From the *æsthetic* standpoint — for other considerations have their own point-of-view — the conscious effort must be negative rather than positive. It is not that truth is beautiful *per se*, for a factory may be as truthful as you please, yet not beautiful. It is not truth that adds, but the appearance of untruth that detracts. Repose is not beautiful in itself, but restlessness is unbeautiful; and so on.

This is a very fine discrimination, whose possible range of effect upon all theories of artistic procedures and criticism may not be at once perceived; but it is destined to excite the animadversion of the literary realists, at least, and, in our opinion, to go much farther. It certainly casts a light upon the nature of our feelings when we have come to find a building which we have always admired for its beauty to be in many respects a structural sham. We are conscious of a loss of regard for it; but this view of Mr. Marshall's would show that the nature of our disillusionment was moral rather than æsthetic. Our æsthetic appreciation suffers along with our moral appreciation; but it is the moral shock which has wrought the mischief, and that alone.

It is impossible to here further suggest the contents of this most able research into the underlying principles of æsthetics, as interpreted by psychology. Mr. Marshall's book is indispensable to all who profess to teach the theory of art. It is not a trifle to be absorbed at a single sitting, or a single reading. It must be patiently mastered, for it requires close thinking and a free mind. It is not a book of recipes for making art, and presents slight attractions for indolent minds. It is, rather, formative in its character, and will be welcomed by those who love to think seriously of art, whatever may be their predilections regarding existing theories.

Mr. Marshall's work yet leaves much to be said regarding the function and service of art; and his book will doubtless prove a stimulus to those who would have "pleasure" defined in larger terms than purely subjective ones. Perhaps the author will himself undertake this task?

HUBERT ROBERT,[1] to whom is devoted a rather too bulky volume, by M. C. Gabillot, the last one issued in the "*Les Artistes Célèbres*" Library, was an eighteenth-century French painter and engraver. He spent some years of his early life in Rome in drawing the remains of its ancient architecture, and after his return to Paris was made a member of the Academy and was much employed by royalty as a landscape architect, the grotto of the Bath of Apollo, at Versailles, being from his design. During the Revolution, Robert was deprived of his position and thrown into prison (where he worked at his art, when possible, with unrestrainable ardor) but was so fortunate as to escape the guillotine through a mistake of the jailer, who sent to the knife another prisoner of the same name instead of our artist, who lived to round out three-quarters of a century of an eventful and busy life.

His great industry and ability as a painter of architectural subjects are attested by the contents of M. Gabillot's monograph, which is well illustrated, not only with specimens of Robert's talent, but with numerous portraits of his friends and contemporaries, who included many notable people. The book is certainly of much interest, but viewed as an artist, Hubert Robert cannot be held to deserve so much more space than some of the greatest names in art have been granted in this series.

PROFESSOR PIERRE PARIS, the author of "*La Sculpture Antique*," has written the volume on Polycletus,[2] which is one of the latest to appear in the series of "*Les Artistes Célèbres*."

This noted Greek sculptor, the friend and fellow-pupil of Phidias, made the great chryselephantine statue of Juno for her temple at Argos, the site of which our American School of Archæology has excavated with important results. The most famous of his smaller works, of which we can form a better idea than of the Juno by the copies of them which remain, were two athletes known respectively as the Doryphoros and the Diadumenos, and an Amazon, the latter being preferred over the competitive model prepared by Phidias for the Temple of Diana at Ephesus. A sculptor rather of men (especially of strong men) than of gods, Polycletus wrote a celebrated treatise upon the structure of the human figure, and was also an architect, the theatre at Epidaurus designed by him, being, according to Pausanias, the most beautiful in the world. Of all this and more, Professor Paris writes learnedly in the book before us, which is illustrated with cuts showing the chief productions of Polycletus.

SOCIETIES

TWENTY-NINTH ANNUAL CONVENTION OF THE AMERICAN INSTITUTE OF ARCHITECTS.

THE Twenty-ninth Annual Convention of the American Institute of Architects is to be held at St. Louis, on Tuesday, Wednesday and Thursday, October 15, 16 and 17, 1895, with headquarters at the St. Nicholas Hotel.

There will be a session on the forenoon of each day, followed by a lunch at the hotel as guests of the St. Louis Chapter.

On Tuesday evening there will be a formal reception at the Museum of Fine Arts as guests of the St. Louis Architectural Club, and an address of welcome by the Mayor of the city. On the afternoon of Wednesday there will be a carriage drive through the residence portion of the city and the parks, and a luncheon at the Columbian Club or an excursion on the river. On Thursday afternoon, the Institute will visit the Anheuser-Busch Brewery, or prominent buildings completed or in course of erection, and in the evening will attend the theatre or Exposition.

The Committee has arranged for rooms at the St. Nicholas Hotel — without bath, for from \$1.50 to \$2.00 per day for each person, and with bath, from \$2.50 to \$4.00 per day for each person, according to location; double rooms for two, with bath, \$1.50 to \$2.00 extra.

The Institute has never met as far west as St. Louis, and the Chapter has made a special effort to prepare to entertain its guests. It is, therefore, hoped that you will be present, and that you will extend an invitation to any practising architects of your acquaintance, not members of the Institute, to attend its meetings.

If persons who propose to attend the Convention from Philadelphia, New York or Boston and the intermediate cities and towns,

[1] "*Hubert Robert et son temps*," *par C. Gabillot*. Paris: *Librairie de l'Art*. 1895.

[2] "*Polyclete*," *par Pierre Paris*. Paris: *Librairie de l'Art*, 1895.

will notify the Secretary before the 28th day of September, he will, if enough desire it, endeavor to obtain a special through car by a route which will accommodate the largest number and at the minimum cost.

Committee of arrangements:

George B. Post, Cass Gilbert, W. W. Clay,	From the A. I. A.
A. F. Rosenheim, Charles K. Ramsey, Thomas C. Young, W. B. Ittner, E. A. Manny,	From the St. Louis Chapter.

Per Order of the Committee,
Alfred Stone, *Secretary, A. I. A.*

The Illustrations

[*Contributors of drawings are requested to send also plans and a full and adequate description of the buildings, including a statement of cost.*]

DINING-ROOM: MONTAUK CLUB-HOUSE, BROOKLYN, N. Y. MR. F. H. KIMBALL, ARCHITECT, NEW YORK, N. Y.

[Gelatine Print issued with the International and Imperial Editions only.]

TWO DOORWAYS AT NEWPORT, R. I. MEASURED AND DRAWN BY MR. P. G. GULBRANSON, ARCHITECT, BOSTON, MASS.

DETAILS OF THE WATSON HOUSE, NEWPORT, R. I.: THREE PLATES. MEASURED AND DRAWN BY MR. P. G. GULBRANSON, ARCHITECT, BOSTON, MASS.

SECTIONS AND CEILING OF THE SHEPARD MEMORIAL CHURCH, SCARBOROUGH HEIGHTS, N. Y. MESSRS. HAYDEL & SHEPARD, ARCHITECTS, NEW YORK, N. Y.

The ceiling is executed in California red-wood.

[Additional Illustrations in the International Edition.]

ENTRANCE-HALL: MONTAUK CLUB-HOUSE, BROOKLYN, N. Y. MR. F. H. KIMBALL, ARCHITECT, NEW YORK, N. Y.

[Gelatine Print.]

A rear view of this building was published in the *American Architect* for April 22, 1893.

READING-ROOM OF THE SAME.

[Gelatine Print.]

SMOKING-ROOM OF THE SAME.

[Gelatine Print.]

BILLIARD-ROOM OF THE SAME.

[Gelatine Print.]

Communications

[*The editors cannot pay attention to demands of correspondents who forget to give their names and addresses as guaranty of good faith; nor do they hold themselves responsible for opinions expressed by their correspondents.*]

DANGEROUS STATE OF SALISBURY TOWER.

To the Editors of the American Architect:—

Dear Sirs,— In connection with the article on the above subject that appeared in this journal under date August 24, 1895, it will not be uninteresting to refer to the work carried out under the direction and supervision of Sir Gilbert Scott, who was appointed, as he says in his "*Recollections,*" "about 1859." He says: "Our next great work was the strengthening of the tower. The original thirteenth-century builders had erected a central tower, rising sufficiently high to receive the roofs of the four arms of the church. The story against which these roofs abutted is a very light structure, and was intended to be visible from within. It is perforated in its thickness by a triforium gallery, leaving externally, a wall of little more than two feet in thickness, while the interior consists of a light arcade with Purbeck marble shafts. The corner turrets have each a staircase, rendering them mere shells.

"On this frail structure the fourteenth-century builders carried up the vast tower some eighty feet high, with walls nearly six feet thick, and upon this, a spire rising 180 feet more. It need not then be wondered that the older story, so unduly loaded, should have become shattered. Subsequent builders have bolstered it up by flying-buttresses, and by every form of prop they could invent, till the sectional area of the added supports exceeded that of the original structure. Still, however, the crushing went on, and when I examined it, it had proceeded to very alarming lengths. I proposed to bond it together (in addition to the numerous ties it already had) by diagonal iron ties, and then gradually to insert new stones, in place of those which were shattered.

"The Chapter, for further satisfaction, called in the aid of an engineer, eminent for iron construction, Mr. Shields, whose opinion very much coincided with my own. To him was confided the arrangement and construction of the ironwork, which was admirably carried out under his direction by Messrs. James, of London. It consisted mainly of two heights of diagonal ties, branching out towards their ends and passing round the stair-turrets, and so grasping them firmly, through a height of several feet, in which space they are connected by vertical irons placed upon the exterior faces. When this system of ties was once firmly fixed, I felt that we could safely proceed with the reparation of the stonework. This was carried out under the direction of my excellent superintendent, Mr. Hutchins. Nearly all the steps of the four staircases were shattered, and had to be taken out and renewed and the same was the case of a very great amount of the stonework. This was effected almost stone by stone, so that small parts were only disturbed at once — a very lengthy process, but the only safe one. It spread over many months, till at last every crushed stone had been replaced by one stronger than the old one had ever been, and set firmly in cement, so that by the time we had done, the work was stronger than it had been when new.

"Reparations of a minor kind were effected throughout the tower and even to the top of the spire, where I had the satisfaction of inspecting them up to the very vane.

"We dare not do anything to the bent piers which carry the tower. Their curvature seems to have arisen from two causes, first, from the pressure of the arcades upon their flanks, and secondly, from their backs or flanks not consisting, as do their fronts, of Purbeck marble closely bedded, but of compressible rubble walling. These two causes acting together would almost necessarily produce flexure. This had been remedied in the north and south arches at an early date, by building arches across them at, say, half height. The same might have been effected by a stone screen in the eastern arch, but in the western it would produce an inconvenient obstruction. I have advised the authorities to keep a watch over the piers, and if any increased curvature should be observed, to take some precaution, such as the insertion of iron beams from pillar to pillar."

From the above quotation, it would appear that Sir Gilbert Scott and Mr. Shields thought that their method of "tying in" the corner stair-turrets would be a sufficient and lasting work of reparation. Sir Arthur Blomfield does not say whether these ties and external bands are causes of injury through rust, and Sir Gilbert Scott does not allude to "the numerous small rods, bands and plates which," says Sir A. Blomfield, "I believe to have been introduced in the upper parts of the angle turrets in the time of Bishop Sherlock." It is evident from the recent investigation that the work of reparation of about thirty-five years ago has to be supplemented to a very great extent by costly works at the present time, due chiefly to the thrust of the spire, and it will be very instructing to see what improvement science will now suggest upon the methods of thirty-five years ago. The immense strides taken during that time, in methods of construction, will probably result in strengthening once and for all the weak places and in giving an abutment to the thrust which will be sufficient for all time, but it may be surmised that Sir Gilbert Scott, whose experience in works of reparation of great magnitude and unusual difficulties was extensive, would be very much surprised to find that further repairs are required now. It is at all events to be hoped that such works as are executed now will not be found by the next generation to need further supplementing.

R. W. G. B.

Exhibitions

Boston, Mass.— *Summer Loan Exhibition; Gobelin Tapestries; Japanese Paintings; Line Engravings, Mezzotints, and Etchings by Rembrandt:* at the Museum of Fine Arts.

New York, N. Y.— *Twenty-eighth Semi-annual Exhibition:* at the Metropolitan Museum of Art.

Summer Charities Loan Exhibition: at the American Art Association Galleries.

Water-colors of American Yachts: at F. Keppel & Co.'s Galleries, 20 East 16th St., September 6 to 17.

NOTES AND CLIPPINGS

The Danger to Salisbury Cathedral. — The Salisbury *Journal*, writing with reference to Sir Arthur Blomfield's report on the danger to the spire of Salisbury Cathedral, says: As originally reared, the Cathedral of New Sarum was destitute of this crowning grace. Added by a bold afterthought on the part of some great architect of the fourteenth century, whose name is lost, Salisbury spire has now continued to lift itself towards the heavens for half a thousand years. But Salisbury spire, though one of the most graceful fabrics that the hand of man ever wrought, is also one of the most daring. The sub-structure on which the spire and the upper part of the tower rest was not intended by the original builders to bear such a burden — gigantic as glorious. We need hardly remind our readers that the early English cathedral church of which Bishop Richard Poore laid the foundations in 1220 included only the lower part of the central tower, originally constructed as a lantern. A hundred years later — in the reign of Edward III, and while Wyvil was Bishop of Salisbury, it was the good fortune of the cathedral to be crowned with its noble spire by some unknown architect. With the insight of true genius, he grasped the opportunity transmitted to him by his thirteenth-century predecessors, and carrying the tower to a greater height, ventured to place on it the lofty spire. But, like some other men of genius, in taking advantage of the means afforded him for a display of his powers, he tried those means to the utmost. While he bequeathed the spire of Salisbury to succeeding ages as an object of reverent wonder, he also made it a treasure which was only to be preserved by the exertion of exceptional vigilance. That vigilance has, on the whole, been displayed; but as Sir Arthur Blomfield's report shows, it has not always been well directed. The numerous iron bands, rods and ties which have been introduced from time to time, with the object of strengthening the fabric, have often done more harm than good; the destructive agencies of wet and frost have been at work from year to year and from century to century; and the tremendous thrust of the spire has never ceased its pressure, which is both downward and outward. This last element of danger cannot be removed or even lessened; but hitherto it has been encountered by a resistance that was strong enough to prevent a catastrophe. No doubt the genius who reared the spire to its splendid height counted on that resistance being watchfully maintained; but the alarming discovery has now been made of a decay — apparently unsuspected until very recently — which has already become so threatening that, unless the damaged portions of the fabric are promptly and effectually repaired, the day may not be far distant when the ceaseless attack of time will prevail at Salisbury, and the beautiful spire of our cathedral will share the fate of other lofty spires and towers that have been laid in ruins. — *St. James's Gazette.*

Experiments on Wind-pressure. — The subject of wind-pressure is one on which our knowledge at the present day is not only limited, but exceedingly vague, and carefully made experiments, if but to investigate a single feature of the problem, are, therefore, of the greatest interest, and can hardly fail to add something new to our information. Mr. J. Irminger, C. E., Member of the Danish Society of Engineers, has determined, what it is believed no one before him has attempted to do, the amount of suction produced by a current of air striking a plane surface, or the surfaces of various bodies; and the results of his experiments form the subject of a paper with the above title, read before that Society in the early part of last summer. These results are remarkable in showing how very large a percentage of the total effect this suction is, not only through its action on the leeward side, but on the windward as well. In fact, when the angle at which the wind strikes a plane surface is small, nothing but suction is produced. The practical importance of these experiments is evident; they throw considerable light on the subject of flight, which at present is engaging so much attention; and in structural designing they point out the way to more rational methods. We have hitherto considered the resultant of the pressure only, but if that of the suction is also taken into account, the final resultant is changed both in amount and direction. Thus in the case of a roof, given below, the resultant of suction and pressure will tend to lift, and not overturn it, which is in accordance with experience. . . . Models were also experimented with representing buildings with roofs of various forms, and diagrams are given showing the distribution of pressure over leeward and windward sides. In all cases rarefaction on the side is quite as important a factor in the actual resultant force on the building as is the positive pressure on the windward side. The case of the pitched roof making angles of 45° with the horizontal on which a horizontal wind acts at right angles to the ridge is particularly worthy of note, and furnishes some food for thought. The normal pressure on the lee side due to suction is more than three times as great as that on the weather side. The resultant pressure on the two faces (neglecting the walls of the building) is inclined upward, and is about three and one-half times as great as that on the weather side. On the weather side the pressure is greatest near the lower edge, diminishes uniformly, and becomes a suction near the ridge. — *Proceedings of the U. S. Naval Institute.*

Earthquake Shocks in New York. — Apropos of the slight earthquake shock that affected New York City on September 1, the *Times* of that city publishes the following data concerning earlier shocks which have been felt there. Manhattan Island has been singularly free from the effects of earthquakes, probably owing to the sandy nature of its foundation. The last serious shock was felt by New Yorkers in March, 1893, about half an hour after midnight. On that occasion houses were shaken to their foundations, people were awakened from sleep, and the animals in the Central Park menagerie howled with terror. The disturbance was most felt in the neighborhood of Seventieth Street. The old clock on the Central Park Arsenal stopped and the Park policemen asked each other what was the matter. In the upper part of the tenement-house district on the east side crockery rolled off the shelves and a number of windows were broken. The general effect was that of a heavy explosion. Another slight subterranean disturbance was felt in Jersey City the following morning, and another shook houses in Brooklyn, frightening people into the streets. This shock was felt all over Long Island, and the water-supply of Flushing was stopped for several hours. When the water again filled the pipes, it was found to be muddy as though effected by some subterranean convulsion. Another shock was felt as far back as 1884, and still another in the latter part of 1891. The latter shook the Fifth Avenue Hotel, the foundations of which, as is well known, rest on a bed of solid rock, and the earthquake was the subject of jocular comment in a gathering of Republican politicians which just at that time happened to be assembled in the hotel.

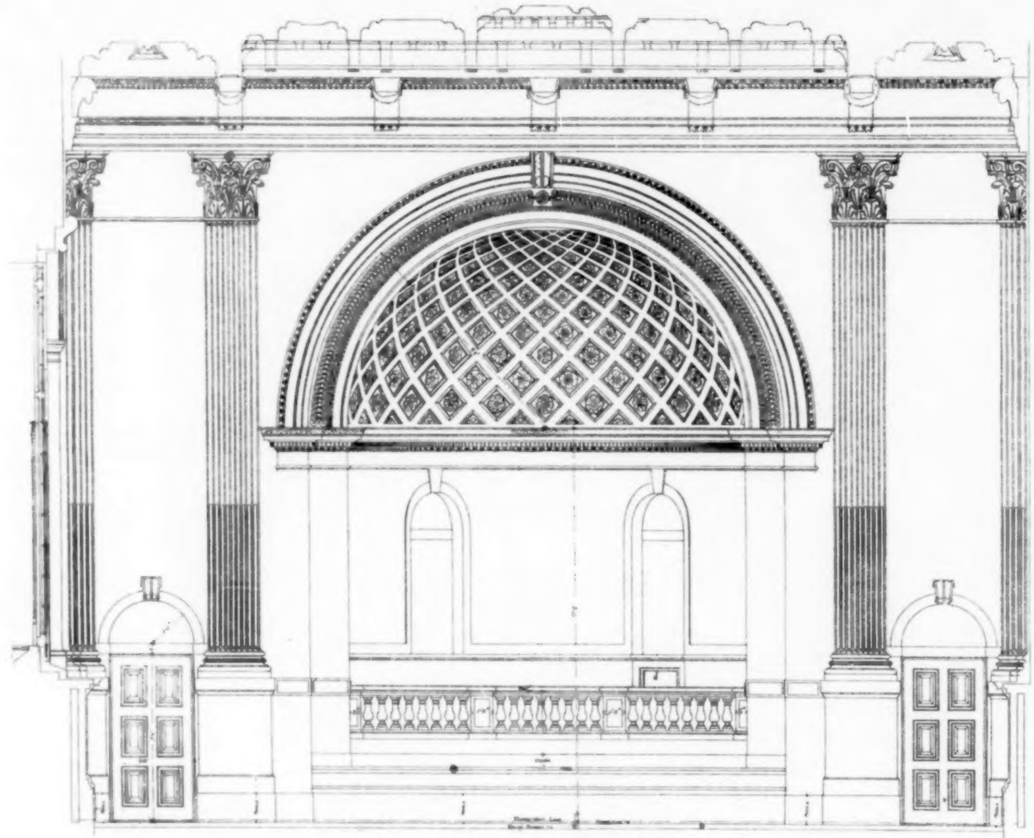
Wind-pressure in India. — At the present juncture, when long established notions of wind-pressure are being severely questioned, the following rule issued by the Public Works Department of India is of interest: — The amount of wind-pressure on a railway bridge is to be calculated on the assumption, that the maximum normal pressure may be 1⅛ tons per 100 sq. ft. of surface exposed. The surface exposed to be reckoned as follows: — A train surface calculated on a height of 13 feet 6 inches on 5-foot 6-inch gauge, or 11 feet on the metre gauge, multiplied by the total length of the girder. The actual surface of that portion of one girder which may be below rail-level, or at a height above rail-level of more than 13 feet 6 inches on the 5-foot 6-inch gauge or 11 feet on the metre gauge. Also, in the case of triangulated girders, the actual vertical surface of that portion of the leeward girder which may be below rail-level, or at a height above rail-level of more than 13 feet 6 inches on the 5-foot 6-inch gauge, or 11 feet on the metre gauge. The total wind-pressure thus calculated is to be provided for by a proper system of wind-bracing, or floor-plating, and its effects taken into account as forming a part of stress on the chords of the main girders. Proper arrangements must also be made at the girder ends to secure sufficient stiffness to resist racking action where diagonal stiffeners are not used. Wind-pressure is to be treated as "fixed load," and its effect on the different members of the structure is to be allowed for as provided in the rule for "maximum permissible stress." — *Building and Engineering Journal.*

Red-tape in French Administration. — Since the success of the play of "M. le Directeur," a satire on the French Circumlocution Office, the subject of red-tapeism has been much discussed in Paris. M. Paule Bourde, a high official in Tunis, declares that when he first obtained an appointment under the Government, he was astounded at the amount of useless trouble taken to put obstacles in every one's way. He remembers that on the occasion of the Centennial Exhibition of French Art, permission was given to an artist to take a cast from Barye's famous lion in the Tuileries Garden. But directly the artist set to work the Public Works Department ordered him to desist. The fact had been overlooked that, while the statue belonged to the Ministry of Fine Arts, the plinth was the property of the Ministry of Public Works. Letters were written, an inquiry was made, and the necessary permission was obtained only after a lapse of six months. Another writer cites a recent case of a subordinate official who asked his chief for a holiday. "You must write a formal request," said the chief. "But I thought," said the subordinate, "that as I was able to to see you personally, it was not necessary to write." However, he was told that it was necessary, but that he might take a pen and write the letter then and there. When this was done his chief said: "You may go now. You will in due course receive my reply, by which I shall have to inform you that it is not possible for me to do as you wish." — *London Daily News.*

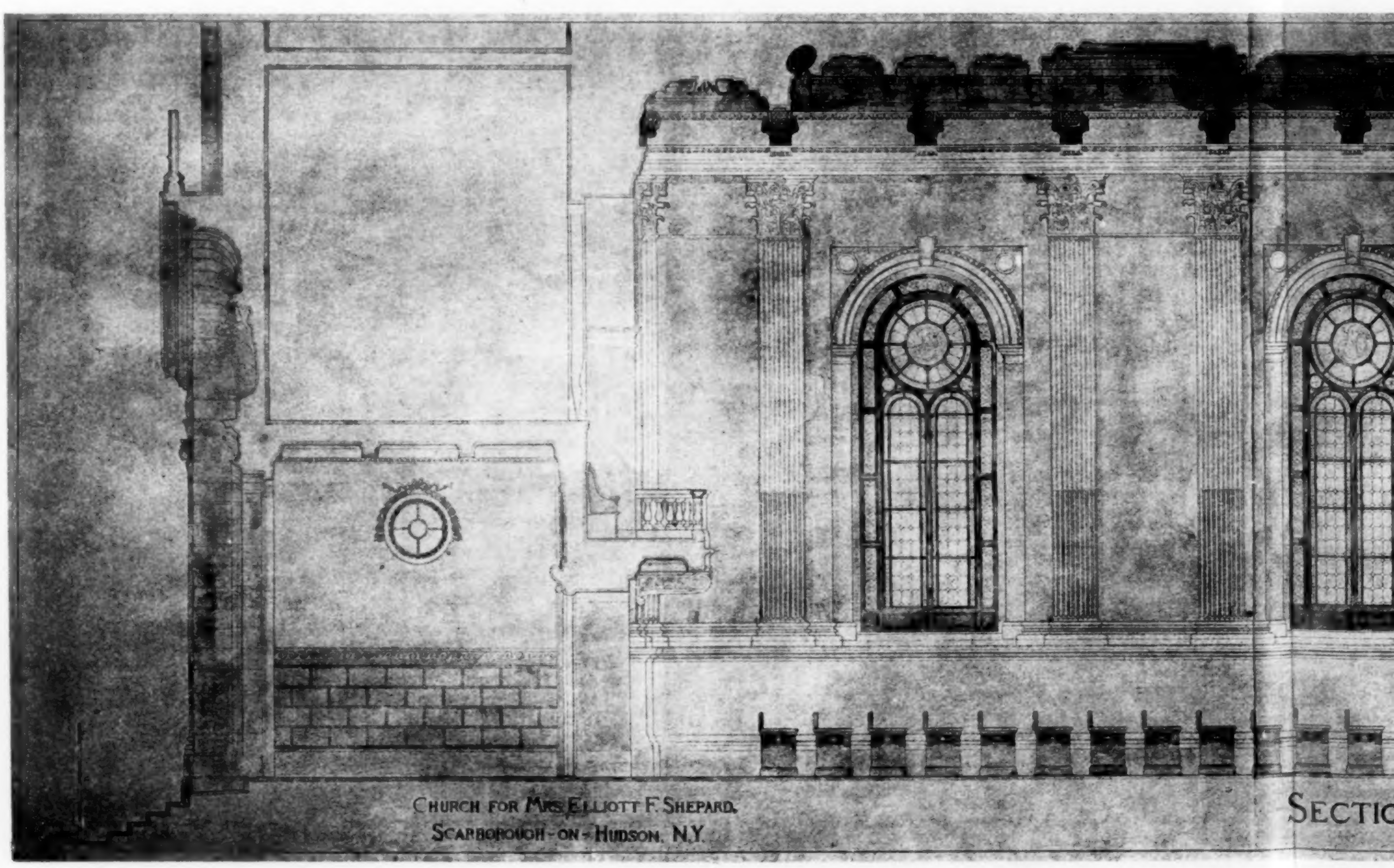
Why Emperors avoid Mayence. — Our Berlin correspondent telegraphs: At the last review at Mayence, the Emperor is reported to have said to the officers: "Do not forget that we must be strong in order to maintain peace, and that the stronger we are, the more respect will others have for us." It has been remarked that the Emperor has not entered the town of Mayence itself, although he has been repeatedly, and even this week, close to it. A local newspaper tells the following story in explanation: On a wall of Mayence Cathedral there is a sculptured hand, which is raised as if in the act of taking an oath. When the Emperor Francis of Austria was still German Emperor, he visited Mayence, and was so hospitably received by the clergy that he solemnly promised, and took an oath, that that German Emperor who from that day came first to Mayence and spent the night there, must pay for the building of the two towers on the cathedral. As a sign of the promise the hand was carved in the stone. "And no Emperor has spent the night there since that time," said the old man who is represented as telling the story, "and you will see that the present Emperor will not stay here any more than his grandfather did." — *London Daily News.*

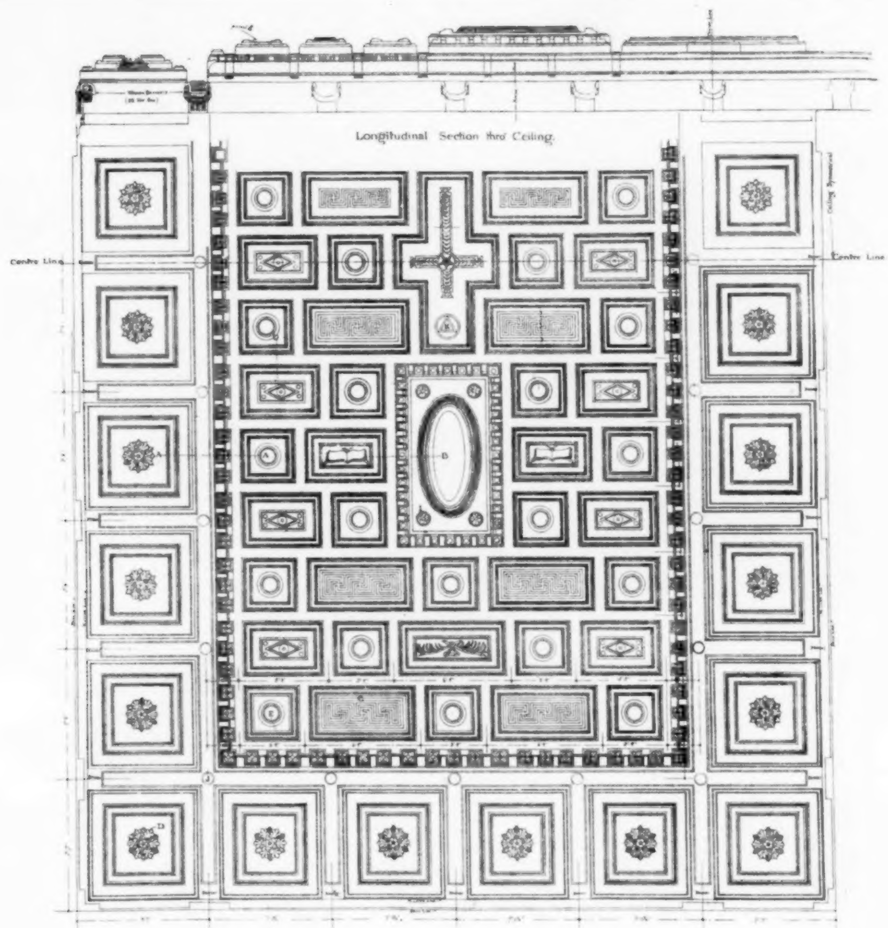
A strayed Canova Monument. — Canova, in 1812, made a monument for a Polish family, in Warsaw, representing a soul floating from heaven. It was sent from Italy, but when it reached Vienna the war made the country so unsafe that the monument was placed temporarily in the parish church of Penzing, just out of Vienna, where it has remained ever since. Recently the family for which it was made asked for it, when the parish priest refused to give it up unless he was paid $1,000 for more than eighty years' storage. The matter was referred to the Government authorities, and by them to the Commission for the Preservation of Artistic and Historical Monuments, which has decided that the priest was not justified in his demand, but that giving up the monument would be an artistic loss to Vienna. — *Cincinnati Commercial-Gazette.*

S. J. Parkhill & Co., Printers, Boston, U. S. A.

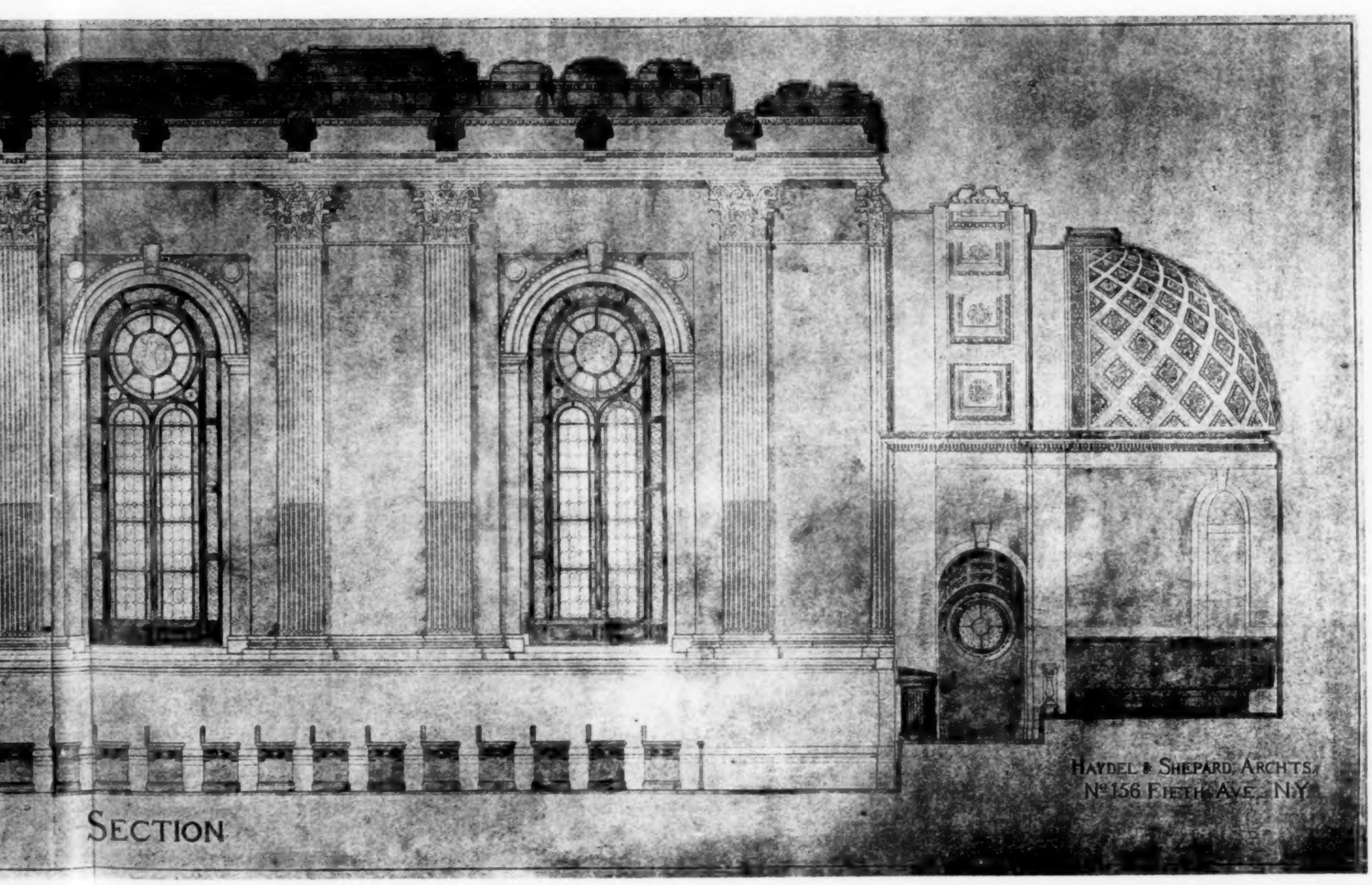


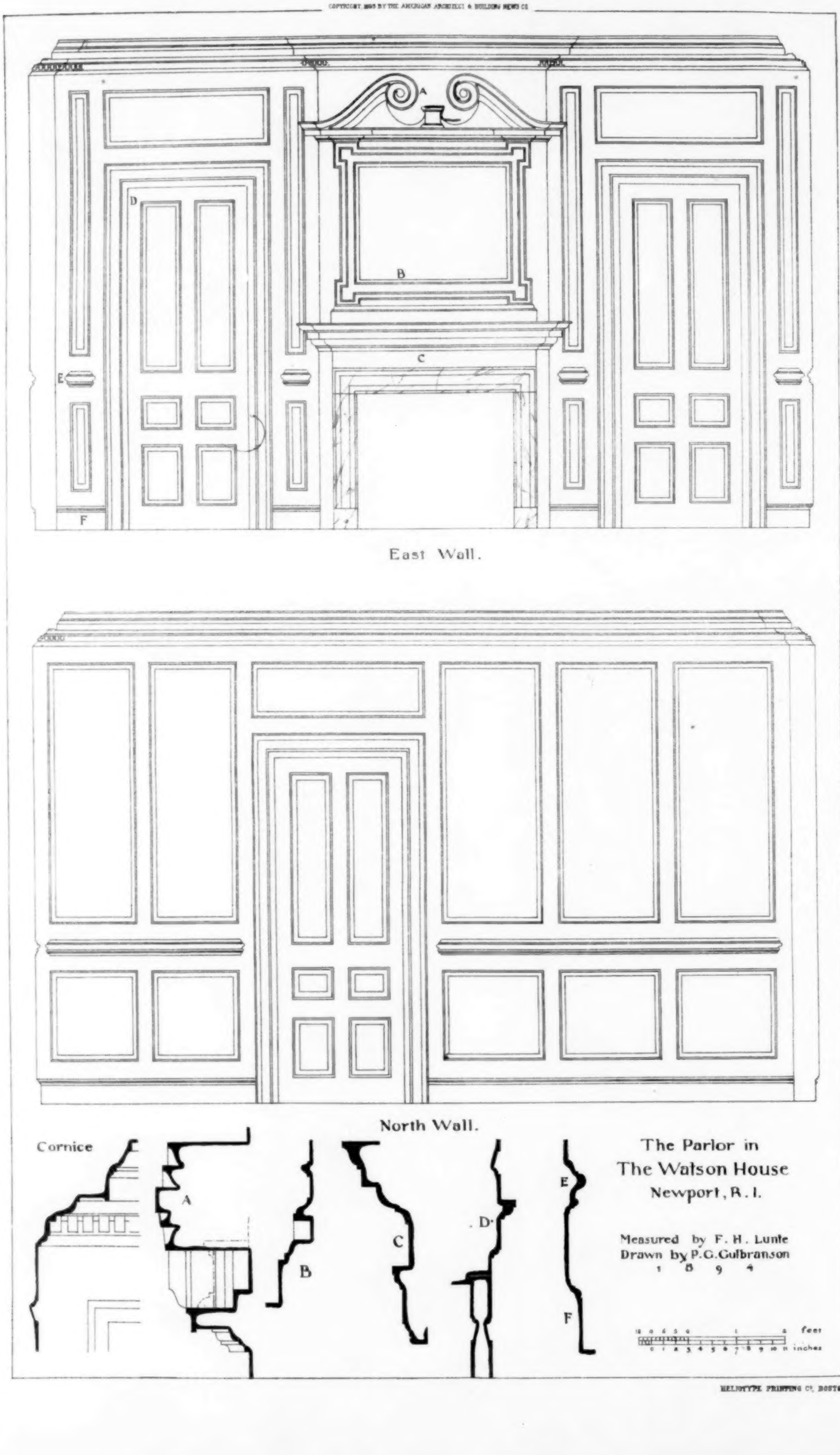
Cross Section looking toward Choir.





Plan of Ceiling.





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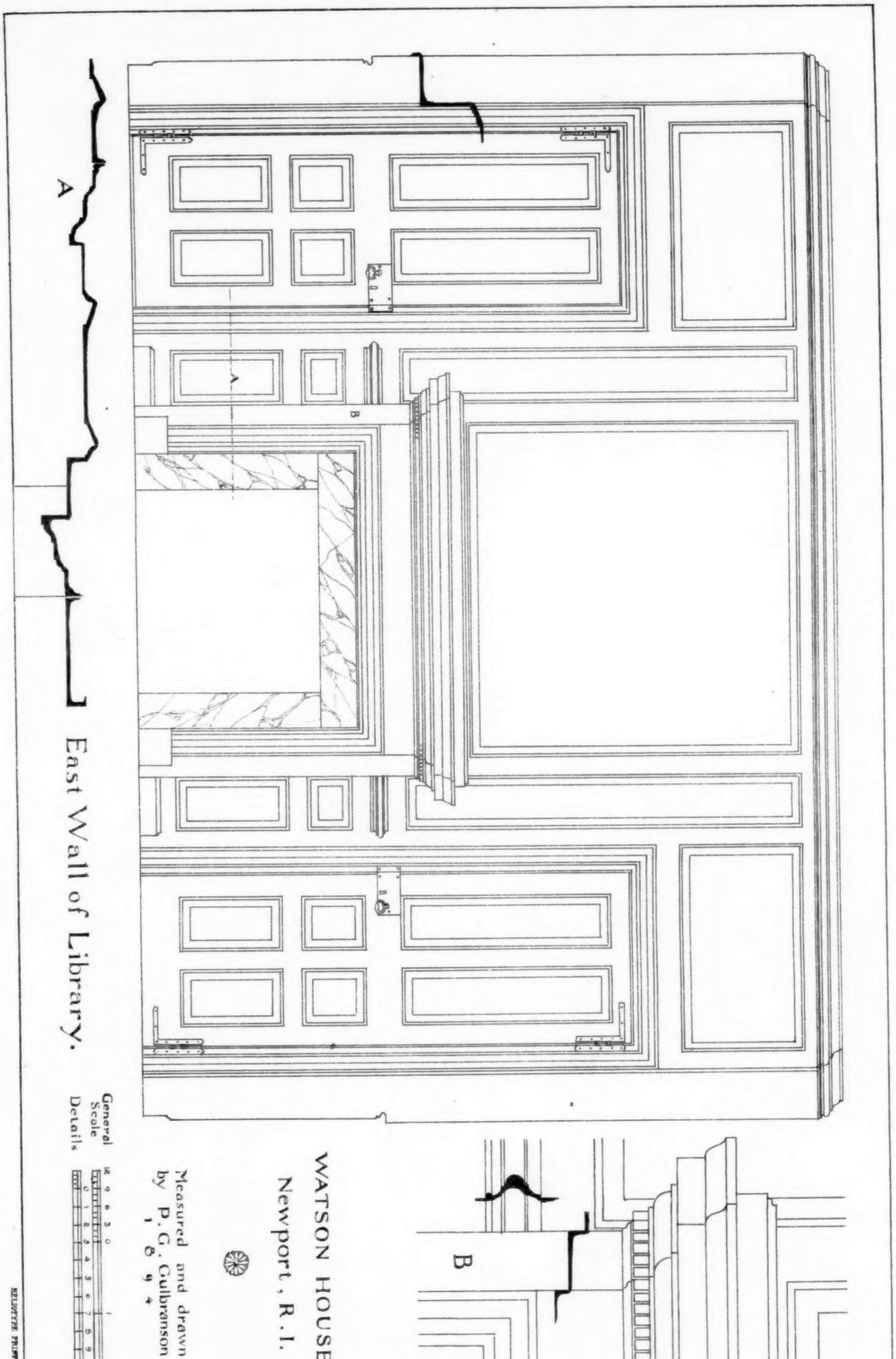
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East Wall of Library.
WATSON HOUSE
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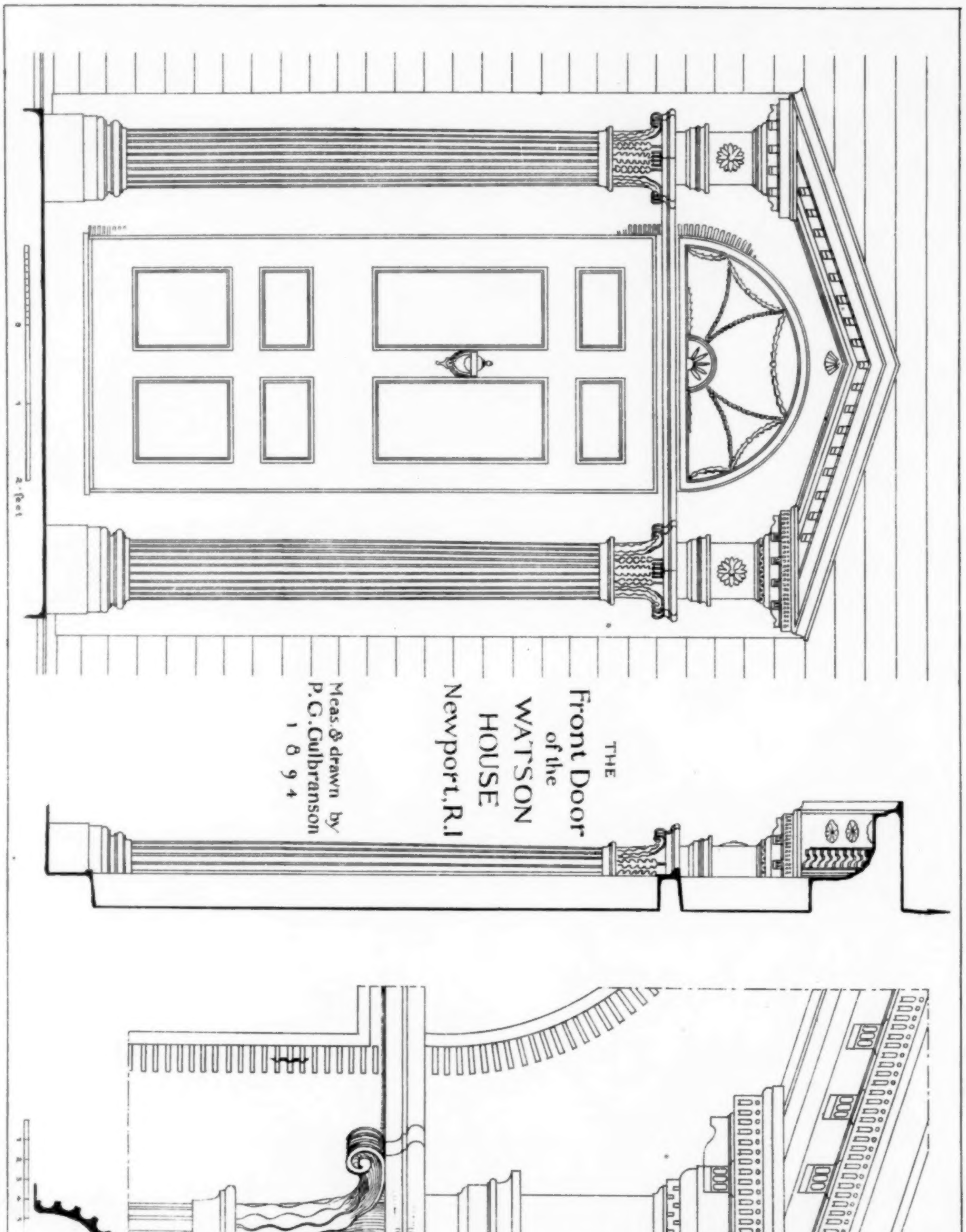
THE
Front Door
of the
WATSON
HOUSE
Newport, R.I.
Meas. & drawn by
P.G. Gulbranson
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AMERICAN ARCHITECT AND BUILDING NEWS, SEPT. 14, 1895. No. 1029.