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CONTENTS.

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A BILL, appropriating seventy-five thousand dollars for removing the Naval Monument, now standing at the foot of Capitol Hill, in Washington, to another part of the city, and erecting a monument to Columbus in its place, was passed by the Senate during the last session, and is now before the House of Representatives, which awaits a report upon it from its Library Committee, to which it has been referred. Meanwhile, the sculptors and architects who have heard of the bill are wondering who is the artist to whom the design of the new monument is to be entrusted. No general information on the subject has been officially given out, but an illustrated weekly recently published a picture of a model, which was described as being under consideration for execution. Who the author of the model was, we do not know, but, as the editor of the journal which published the design characterized it as having a large portion, at least, of the qualities which would render it unsuitable for execution, it seems safe to presume that it did not represent the best that American sculpture is capable of. Whether the author of this model was a volunteer, or was invited to prepare it, and if the latter is the case, on what principle the choice of him was made, are all equally uncertain. The time has rather gone by when the sculptor who had the prettiest curls was the one to receive the commissions for public work, but no very clear system of selection has been substituted for that of appeal to the susceptibilities of Congressmen, and it would seem as if the commemoration of Columbus by a seventy-five-thousand-dollar monument would furnish a very suitable occasion for the adoption of a practice in such matters worthy of the growing greatness of American art.

THE newspapers report that a large number of farmers in Aroostook County, Maine, which was a few years ago almost a primeval forest, are engaged in drilling wells through the rock which underlies the soil. It seems that, until within a few years, sufficient water could be obtained for domestic use from shallow wells, stoned around in the old New England fashion; but since the destruction of the forest by the lumbermen these wells have run dry, and it is now necessary to sink shafts through the solid rock. Worse even than this, it is said that the climate has become so dry that some of the more intelligent farmers are now considering the expediency of drilling deep and large artesian wells to supply them with water for irrigating their farms in time of drought. There is something rather curious and rather melancholy, also, in the idea of New England farmers, who certainly have enough to contend with in their business, being obliged to pump water from artesian wells to irrigate the scanty soil which barely covers their granite rocks, and it does not mend matters to think that they are driven to such a necessity by the ignorance and selfishness of their own fellow-citizens. The economic history of New England, whose first settlers found its fertile soil covered with the finest timber trees in the world, and immediately devoted themselves to exterminating, generally by fire, all trace of this vegetation, and whose descendants then, having converted the moist, fertile soil of their province into dry pasture-land, exhausted it with a few good crops, leaving it a barren waste, from which the present inhabitants are anxiously endeavoring to extract a scanty living by cultivating on it a few stunted specimens of the very tree which their great-grandfathers took so much pains to destroy, would be the marvel of the world, were it not that it has been repeated in nearly every State in the Union. Possibly it may occur to the Aroostook farmers that if their fathers had exerted their influence to have the forests of the United States put under intelligent official protection, they would not now be pinching themselves to pay for artesian wells to preserve themselves from thirst and their land from barrenness; and if this reflection should suggest to them the advisability of using their own influence to have the lands now waste replanted by the public authority, for the benefit of their children, their experience will not have been in vain.

A TRADES-UNION Congress was recently held at Belfast, Ireland, in which resolutions were adopted, indicating the sort of legislation which would be acceptable to the unions, in case they should ever have a chance to dictate in such matters. One of the most interesting of the laws which the Congress thought necessary was one by which the Government was obliged to provide employment for all unemployed persons, so that, in case of a strike in any trade, no one could be had to take the place of the strikers, and they would have their employers at their mercy. In addition to this, it was decided that the military ought, under no circumstances, to be allowed to interfere with riotous strikers. Evidently, with the employers prevented by law from getting any one to take the place of strikers, and left outside the protection of the public force, so that they could be hung, drawn and quartered, or simply tortured, as the interests of "labor" seemed to require, the millennium of the walking-delegates would be near at hand. Whether the people not belonging to the unions would find this state of affairs so pleasant is another question. It would not take long, under such a régime, to exterminate the whole race of private employers, leaving the Government the only employer, and the Government itself compelled to employ everybody. As the Government, in all civilized countries, consists practically of the citizens themselves, it follows that every one would have a claim on every one else for employment, and society would resolve itself into a simple struggle between the strong and the weak.

IT is curious that newspapers and politicians do not see how reactionary and subversive of all idea of liberty the trades-union system is. The whole of modern social progress has been in the direction of preventing the rich, strong and arrogant from oppressing the poor and weak, and a great deal has been accomplished. In the United States, at least, no nobles can obtain public employment in preference to the sons of workingmen; no rich man can bribe a judge to decide against a poorer opponent, and, until recently, no strong man could with impunity keep a weaker one, by blows and violence, from earning his daily bread. Now, however, the fashion has changed. Small bodies of delegates, professing to represent "organized labor," boldly threaten legislators unless laws are passed to give them advantages over other people, combine to cause extensive disaster unless their demands are complied with, and concoct all sorts of persecution and violence against free-born citizens who do not choose to submit to their will; yet the newspapers and party politicians vie with each other as to which shall be most obsequious to the inflated magnates of these mediæval associations. There seems to be reason for supposing that the union system is, in the United States, at least, on the decline, and he is no friend to the Republic who does anything to revive or render respectable one of the worst systems of tyranny that has ever infested any country.

THE prospect of railroad communication between New York City and the New Jersey shore seems to be rather distant, and there is no present prospect of its getting nearer. The Hudson River Tunnel Company, after constructing one tunnel nearly across the river, and making considerable progress on another, has been thrown into the hands of a receiver. The securities of the company are said to be mostly held in England, and it seems doubtful whether the work will be completed for many years, if at all. Besides the tunnels, two bridges have been designed to cross the Hudson River. One is a suspension bridge, and the other a cantilever. Both the schemes have been approved by the officials at Washington, and permission to carry them out will probably be given, but, as they are in charge of two different, not to say rival, companies, there is likely to be difficulty in securing the execution of either, unless the two companies should find some way of consolidating their interests.

THE New York *Sun* mentions a case involving a contract, which was decided a few days ago in Buffalo, by the Superior Court of the county. A man hired a team of horses, under a written agreement, which stipulated that upon one day's notice he should return the horses in the same condition that they were received. While they were in his possession, one of them was taken sick and died. The owners of the horses sued to recover the value of the horse, the lessee being unable to return the animal itself, but were defeated, the Court holding that the parties to the contract did not contemplate compliance with it on the part of the defendant, unless the horses mentioned in it should continue to exist, and as one of them had ceased to exist, from causes for which he was not responsible, as it was not alleged that the death of the animal was due to his fault, he could not be required to pay damages. The *Sun* compares this case with that of a builder who agreed to finish and deliver a house on a certain day, but was prevented by reason of the destruction of the building by lightning, and appears to think that there is a peculiarity about horses, which exempts them from conditions which would apply to inanimate objects; and cites from Benjamin's book on sales, in which it is said that "If A agrees to sell and deliver his horse Eclipse to B on a fixed future day, and the horse dies in the interval, the obligation is at an end," observing that "this illustration is directly applicable to the Buffalo case." With all possible respect for the *Sun*, we cannot think that Mr. Benjamin's illustration is at all suitable to the Buffalo case. A, in Mr. Benjamin's story, agrees to sell a certain horse, namely, Eclipse. When Eclipse dies, the parties to the contract are put back into the same condition that they would have been in if he had never existed. If, however, instead of Eclipse, A had agreed to deliver a horse of a certain value, without mentioning any particular one, he would not be excused from fulfilling his contract by the death of the one which he had in his own mind intended to sell. But if he would be bound to deliver some horse of the value specified to the purchaser who had agreed to pay a certain price for him, he would be still more bound to do so if the purchaser had paid the money in advance; and this was virtually the case at Buffalo. There is no more familiar rule than that if any one borrows or hires a piece of property, and it perishes in his hands, he must return a satisfactory substitute for it. If the Buffalo teamster had hired carts instead of horses, there would have been no doubt about his duty, in case one of the carts had been accidentally destroyed, and the real question before the Court seems to have been whether, in case of a contract relating to horses, which are goods of a peculiarly perishable kind, the risk of their remaining alive should be borne by the lessor or the lessee. This would be a question of the interpretation of the actual contract, and the court undoubtedly interpreted it correctly.

PROFESSOR JULIEN, of Columbia College, writes to the New York *Times*, proposing that the Egyptian obelisk in the Central Park should not only be protected by a metal cap over the top, as has been several times before suggested, but that the hieroglyphics should be gilded. What is most curious, however, is that, as Professor Julien says, these changes would restore to it the appearance that it had when originally set up in Egypt. According to him, the obelisks in Egypt were always furnished with a cap of gold or gilded metal, to reflect the rays of the sun, which the obelisks in some way symbolized, and he says that investigation shows that the intaglio hieroglyphics on most of them were either gilded or filled in with gold. Unfortunately, the rose-colored granite of the New York obelisk has faded so that the effect of the gold would not be quite what it was five thousand years ago; but it would certainly be interesting, and, with all its surfaces, except those nearly vertical, covered with impervious metal, the future preservation of the stone, for several hundred years at least, would seem to be assured.

AN Exhibition of Hygiene was recently held in Havre, and the managers of the affair had the good sense to leave the arrangement of the exhibits pretty much in the hands of the architect, M. Léon David, to whom, indeed, the original idea of the exhibition was due. M. David seems to have carried out his task with the zeal of an enthusiast, joined to the fertility of resource and eye for effect of a well-trained architect. Among other things, he prepared two types of houses, one sanitary and the other insanitary. In the latter, the errors of design and fault of execution, which, apart from the situation, help to render a house unwholesome, were shown to the life, even the spiders, cockroaches and other insects which harbor in damp and ill-built habitations being presented for the edification of the visitor. Just how M. David would construct a house which spiders and cockroaches could not enter we are not informed, but his models at least showed that hollow, unventilated spaces are favorable to the development of vermin.

ONE of the most interesting things shown in the exhibition was an apparatus for purifying sewage by electricity. It will be remembered that some experiments have been made in New York for purifying Croton water by treatment with electricity; but MM. Hermite & Company, at Havre, have undertaken a much more difficult task. The theory seems to be that, by electrolyzing a small part of the water, its constituents are disengaged in a condition in which they can act powerfully on the organic impurities contained in it. In the case of the Croton water this result seems to be successfully attained, but MM. Hermite & Company extend the principle by electrolyzing sea-water, portions of which are disengaged in such a form as to render the whole liquid a powerful disinfectant, which, on being mixed with sewage, destroys the organic matter present. In practice, MM. Hermite & Company, under the contract which they have already made with the city authorities of Havre, place electrical apparatus on the streets, which supply electrolyzed sea-water in large quantities. This liquid is allowed, at intervals, to run into the gutters, which it instantly disinfects, and then passes into the sewers, where it continues its purifying action. It must be confessed that the idea of using water from the docks as a disinfectant for seaport towns is adapted to excite some incredulity, but, to show its efficacy, MM. Hermite & Company have arranged to discharge a small quantity into the basins of several water-closets in the City-hall of Havre, and *L'Architecture* says that the matters in the basins are instantly dissolved into an almost inodorous liquid.

DIRECTOR BURNHAM is credited with an available idea for disposing of the World's Fair buildings. Knowing, as any architect would, that the cost of tearing down the buildings would be far more than the materials would be worth, he suggests that it would be economical, and perhaps profitable, to burn them after the exhibits are removed. He proposes to burn one at a time, setting them on fire at night, and charging fifty cents admission to the fair grounds for each occasion. If they burn briskly, the sight would undoubtedly be well worth the price of admission, but we imagine that the satisfaction of the architects, exhibitors and insurance men, who supposed that the "staff" construction was nearly fireproof, will be in inverse proportion to that of the spectators. Mr. Burnham thinks, with reason, that the steel roof-trusses, which are the most valuable part of the buildings, would not be materially injured by the fire, and it will be all the easier to take them down after the combustible surroundings are cleared away, and the lime and plaster rubbish, of which there will be vast quantities, will then be in tolerably available shape to be used for filling along the lake front, which is said to be their destination.

OFFICE-HELP FOR ARCHITECTS.[1] — XIX.

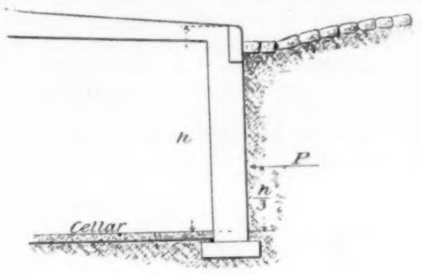


Fig. 78.

SECTION II. —

§ 257. Walls: *Sizes:* — Sizes of foundation-walls and piers will be given fully in Chapter VIII.

§ 258. Vault-walls: — A special case of retaining-wall.

The walls must resist:

(*a*) The horizontal effect of the earth-thrust.

(*b*) The vertical effect of the sidewalk load, or that of the superimposed earth.

The effect of load (*a*) on a wall with a vertical inner face (of approximately rectangular section) is to set up tension in the inner face of wall ∴ for stability the effect of (*a*) in creating tension on the inner 8″ of the wall should = or < the effect of (*b*).

The horizontal effect of the earth-pressure against any wall of approximately rectangular section is as follows:

Assumption: — Consider section 1′ 0″ long. Weight of material or earth against wall, 140 pounds cubic feet. (Fig. 78.)

Angle of repose of material, 30°.

t = thickness of wall in feet.

h = height of wall in feet.

P = horizontal component of pressure.

Then

$$P = \frac{h^2}{2} \times 140 \times .288 \qquad (54)$$

$$= h^2 \times 20.16.$$

P may be resisted in three ways:

First. — If walls across the vault, each 10′ 0″ are practicable by connecting these walls with horizontal arches five rowlocks thick, and 18″ rise, or arches of hollow fire-clay of 12″ rise (Fig. 79).

Or Buttresses may be built to resist the thrust, and arches built as outlined.

(For proportioning buttresses, see Chapter VIII.)

In proportioning, P from Formula (54) must be converted to the pressure per square foot at the bottom of the arch, and then L found by multiplying by l, and for a section 1′ 0″ high, $L = L^{\square} l$, thus:

$$\text{Maximum } L = \frac{P \times 1.5}{h} \qquad (55)$$

Then proportion the arch from Chapter V, or the necessary thickness of the arch may be taken from Tables of Flat Arches in Chapter IX.

Second. — Where walls are more than 10′ 0″ high, from underside of sidewalk beams to finished cellar bottom, it is probably more economical of money, and certainly more so of space, to support each sidewalk beam with an I-beam column, and connect the columns

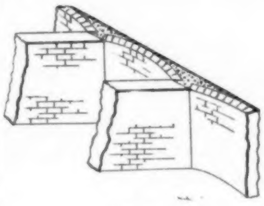


Fig. 79.

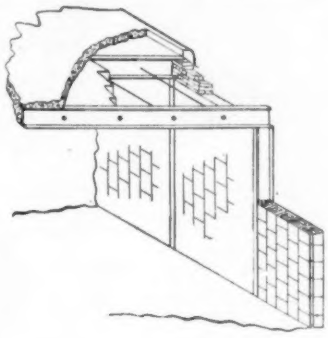


Fig. 80.

with either flat or segmental arches. In this case the columns would be proportioned so that the upper flanges shall have an area sufficient to resist the compressive strain due to the pressure from the earth, and in addition sufficient area to resist the compression from the sidewalk beams (See Chapter IV) Figure 80; the earth-thrust being assumed as concentrated at $\frac{1}{3}h$ and of amount $= P$.

The bases of the columns should be proportioned as per Section III, "Footings."

Third. — Where walls are less than 10′ 0″ high in the clear, or when the vault is divided into basement or sub-basement, so that the clear height is 10′ 0″ or less, the pressure may be resisted by means of rectangular walls.

In this case, as in all other cases of earth-pressure against a vault wall, the pressure due to the earth is assumed as concentrated at one-third the height of wall above the bottom; its bending-moment then at this point, the upper edge being assumed to be held by the sidewalk beam, is

$$M = \frac{P \times \frac{1}{3}h \times \frac{2}{3}h}{h} = 20.16\, h^2 \times h \times 0.22 = 4.46\, h^3 \qquad (56)$$

This is resisted, first, by the weight of the wall multiplied by its lever arm or

$$W = 70\, h\, t^2 \qquad (57)$$

and second, by the effect of the sidewalk load which produces compression on the inner 8″ of wall, and is

$$C = l \times 100 \times (t - .33) \qquad (58)$$

Then we must have for equilibrium

$$M = W + C.$$

If the wall fulfil this condition, it may be considered safe.

Any wall to resist the frost-thrust must be at least 12″ thick, and for wide sidewalks, to be safe against shocks, should be 16″ thick.

On this basis Table XXXII has been computed.

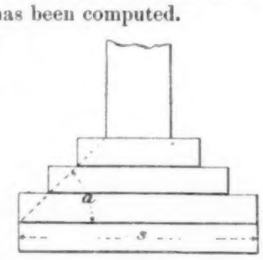


Fig. 81.

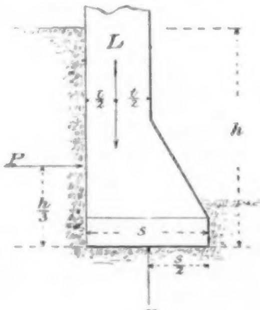


Fig. 82.

The inner faces of all walls should be vertical, the walls decreasing in thickness if desired, proportionately, on the outside.

If there are stories in the cellar, the effect of the floors is to stiffen the vault walls, and they then should be proportioned as

[1] By George Hill, Consulting Engineer. Continued from No. 926, page 182.

ABBREVIATIONS AND SYMBOLS.

= equal to.
|| parallel to.
÷ divided by.
× multiplied by.
\+ added to.
a^2 a multiplied by itself.
$a > b$: — a greater than b.
$a < b$: — a less than b.
$\frac{a}{b}$: — a divided by b.
∴ therefore.
□′ square feet.
□″ square inches.
8# read 8 pounds per lineal foot.
[channel bar.
I I-beam.
T T-iron.
L angle iron.
⊥ deck beam.
● round section.

I ton = 2,000 pounds as this is the conventional ton, the legal ton is 2,240 pounds, but is rarely used.
l = the length between supports of any beam or girder or height of any column, always in feet.
b = breadth of any beam or girder, always in inches.
d = depth of any beam or girder, or the least transverse dimension of any column, always in inches.
L = total load uniformly distributed coming on any piece in pounds.
$L^{\square\prime}$ = " " " " per square foot in pounds.
W = concentrated load on any piece in pounds.
s = span of any arch or truss between centres of end pins in fee[illegible] r spread of footing courses.
A = area of any section in square inches.
M = maximum bending-moment in inch pounds.
n = distance of centre of gravity of section from either top or bottom edge in inches.
I = moment of inertia, neutral axis through centre of gravity.
R = moment of resistance of section.
r = radius of gyration, in inches.
Sc = safe compressive strain in pounds per square inch.
St = " tensile " " " " " "
Ss = " shearing " " " " " "
S = strain per square inch in extreme fibre.
P_e = upward reaction of support at left-hand end of beam.
P_f = " " " " " right " " " "
e = distance of centre of gravity of load from left hand of beam.
f = " " " " " " " " right " " "

though their depth were the distance from sidewalk to basement beams, and for each additional story in depth increase the the thickness 4″.

Sizes: — Are for brickwork in hydraulic-cement mortar. For stonework use same thickness, but make minimum thickness 18″.

TABLE XXXII.

THICKNESS OF VAULT WALLS, AT BOTTOM FOR VARIOUS DEPTHS, h, AND FOR VARIOUS WIDTHS OF SIDEWALK l.

h	$l=12'$	$l=16'$	$l=18'$	$l=20'$
4′	12″	12″	16″	16″
6′	16″	12″	16″	16″
8′	20″	16″	16″	16″
10′	28″	28″	24″	24″
12′	36″	36″	36″	32″
14′	48″	44″	44″	40″
16′	56″	52″	52″	48″

§ 259. Piers: — Weight on piers should be carefully computed (see § 251). Size for first-class brickwork in Rosendale cement should be such that load = 10 tons per square foot. If permitted, have them built with every joint filled with mortar (no grouting) and without bond-stones. Cap with blue-stone or granite of thickness = the projection of stone beyond the steel or iron base.

Make base so that load on cap-stone from it = 60 tons per square foot. Height of piers should never exceed eight diameters.

SECTION III.—

§ 260. Footings: *Materials:* — Should be of rigid, imperishable nature: brick, stone, concrete, metal and occasionally wood (treated of under "Substructure").

Footings are intended to receive the load from the walls at their top, at an intensity of about 10 tons per square foot, and distribute it over the natural material, reduced to about 4 tons per square foot.

§ 261. Proportions: — Are fixed primarily by the requirements of the sub-strata.

$$\frac{\text{Total load from § 251 for soils}}{\text{Bearing-value, Table XXIX}} = \text{Spread of footings.} \qquad (59)$$

And for piles,

$$\frac{\text{Total load from § 251}}{\text{Bearing-value of piles, Table XXXI.}} = \frac{\text{Number of piles}}{\text{per lineal foot.}} \qquad (60)$$

Spacing of piles will be fully treated under "Substructures," § 270, which see.

The width of spread being determined, the material and proportions will be determined by limitations as to

(*a*) Allowable width.
(*b*) Allowable height.
(*c*) Allowable time for construction.
(*d*) Cost of materials.

Generally, the angle a Figure 81 will be as per Table XXXIII.

TABLE XXXIII.

INCLINATION OF FOOTINGS.

For metal	footings — 75°	3′ 9″	batter per foot.
" stone	" — 60°	1′ 9″	" " "
" concrete	" — 45°	1′ 0″	" " "
" brick	" — 30°	0′ 7″	" " " or 1⅝″ per course.

All footings should start with a vertical portion 16″ high.

With the material on the ground, footings can be constructed in point of least time in the following order: metal, brick, concrete, stone.

As to cost under usual conditions, least cost will be for brick, then concrete, metal, stone.

Usually there will be limitations coming under one of the four heads given above, which will narrow down the conditions, so as to leave but little choice.

Where only the best results are sought, the writer believes that brick should be used, since in brickwork, the effect of poor work on the part of the mechanics is least felt.

§ 262. Brick Footings: — Should be of the best hard common brick, or common hydraulic pressed brick, laid in Rosendale-cement mortar, one cement to three sand, carried up one course at a time, with all of the joints of the two outer courses filled full, then the space between them filled half-full with mortar, and the bricks pushed into place, with a sliding motion, so that the mortar will be pressed up, and fill the joints.

Especial care should be taken with the bonding, so that each brick may bear on at least two bricks below, and if practicable

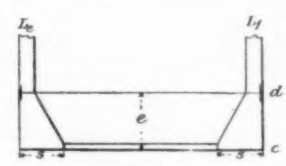


Fig. 83.

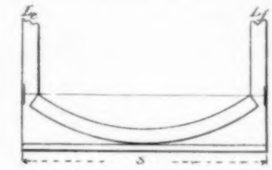


Fig. 84.

on four, and the bonding should be carried back through the entire thickness and height of the footings, excluding all bats except such as are necessary for closures. The laying should proceed as follows:

Spread a levelling course of cement-mortar 2″ thick.

FOR WALLS 24″ THICK OR OVER.

First Course: — One row of headers on each face, then a row of stretchers, then alternate headers and stretchers to a closure.

Second Course: — One row of stretchers on each face, starting with a ¼ brick, so as to bring the first brick overlapping on three, then a row of headers, then alternate stretchers and headers to a closure.

Third Course: — Same as first.
Fourth Course: — Same as second.
Fifth Course: — Same as first.
Sixth Course: — Same as second. These courses vertically over one another. Then begin racking back 1⅝″ for each course until thickness of wall is reached.
Seventh Course: — Same as first.
Eighth Course: — Same as second, and following out in the same way until the wall thickness is reached. The last course of the footings, or the first course of the wall should always have header courses on the outside.

FOR WALLS LESS THAN 24″ THICK.

Proceed as above described, making only three courses vertical.

Exception: — Treat chimney-stacks 60′ 0″ high or over as though walls were 24″ thick.

Make the footings for all walls symmetrical on both sides wherever possible.

§ 263. Unsymmetrical Masonry Footings: —

P = Earth pressure. (Formula 54.)
L = Load from wall. (Tons.)
R = Upward reaction from earth = L.
$a = \frac{1}{3} h$ or $\frac{1}{3}$ of depth of footings below grade.

Then for equilibrium we must have, (Fig. 82).

$$L\left(s-\frac{t}{2}\right)-\frac{R\,s}{2}=\frac{P\,a}{2{,}000} \qquad (61)$$

a should never be more than t above the footings, and should also be as high up as possible — remember also that L and R are

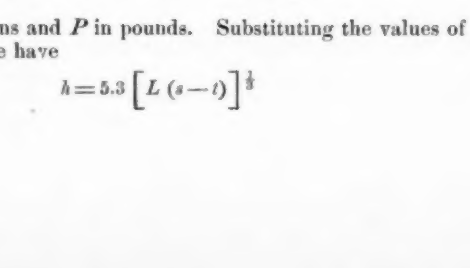


Fig. 85.

in tons and P in pounds. Substituting the values of P, R and a, we have

$$h=5.3\left[L\,(s-t)\right]^{\frac{1}{3}} \qquad (62)$$

Where this gives impracticable results for h (as it will for heavy buildings) two courses are open:

First. — Arrange the footings of two walls or piers, carrying the same weight as nearly opposite as possible; extend a bed of concrete 16″ thick from one to the other at c, and connect the parts at d with tie-rods or beams forming the flooring, making the area of tie-rods in square inches A according to formula.

$$A = \frac{L\,(s - t)}{16\,e} \qquad (63)$$

The anchor-plates holding these ties into the walls should be placed as far from d as possible, and should have ½ square foot of area for each square inch of A. These results are for one lineal foot of wall; the distribution may be made to suit each case, but the tie-plates should be spaced apart not more than $2\,t$ (Fig. 83) in the clear.

Second. — A series of inverted arches may be constructed either in metal or masonry (Fig. 84) connecting walls or piers of nearly similar weights:

For Walls: — If

$$R = \frac{P_e + P_f}{s} \qquad (64)$$

it is safe to found on the soil. If R is less, then piling or some other method must be resorted to to increase R to the value required to fill the conditions of (65) for walls.

For Piers: — The spread of footings under the arch may be increased by means of I-beams or rails to almost any desired depth (see "Metal") then, calling the spread in the other direction w, we have

$$\frac{W_e + W_f}{s\,w} = R\square' \qquad (65)$$

To Proportion: — Make arch a segment of a circle.

Make e as great as possible.

Make skew-backs of cast-iron dipped in hot asphalt, and coat with hot asphalt after setting, two coats.

Make pins and tie-rods of steel, and paint with metal paint, hereinafter described, one coat before setting, and three coats afterwards.

Make A = total area in square inches of tie-rods per foot of wall or for pier.

$$A = \frac{s}{64\,e}\,(L_e + L_f) \qquad (66)$$

Make $A\,v$ = total area in square inches of masonry in inverted arch

$$A\,v = \frac{s}{2\,e}\,(L_e + L_f) \qquad (67)$$

and make masonry of first quality hydraulic pressed brick, laid in Rosendale-cement mortar. If $A\,v$ = total area in square inches of steel in inverted arch,

$$A\,v = \frac{s}{80\,e}\,(L_e + L_f) \qquad (68)$$

In Steel: — Proportion depth of arch to fill the following conditions:

(*a*) Use I-beams for the compression member.

(*b*) Beams should be distance apart in clear = width of flange.

(*c*) Total width across beams = width of pier, or twice width of columns.

(*d*) Use a medium weight of the height of beam decided on, say 10% less than the maximum weight rolled.

The area of metal in a horizontal plane in the vertical ribs of the skew-back must be in square inches

$$A = \frac{L}{4} \qquad (69)$$

No rib less in thickness than 1″.

Area of pin and size of eye-bar must be taken from the tables.

In setting, spread the footing-course over and compact carefully. After two days, pick the surface over, wash with a hose, and then lay concrete to the exact shape of the arch, carrying up at the ends to the height determined for the bottom of the skew-back.

Carry up all this work as nearly simultaneously for one arch as possible; then spread a thin layer of hot asphalt over the arch, if for metal (omit this for masonry); then bed the bottom skew-back plate in Portland-cement mortar; bed the bent beams forming the arch in the same mortar. When all the beams are in, slip in the pin, fill the space around and between them with hot asphalt; then draw the pin, insert the tie-rods, slip in the pin and draw tight. The ends of the beams and their seats must be planed.

For Masonry: — Carry up the rowlocks in cement, taking especial pains to have all the joints filled full. Bed well against the skew-back, put in tie-rods, and bring them to a bearing against the pin.

All this must be done with great care, no undue strain being brought against the pin; the skew-back must rest evenly on its plate, and the plate evenly on the arch; the continuation of the centre line of the arch must pass through the centre of the pin; the skew-back surfaces must be exactly radial and exactly the same on each side of the centre line.

In proportioning a foundation in this manner, the service of an engineer should be obtained to check all of the computations before the work is let, so as to be absolutely certain that no error has been made.

§ 264. Stone Footings: — For walls 24″ thick, or more, footings should be of granite, trap, limestone, dense marble or very dense sandstone.

Courses should be from 15″ to 24″ high. Stones should be laid out as large as practicable, departing in no case more than 4″ from the dimensions given, beds and builds parallel and plane. (Fig. 86.)

Projection should be one-half the built-in portion of the stone, and as given under § 261.

Top stones should be through-stones. Bottom courses should start on a levelling of concrete 6″ thick, each stone should be bedded in a fresh-mixed bed of cement, and the stone so bedded as to have every void below it filled. All joints should be filled full of Portland-cement mortar well rammed in. Each stone should be washed with a hose immediately before being

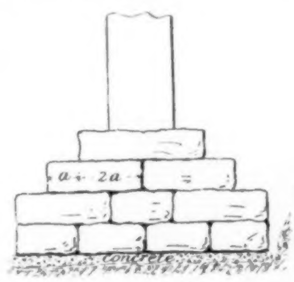


Fig. 86.

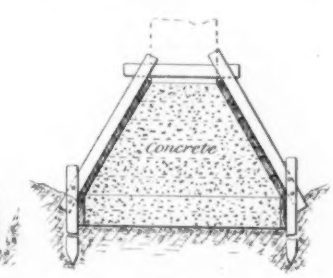


Fig. 87.

set. The mortar used must be freshly mixed, and the stones thoroughly bedded.

For walls less than 24″ thick, footings may be of any of the above, or any good ledge stone from 15″ to 24″ thick. They can often be made in one course, in which case thickness should equal projection beyond wall. They should be thoroughly bedded in cement-mortar spread over 2″ of concrete, and the top levelled off with spawls in cement-mortar to start the wall.

All the precautions noted for the heavier foundations should be observed for this case.

Generally: — Stone foundations require greater care and better workmanship than those of brick.

§ 265. Concrete Footings: — For walls 24″ thick or more, batter as per Table XXXIII.

Part a should be vertical, and 12″ to 18″ high, built-up in two or three layers well consolidated by rammers.

The batter can be obtained by putting in 2″ × 6″ studs, 6′ 0″ c to c, to the batter given, securing them at the top, bedding them in soil at the foot, and putting in 2″ × 8″ plank on the sides (Fig. 87). On the completion of the work the whole is readily removed.

For walls less than 24″ thick, make rectangular in cross-section, making thickness 1.50 projection on one side.

For mixing, setting, etc., see Chapter I.

§ 266. Metal Footings: — One method of using metal has already been described under § 263.

Another method, and one much used in the West for the support of columns, is to build a crib of I-beams and steel rails, entirely filled-in and surrounded with concrete.

This style of foundation depends for its stability on one of two assumptions:

(*a*) That the concrete causes the several courses to act together like a built beam, which is absurd.

(*b*) That the metal is strained beyond the elastic limit, which is dangerous.

Where it is desirable to minimize the height occupied by the footings and gain a wide spread, use all steel, and proceed as follows:

Let W = load at the foot of the column in tons.

L = load per lineal foot of the wall in tons.

B = safe bearing-value of the soil per square foot in tons.

C = the coefficient given in Table VII.

D = depth of the girders, or distance from the centre of the tie-rod to centre of arch in inverted arches, in feet.

x, y, z = variable dimensions in feet.

c = spacing of the beams, centre to centre, in the bottom course, in feet.

§ 267. Column Footings: *First Method*: — Where columns are arranged symmetrically, so as to be in pairs. (Fig. 88.)

Girders may be assumed as supported at each end and uniformly loaded with a load equivalent to the combined weight on the columns, and would be proportioned according to Chapter III, provision being made at the end to take up the shear of the column, and the flanges being made as broad as possible. The spread of the beams beneath will be found from the formula

$$W_{,} + W_{,,} = B\,y\,(2z + x) \qquad (71)$$

y being necessarily the spacing of the columns, out to out.

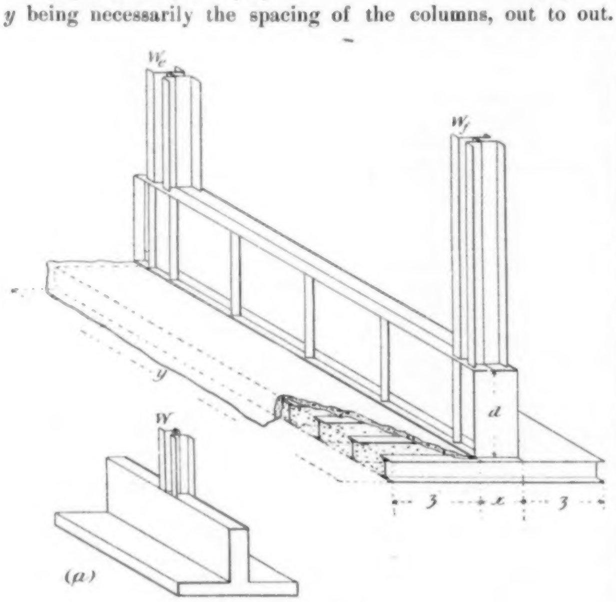


Fig. 88.

$2z + x$ is determined at once. Practical conditions will determine x which is the width of the girder flange, and then z can be readily found.

The size of the beams required for z is found by the formula

$$R = \tfrac{3}{4}\,B\,c\,z^2 \qquad (72)$$

c should not exceed four times the depth of the beams used for the spread.

For isolated columns, the footings shown, Figure 88 (*a*) can be used, the girder being proportioned then as one fixed at one end, free at the other and uniformly loaded, for each half of its length.

Second Method: — To support the load W, we must have,

$$W = B\,(2\,x\,y\,z) \qquad (73)$$
$$y = 4\,z \qquad (74)$$
$$y = x = 4\,d \qquad (75)$$
$$W = 24\,B\,z^3 \qquad (76)$$

The size of beams required for any projection x will be governed by the spacing of beams or rails, c to c, which must not exceed four times depth of beam; thickness of concrete under beams or rails must equal width of bottom flange. Thickness of concrete + height of beam or rail + d must not exceed the height that can be allowed for the footings. Then the size of I-beam or rail required for projection is as given in Formula 72.

The sizes of the girders, a, b, b, can be computed as per §206, taking the load on a as W at the centre, considering the girder as supported at the ends and of length y; and girder b as uniformly loaded with $\frac{1}{4}\,W$, and fixed at the centre so that length $= \frac{1}{2}\,z$. The connection between a and b, b, must be such as to carry a shear due to $\frac{1}{2}\,W$.

Remarks: — The proportions of x, y, z may be varied, so long as y does not exceed $4\,z$, y need not equal x, although this gives best results, but y should not exceed $6\,d$.

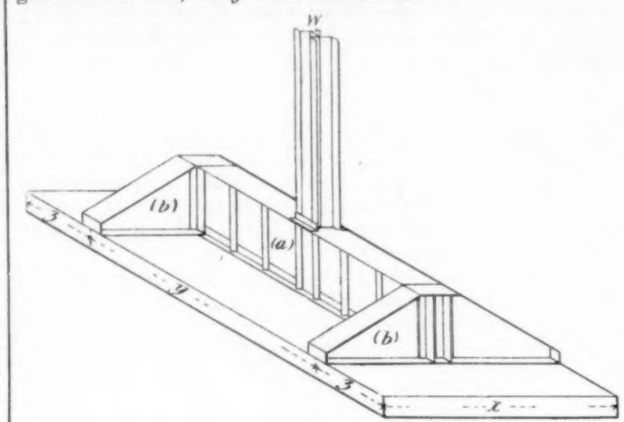


Fig. 89.

This same principle may be applied to the support of two or more columns (Fig. 90).

If the flange area of girders exceeds 72 square inches, or if the other proportions are excessive, then we must increase the depth.

General Remarks: — Every portion of the steel-work should be dipped in a bath of hot asphaltum, or heated and coated with two coats of asphalt, after being thoroughly cleaned with wire brushes and while absolutely dry, or painted with the iron paint described in Chapter XI.

The concrete on which the material rests should be covered with two courses of tarred felt in hot asphalt and worked with a bed of strong mortar 1½″ thick immediately before the girder is set. After the mortar is in place, the concrete should be put on in the very best possible manner, so as to cover every portion of it, and rendered with two coats of hot asphalt.

Immediately before the concrete is applied, every portion of the metal should be examined and any portion that has had the covering knocked off should be dried, and have it renewed. Instead of asphalt the metal paint hereafter described may be used.

All of this work should be rigidly inspected, and workmanship and material brought up to the highest attainable standard. It would also be advisable to employ an engineer to check the computations and supervise the work to guard against mistakes. Use four or more screw-jacks in setting the heavy girders.

§ 268. Metal Spread for Walls: — One method of treatment in metal has already been given under heading "Unsym-

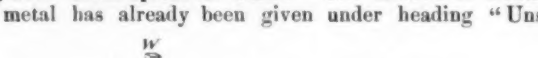


Fig. 90.

metrical Footings," another method for symmetrical footings is as follows (Fig. 91):

Find necessary spread by making

$$(2z + a)\,B = L \qquad (77)$$

a = width of masonry footings.

Space the beams forming z a distance apart, c to c, = 4 times depth of beam as a maximum: it may be necessary to bring them closer; call this distance in feet c, then R needed for z will be found as in (72) and find size of beam from Table VII.

Remarks: — In execution, spread a bed of concrete 2″ or 3″ in thickness, cover it with two courses of tarred felt in hot asphalt. Then coat the beams with hot asphalt, lay them on a

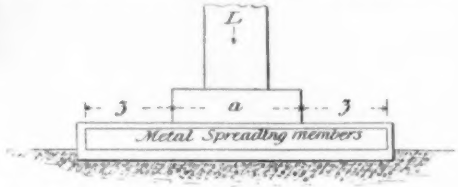


Fig. 91.

$1\frac{1}{2}$″ bed of strong mortar and pack well in between concrete, cover then with cement-and-sand mortar 1″ thick on all sides, then render again with two coats of asphalt, then cover again with 2″ of cement-and-sand mortar, and start the masonry.

In proportioning, make a as large as possible. Usually it will be necessary to make one or two trials before the proper size is found, but that is readily done, especially if the slide-rule is used, since c is the only variable. See that the thickness of the web of the beam is sufficient to resist the crushing strains.

[To be continued.]

THE GREAT EXHIBITION REVIEWED. — I.

AS A SPECTACLE.

TO one who has been in almost daily attendance at the Exposition during its formative stages, and later as a disinterested spectator, the earlier period, during which the development of its skeleton has given a lasting impression of its present unreality, might naturally have produced a feeling of disenchantment. But, on the contrary, the enchantment broadens with every passing day, and the thought that all is to pass away forever only tinctures a growing enthusiasm with a feeling of sadness. It is no longer an extravagance to say that, as a spectacle, it has never before been equalled. Memory and history have been searched to find its equal. Other comparable spectacles have only been creatures of the imagination expressed in pictures and romance. Of what the great agglomerations of palaces and sacred buildings of Thebes were we have only a few suggestions in scattered ruins and the fragmentary accounts in the Scriptures. Only one artist, we forget his name, could suggest what they might have been, and we have them in that well-known picture called "The Bearer of Evil Tidings." Another artist, Martin by name, copies of whose pictures are now seldom met with, took for his subject scenes in "*Paradise Lost*," and illustrated them largely by imaginative architecture. In one, the whole amphitheatre of Heaven is shown clothed with architectural forms and peopled by angels on foot and on wing. In another, Satan is shown on a wondrous throne reigning in all his infernal pomp and splendor over the kingdom of darkness, its unearthly and unheavenly structures peopled with the fallen angels.

In all of these the grandeur and sublimity of architecture are suggested, but here we have a spectacle suggestive only of "Peace on earth, good will to men." Our Court of Honor might possibly be compared with the ancient Forum of Rome, with its surrounding structures, of which several ably-drawn restorations have been suggested, or to the great open places of some of the modern European capitals, with their permanent buildings; but the Court is but a small part of the whole scheme, however important it may be from its topographical and official position with reference to the rest of the enclosure. The ground covered is more than a square mile in area, and has a frontage on navigable water of more than a mile. Even this water-frontage has its variations on the land side, from stony beach to carved stone terrace and low, rocky cliffs. It is intersected by two piers jutting out into the Lake, one of which is two thousand two hundred feet long, two hundred and fifty feet wide, and high enough from the water-surface to let the heaviest waves pass harmlessly through it. There are three inlets from the Lake to the inland water-ways, so that steam and electric launches that traverse the basins and lagoons can make a circuit which includes a lake journey through rough water as well as the quiet repose of the Park region.

Even this wave-beaten shore has its ever-changing phases, from the placidity of an inland river to the ravings of an ocean storm; and the rock-bound promontory on which stands the modern reproduction of La Rabida, like its prototype in ancient Spain, drives back the angry waves, while the caravels, as if waiting for the departure of a new Columbus, rest in peaceful security under its sheltering arm in the harbor within. Yet this is not a barren shore: within the line of perfect safety from the waves are marvels of architectural skill, which, seen from the Lake, show every diversity in style, from the rigid Classic of the Peristyle and the modern Renaissance of the Manufactures Building to the Elizabethan Victoria House on its lonely eminence and the quaint mediævalism of the German headquarters. And before them all lies the latest model of naval architecture, the battleship "*Illinois*," under its protecting mole, and the guns of Krupp frown from mimic bastions on the land near its southern extremity. Here Nature and Art lie under the veil of peace, their security assured by the ever-present engines which science has provided for their protection.

The water-front of the Exposition is the only approach from which its full nature and extent can be appreciated. It was always the desire of its landscape-designer, Frederick Law Olmsted, that the greatest number should see it first from the Lake, and then be introduced to its spectacular splendors through a gateway therefrom. The water-gate is here through the centre of the Peristyle, spanned by the first bridge under the "Columbus Arch," and the second one connecting the terraces which surround the Grand Basin, all, with the surrounding buildings, constituting the Court of Honor. Passing out from under this inner bridge, the whole glory of the Court is revealed. Here the Administration Building, the greatest monumental work of Richard M. Hunt, is seen, eleven hundred feet away. Behind it, forming a background at the west end of the Court, is a lower but palatial building by Charles B. Atwood, which is the Terminal Railroad Station, where passengers should land who go from the city by rail — but only a small proportion do so. To the right are the south ends of the Manufactures Building, by George B. Post, the Electricity Building, by Van Brunt & Howe, and the Mines Building, by S. S. Beman, all on one line, and their cornices of uniform height. To the left are the Agricultural Building, by McKim, Mead & White, and the Palace of Mechanic Arts, by Peabody & Stearns, also on one line and of uniform height.

But this effect cannot be seen by the stranger making his first approach, because, if he goes by water, he is landed at the long pier, and he can only be transferred to the smaller steam-launches after walking to the landing-places inside of the basin. The full approach by water through the Columbus Arch may, however, be made by taking a steam-launch in the south pond, behind La Rabida. These launches go first into the Lake, around the great pier, and approach the basin by the route above mentioned.

The Court of Honor is the artistic and geographical, as well as the official, heart of the Exposition. Its fame is now world-wide, but the honor of the Exposition will not rest upon it alone, even regarded as a spectacle. Its designers have crossed it by another court of similar treatment, so that, traversing the Grand Basin, the visitor suddenly emerges upon the vistas of the north and south canals, which branch out from it on either side. The form of the united waters is that of the letter T, while that of the line of buildings that surrounds the whole is a Latin cross, the upper arm of which is the Grand Plaza, in the centre of which stands the Administration Building. The north or right arm is between the Manufactures and Electricity Building, and the left or south arm is between the Agricultural and Machinery Buildings. This arm is closed at the south end by the Colonnade, which is not only a colonnade proper, but consists of a small building at each end and a triumphal arch in the centre (which is the entrance to the out-door agricultural exhibits), these being connected by columns and entablatures of the same design as those of Machinery Building. In front of the arch, on the lower terrace, stands the commemorative monument of the World's Columbian Exposition, of which more hereafter.

The aggregation of buildings surrounding the four arms of the Latin Cross: the Administration Building, the Peristyle at the east, the Grand Plaza, the double terraces surrounding the three basins with their many flights of steps and double rows of balustrades, the three bridges crossing the basins, the eight colossal domestic and draught animals that stand in front of the buildings, the numerous statues of wild beasts on the balustrades of the terraces, the eight rostral columns, the monument at the south end, the electric fountains and McMonnies Fountain, the Columbus statue by St. Gaudens at the west and the great statue of the Republic by French that rises from the water at the east, — together form a one-and-indivisible, harmonious and complete composition, to which every art ever practised by man has contributed; a composition which has never been equalled in extent, proportion and harmonious blending of all its component parts; not a triumph of architecture alone, or even comprised of perfect architectural elements, but as nearly perfect as a whole as human brains, hearts and hands have ever devised; for the men who did this had their hearts in the work as well as their heads and hands. By the touch of genius water and earth have here become the handmaids of architecture — sculpture and painting have been her sisters, and it seems as if nothing but a great Spirit could have brought these souls together to guide them in what they have wrought. The grand Court is a symphony complete in all its parts and from which nothing can be left out. The voice of criticism has not thus far asked that anything be added to or taken from it. To make this scene of enchantment complete, the management has peopled it with boats — not too few nor yet too many of them: they move about with graceful motion like things that belong there; half of them are gondolas from Venice, painted not as they are in modern Venice, but as they were in the fourteenth century, and manned by Venetian gondoliers. That the scene may not be too Venetian and to remind us that we are still in a practical and progressing world, half of the boats are electric-launches gliding silently about with no apparent means of locomotion. There are also a few steam-launches so that we need not suspect that there is any mystery in the science of locomotion.

Nor is all this the work of one mind but of many master-minds. One master-mind, that of D. H. Burnham, acted as the moderator and balance-wheel for the rest. They all acted in concert, and yet independently. All were the critics of each by mutual consent. The work of each was approved by all the rest, and that is the only underlying secret leading to this grand success. No one man could have done this. No body of men could have done it otherwise.

But as has been said, wonderful as may have been the result here achieved the honor of the Exposition is not due alone to the Grand Court. It is only one of five grand subdivisions each of which has its distinctive characteristics. South of this central attraction lies the space devoted mainly to agriculture, stock and out-door exhibits.

In this district, which can be seen only by itself, architecture does not play a prominent part: it is devoted to the useful and the practical only, as also to the educational features of the Fair.

Next north of the formally arranged Court, but blending into it, is the section devoted to the picturesque in architecture and landscape art. It is the part immediately surrounding the Wooded Island and lagoon. The transition, however, is not through a barrier, but is gradual. The irregular lagoon is the central feature. The great Manufactures Building, too large for any one section to contain it, encroaches on this and one side continues half-way north along the lagoon. In addition to this, the north ends of the Electricity and Mines Buildings face on this district. The Transportation Building by Adler & Sullivan gives the festive character to the scene and is the first to break from the formal arrangement of the central group of buildings. Here styles of architecture change and the utmost variety in design prevails. Transportation Building is all color, Horticulture Building, by Jenney & Mundie, is light, graceful and full of sculptured form. The Woman's Building, by Miss Hayden, follows and is rightly effeminate in its architecture. To the north of the lagoon is the picturesque Fisheries Building, by Henry Ives Cobb, which bounds the northern part of this group.

The last general subdivision to the north comprises the State and Foreign Buildings. Near the centre of these is what is now an arm of the lagoon, but formerly the lake in what was once the improved part of Jackson Park. On the north of this lake is the Fine Arts Palace by Charles B. Atwood. This was the last large building located in the Park, as for a long time it was thought that it would be built on the Lake Front Park. When it was finally sent to Jackson Park it had to take the only large vacant place that was left — and thus spoiled a beautiful open campus about which the State and Foreign Buildings were to have been grouped. Its façade on the lake shows to good advantage, its long annexes being scarcely visible on that side. The architecture of the State buildings is so varied and incongruous and their locations in many cases so badly chosen that little can be expected from the resultant groupings, and it can be truly said that the face of nature has been blemished by their presence. The same is almost true of the foreign buildings, which with the exception of that of Germany are badly placed. But the architecture of Germany, England, Sweden and Norway is admirably characteristic of those countries.

The fifth division of the Exposition is the strip 600 feet wide and one mile long connecting Jackson with Washington Park, and called the Midway Plaisance. This is a name that was given to it by Mr. Olmsted when he designed the South Park System twenty-five years ago. It signified the playground between the parks. It is now the playground of the great exhibition and as such has removed from the immediate vicinity of the artistic, scientific and industrial features, everything of the nature of an amusement. It is, therefore, spectacular to the highest degree. Here is a broad street a mile long completely filled on each side with places of amusement. Many of them comprise considerable areas of ground, but most of them are very shabby affairs. The best are mainly of ethnological interest, and only three have any architectural value. These are the German Village designed by Karl Hoffaker of Berlin, the Street in Cairo by Mr. Haas of Cairo assisted by Henry Ives Cobb of Chicago, and the Java Village by native builders who have provided a very interesting illustration of building with bamboo and rushes.

Leaving the Fair by the western gate of the Midway the reader will be asked to return with us again and examine it more in detail. We have only seen in a cursory way what in many respects is the culminating glory of American architecture; for with the exception of the buildings of foreign governments it is the work of American architects, sculptors and painters, and will go down to history as an American exhibit. Such a spectacle may well strike the beholder with surprise if not with awe. It shows what organization and coöperation will do when directed by an efficient head, and subject to a wise censorship. No wonder then that this architectural spectacle has overwhelmed those features that to the world at large, should be held to be of the greatest importance in an International Exhibition — its progress in art, science and all industrial pursuits. But architecture is itself an exhibit and as here exemplified its exhibition will lead to a better popular appreciation of the importance of grouping no less than of design, the effects of which must be seen throughout our land in the near future. It alone will take this down to history as *the* Great Exposition. The first of an international character, at London in 1851 was called the "Great Exhibition." It has been eclipsed by greater ones, and even the last is only known as *the* Paris Exposition to distinguish it from all others previously held in Paris. But the old title of the first will be revived and this should hereafter be known as the Great Exposition.

P. B. Wight.

[To be continued.]

WATER-POWER.[1]

Where there exists a natural waterfall, with a considerable and regular flow, and where local conditions are favorable for the construction of the necessary works, water-power is generally cheaper than steam-power. The water costs little or nothing; the cost of maintenance of hydraulic machinery, and the cost of superintendence are small; the power is regular, controllable and convenient. In such cases, the annual cost of the power consists almost entirely of interest charges on the capital expended in works and machinery.

With some exceptions, water-power is at present utilized in the neighborhood of a natural waterfall. The usual means of transferring the power of the fall adopted, till a recent period, has been the conveyance of the water itself in canals and pipes. In some cases water has been thus conveyed for hydraulic mining, and manufacturing purposes very considerable distances. But a more convenient and cheaper means of transmission would greatly increase the availability of water-power, and the relative importance of steam-power and water-power would, in some countries, be very considerably changed.

It appears, from a report by Mr. Weissenbach, that in 1876, 70,000 horse-power derived from waterfalls were applied in manufacturing in Switzerland. Probably the amount now employed is at least 80,000 horse-power. It is estimated that the total available water-power in Switzerland amounts to 582,000 horse-power. Putting the annual value of a horse-power at £6, this represents an annual value of £3,500,000. Used to replace steam-power, it would save annually 1,250,000 tons of coal. It is stated that at the present time Switzerland pays £800,000 annually to other countries for coal.[2] Nearly the whole of this expenditure could be saved if its natural wealth of water-power were utilized. The recognition of the importance of this supply of power is exciting great interest in Switzerland, and there is hardly an important factory which is not either using water-power or making preparations or surveys with a view of doing so.

The utilization of water-power often involves the construction of large permanent works, such as river dams, reservoirs and canals. Mr. Emery estimates that at Lawrence, in the United States, £200,000 were spent on works, independent of the hydraulic machinery; and, at Lowell, a still larger sum.[3]

Such extensive works can best be executed by an association in the interest of many consumers. Thus is created a water-power company, who establish what is virtually a central water-power station and a distribution of power at a rental to consumers. In the American cases, as already stated, the water itself is distributed in canals to consumers at a level permitting the creation of a waterfall at the mill or factory. But in certain other cases a further step was taken; the water-power company utilized a natural fall and erected the necessary turbines, and then transmitted the power in the form of mechanical energy to consumers. Installations of such a kind, now of a quite respectable antiquity, were erected at Schaffhausen, Freiberg, Zurich and Bellegarde. In these cases the means of transmitting power adopted, admirable as it was, had limitations and the extension of the works was restricted. Now that there are new means of transmission, the Schaffhausen and Zurich power-generating stations are being increased, and a new and remarkable installation has been erected at Geneva.

The original project for utilizing the motive-power of the Rhone at Geneva, partly for pumping a supply of water, partly for motive-power for industry, comprised 20 turbines of 300 horse-power each, or an aggregate of 6,000 horse-power. Fourteen of these were at work in 1892. Four more of somewhat larger size will, it is expected, be constructed by 1898. When these are at work, the whole available water-power in Geneva will be utilized. But it is foreseen that the demand for power will not then have been satisfied. The total receipts for the installation reached £22,500 in 1891, and were increasing £2,200 annually. The Municipality of Geneva has determined to provide for future demands, and plans are being studied for utilizing 12,000 horse-power at a point on the Rhone six kilometres below Geneva, whence the power will be distributed electrically. At Biberest, near Soleure, Messrs. Cuenod, Sautter & Company have utilized 360 horse-power, and transmitted it 28 kilometres electrically. At Genoa water-power due to surplus fall along a line of water main has been utilized at three stations. The greater part of the energy is transmitted to Genoa for electric lighting and power purposes.

These are cases where water-power has been utilized and distributed, which are actually in operation; but there are many other schemes projected: one is for utilizing 10,000 horse-power on the Drause, near Martigny; another to utilize 20,000 horse-power at a point 17 kilometres above Lyons. In Sweden, there is a project to transmit power from the Dal River Fall, at Mansbo, to the Norberg mining district, a distance of 10 miles; another to transmit the power

[1] Extracts from a lecture by Prof. W. Cawthorne Unwin, F. R. S., delivered before the Society of Arts and published in the *Journal* of the Society.

[2] Reifer: "*Berechnung der Turbinen.*"

[3] "*Cost of Steam-power.*" By C. E. Emery. "Trans. Am. Soc. of Electrical Engineers," vol. x, p. 123.

of the Strup Waterfall, on the Judal River, to the town of Ostersund, a distance of 11 miles. Projects for utilizing the Falls of Trollhatan, and the River Motala to supply power to Gothenburg and Nord Koeping, have also been studied.

Water-power in the United States of America. — It is in the United States of America that water-power is most largely used, where it is in most direct competition with steam-power, and where data for a comparison of their relative advantages can best be obtained. Interesting data as to the extent to which water-power is utilized in the United States are given in a paper by Mr. G. F. Swain, read before the American Statistical Association.[1]

The money value of the water-power utilized in the United States is very considerable. From the returns of the Tenth Census it appears that in 1880 there were 55,000 water-wheels and turbines of an aggregate of 1,250,000 horse-power. At £5 per horse-power per annum the water-power utilized is worth £6,250,000 a year.

The comparison of the relative amount of water and steam-power is interesting. Taking the whole of the United States, 36 per cent of the power used in manufacturing was at that date water-power, and 64 per cent steam-power. In certain industries the proportion of water-power was greater. In the manufacture of cotton and woollen goods, of paper and of flour, 760,000 horse-power derived from water, and 515,000 horse-power derived from steam, were employed. In the North Atlantic division 4.81 water horse-power are utilized per square mile.

DIVISION.	Water-power per cent.	Steam-power per cent.
N. Atlantic	43.1	56.9
S. Atlantic	49.5	50.5
N. Central	22.2	77.8
S. Central	22.5	77.5
Western	35.3	64.7
The United States	35.9	64.1

With Mr. Swain's paper was published a map, which shows that over a considerable area of the United States the water-power used exceeds the steam-power. It should, however, be pointed out that in the decade 1870–80, during which the total power used increased 45 per cent, 9 per cent of the increase was due to water-power and 91 per cent to steam-power. It is possible that under the new conditions now obtaining the present decade will show a greater relative increase of water-power.

American Method of Distributing Water-power. — The method in which water-power is distributed in America to a number of consumers is almost peculiar to that country. A water-power company is formed, which undertakes the construction of the permanent works, such as a river dam, sluices and distributing-canals. In New England there are five water-power stations, where more than 10,000 horse-power is utilized during working hours, and thirteen stations where more than 2,000 horse-power is utilized. The water is distributed to mill owners, who construct the turbines and pay a rental to the water-power company proportional to the amount of water used. The earliest application of this system was at Paterson, New Jersey where the Passaic river furnishes about 1,100 horse-power night and day.[2] At Lowell, Massachusetts, the utilization of the water-power began in 1822. The Merrimac River has a fall of 35 feet, and furnishes, at the maximum, about 10,000 horse-power during the usual working hours. At Cohoes, in the State of New York, the Mohawk River has a fall of 105. It could furnish about 14,000 horse-power during working hours, but is only partly utilized at present. At Manchester, New Hampshire, the Merrimac has a fall of 52 feet, and furnishes, at the minimum, about 10,000 horse-power during working hours. At Lawrence, Massachusetts, the Essex Company built a dam forming a fall of 28 feet, and obtaining a minimum power of 10,000 horse-power during working hours. At Holyoke, the Hadley Falls Company built a dam forming a fall of 60 feet, rendering a power of 17,000 horse-power available during working hours.

To indicate the magnitude of some of these works, it may be stated that at Lawrence the masonry river-dam is 900 feet long and 32 feet in height. The cost was £50,000. From this dam two canals extend down stream, one on each bank, and between these canals and the river are located the mills, occupying the entire river-front. On the north side the mills extend for a distance of more than a mile. The cost of the canal on the north side, 5,330 feet in length and 100 feet in width at the upper end, was £50,000. The canal on the south side, 2,000 feet in length and 60 feet in width, cost £30,000.

The case of Holyoke may be described in somewhat greater detail. The whole of the factories in the town are worked by water-power, and the system is simply a distribution of power to many consumers at a rental strictly proportional to the amount of power used, although the power is actually developed in the mills by turbines belonging to the mill-owners. The first wier or dam was built in 1847, but it was carried away. A second dam of cribwork was built in 1849. In 1868 an apron was constructed to protect the rock immediately below the dam; since then, Mr. Clemens Herschel[3] has carried out extensive repairs of the dam under conditions of singular difficulty and with great success. The structure is now 130 feet in width, 30 feet high and 1,019 feet in length. From above the weir a first canal supplies water to the highest line of mills. From these mills, after driving turbines, the water is discharged into a second canal, which is a supply-canal to a second line of mills. The tail races of these mills discharge into a third canal feeding a third line of mills, and there are still other mills worked by the water before it returns into the river. The power now utilized is 15,000 horse-power by day, and 8,000 horse-power at night. Altogether there are about fifty-three mills.

With the grant of land for a mill there was leased the right to use a definite portion of the water. A "mill-power" is defined as thirty-eight cubic feet of water per second on a fall of twenty feet during sixteen hours per day. This gives about sixty-three effective horse-power on the turbine shaft. At the time when Mr. Herschel became engineer to the water-company the water was used extravagantly. By introducing a system of testing the turbines, and by establishing gauges at each mill showing at any moment the amount of water passing through the turbines, great economy in the use of the water was secured. The water saved was sold for surplus-power. Observations of the amount of water used by each turbine, and the difference of level in the head and tail race are made once in the day and once at night. Three inspectors are engaged exclusively in this work. From the daily observations the amount of power used by each mill is calculated. A portion of the power is charged for according to the terms of the lease, at a fixed rental. The balance is charged for as surplus-power. In times of very low water, the power is restricted to the amount guaranteed in the lease.

Relative Cost of Water and Steam-power in the United States. — In some cases local conditions are so favorable that water-power can be developed at an almost nominal cost. In other cases unforeseen contingencies have led to expenditures, which have made the cost of water-power excessive; greater, in fact, than that of steam-power. Mr. Swain puts the average cost of steam-power in the States, in favorable localities, at £4 per horse-power per annum, and that of water-power at about £2 per horse-power per annum. Both these estimates are so low that it may be suspected that they are based rather on the nominal power of the plants than on the average actual horse-power used throughout the year. The cost of water-power, however, varies greatly. Mr. Swain states that while in the north-west of the United States the cost for interest, depreciation and water-rental is about £2.2 to £2.5 per horse-power per annum, in New Jersey it is from £12 to £15. That water-power is used at all at a cost so large as this proves that it has advantages of convenience compared with steam-power, which balance some excess of cost.

It is somewhat difficult to arrive at a precise knowledge of the cost of water-power in the great works in America, because of the gradual way in which they have been developed, and the want of complete data as to the amount expended. Mr. C. E. Emery,[4] who is probably rather prepossessed in favor of steam-power, has made the following estimate of the cost of water-power at Lawrence. He puts the total cost of the structural works at Lawrence at £200,000, and the power utilized as equivalent to 13,000 horse-power for ten hours daily throughout the year. That makes the cost of structural works £15.4 per horse-power. The cost incurred by the mill-owners in erecting turbines, sluices, etc., he puts at £9 per horse-power of turbines, or £13 per average horse-power, actually utilized, the turbines being generally constructed to yield the surplus power in times of emergency. This makes the total expenditure £28.4 per average horse-power, utilized ten hours daily throughout the year. He allows 2½ per cent for depreciation, 1¼ per cent for repairs, 1¼ per cent for taxes, 10 per cent for interest and 2 per cent for working expenses, or, altogether, 17 per cent on the capital expenditure. This makes the annual cost of a horse-power at Lawrence £4.7 per annum, which he takes to be about the same cost as that of steam-power with economical engines and coal at 8s. to 12s. a ton. No doubt, however, in many cases, water-power can be utilized at a less cost per horse-power than that incurred at Lawrence.

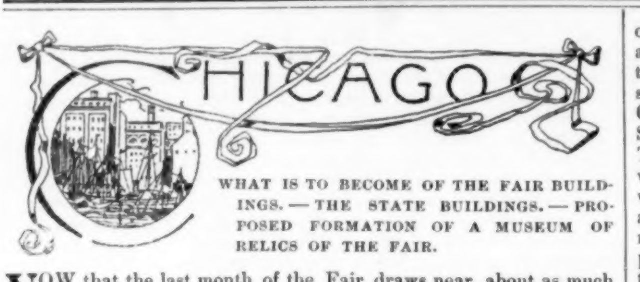
Cost of Water-power at Geneva. — It appears that at Geneva, for the first groups of turbines erected, of 840 horse-power, and for the river works then completed, the capital cost amounted to £60 per effective horse-power. The groups of turbines subsequently erected have cost only £19 per horse-power. The mean cost, when the present works are completed, will amount to £27 per effective horse-power. In this case the water costs nothing. If we allow 5 per cent for depreciation, repairs and working expenses, and 10 per cent for interest on capital, the cost per horse-power per annum will only amount to £4. In the new works below Geneva, where 12,000 horse-power are to be utilized, it is estimated that the whole cost for turbines and structural works will amount to £60 per horse-power for the first 2,400 horse-power. When the installation is completed, the capital cost will be only £27 per horse-power. — *Journal of the Society of Arts.*

[1] "Statistics of Water-power Employed in Manufacturing in the United States." By G. F. Swain. Publications of the American Statistical Association, March, 1888.

[2] J. B. Francis: "Trans. Am. Soc. of C. E.," vol. x, p. 189.

[3] "On the work done for the Preservation of the Holyoke Dam, in 1885." By Clemens Herschel. "Trans. Am. Soc. Civil Engineers," vol. xv, p. 543.

[4] "The Cost of Steam-power," By C. E. Emery. "Trans. Am. Soc. of Electrical Engineers," March, 1893.



WHAT IS TO BECOME OF THE FAIR BUILDINGS. — THE STATE BUILDINGS. — PROPOSED FORMATION OF A MUSEUM OF RELICS OF THE FAIR.

NOW that the last month of the Fair draws near, about as much interest is displayed as to how the buildings will be disposed of on the grounds as there was over their erection more than two years ago. To say that the Directors have a white elephant on their hands repeats a hackneyed joke which but feebly expresses the actual state of affairs. In round numbers, nineteen millions of dollars represent the sum which was expended on the World's Fair buildings and grounds. The chief point of interest now not only to the stockholders, but as a matter of curiosity to the whole country, is how much of this nineteen millions can be realized from the material now on hand. The labor, which was a large item, of course, goes for naught, and at present it looks as if much of the material will realize but little. It has been a generally-accepted opinion that the ironwork used in the great buildings could be utilized in others, but it now seems that much of this ironwork, as any sane person would know, was especially planned for its especial place, and that it will in all probability not be feasible to use it anywhere else. The putting in place of these huge trusses and beams was, of course, a tremendous undertaking, and to take them down will cost nearly as much. Various contractors and iron-men are reported as giving very discouraging views concerning the practicability of using the metal-work. The good pine lumber in the floors and galleries of the buildings would be of some worth, but the disposal of the staff covering of the structures is, of all the material used, the most discouraging problem.

There is much talk about keeping the Fair buildings, and not destroying them at all, but this is simply nonsense, for already they have lost the sparkling beauty which so charmed the visitor through May and June. Large pieces of staff are continually falling from the walls, and here and there holes are appearing in some seemingly massive column or balustrade. The idea of keeping the buildings for beauty's or utility's sake could not be entertained by the Directory for a moment. That this fine creation should be allowed to grow shabby and grimy and shoddy-looking before our eyes would be a much greater hardship than to have it fade from sight all too soon.

In the meantime, the press and private individuals, through the press, are not backward in giving all sorts of valuable suggestions concerning this part of the enterprise.

The Director of Works is reported as advocating the scheme of having the buildings fired, burning in this way the staff and timber, and leaving the iron for future use. The papers suggest that if the buildings were burned on different evenings, large prices would be paid for admission-tickets to so grand a sight. There seems to be numerous drawbacks to this plan. One is that the material best worth saving would be entirely destroyed, and the iron would be so affected by the heat as to become quite useless.

Another idea is to let the buildings remain, and plant vines and ivy around them, trusting to the elements in time to transform them into picturesque ruins, thus supplying a long-felt want in the country.

Next to this plan stands one to demolish the buildings and by dumping the refuse into the lake form in this way what has been always much desired here, islands in our harbor.

The Directors of the Fair have given bonds to the amount of one hundred thousand dollars to remove the buildings before a certain date and it has now been suggested that the easiest way out of the difficulty for the Directory would be to forfeit the bonds and let the Park Commissioners solve the difficulty themselves. These gentlemen are consequently coming in for their share of the anxiety as to what could be done should all these buildings be left upon their hands.

Concerning the disposal of the State and Foreign buildings this controversy is being carried-on on a somewhat smaller scale. Some of the structures are reported as having been given to certain societies, some are being quite thoroughly advertised as for sale, others as having numerous bids made for them, some as already sold, while a few, a very few, are not in the market, but will be returned to the section of the country from whence they came. Many of the buildings are quite unworthy being preserved anywhere, and their remains would be fit subjects to rest in the unknown grave, wherever it may prove to be, of the great and departed glory of the Fair. Many of the buildings are simply atrocious, and when in the midst of the worst of the collection, you begin to be convinced that from an artistic standpoint at least, it was not a wise thing to have allowed the States to represent themselves by such architectural abominations. The Illinois State Building has been severely enough criticised to have gained an unenviable reputation, but there certainly are others, smaller and less conspicuous, which equal, if not excel it in bad style and poor taste. It has become the fashion to criticise and scorn the Illinois Building and certainly it is not an artistic creation, but it is often the most severely condemned by people who understand any architectural feature so little that had they been told that the proper thing was to admire it they would have been loudest in its praise. It simply represents that adaptation of what was supposed to be the Classic style of architecture which was so popular for out-of-the-way State capitols and small country court-houses, not many years ago. The building might have been worse, we see, when we compare it with certain smaller buildings, and also when we look at better ones, we see a still sadder "might have been." Nothing could be more atrocious than the interior decoration of the central dome, but some really charming work has been done by the Illinois women in the parlor and little library. The decorative panels on the wall of the parlor, done by different artists on canvas in oils, and treated in a not too rigid conventionality of style are delightful, strong in drawing and most harmonious in coloring. They surpass in excellence work of a similar nature done in the Pennsylvania Building, which is not in itself poor. The decoration in the small library, opening out of the Illinois parlor is the work of one young woman and is quite different in treatment from that of the larger rooms. Like the other work it is oil on canvas, but consists of strictly conventionalized designs in rich warm colors, one of the chief features of the decoration and a very charming and appropriate one being the introduction of old book-plates. The Illinois Building, at least on the interior, is quite typical of our State: side by side with high artistic feeling and culture is to be seen the evidence of the most illiterate and inartistic existence. One of the best American educational exhibits is found in this building, in the department of architecture, engineering, physics and natural history, and not many steps removed from it is some abomination of a false stone grotto, or some libel, in the shape of a cereal picture of the waving cornfields and rolling prairies.

Kansas when we are looking for something most to be avoided stands out in good shape — a heterogenous mass of "architecture."

The Arkansas State Building, this time the work of a woman, is a curious confection of staff, painted white. The exterior ornamentation in lack of any style is only equalled by the decoration of the interior.

But in the midst of the large number of State buildings one has hardly time to waste among the poor ones when there are really some such delightful specimens to claim one's attention. Idaho's Building is not excelled by that of any State structure in the artistic application of the characteristics and features of the State in the construction of its building. The structure is a combination of the Swiss and Norwegian peasant style, and the log cabin of America, with certain local modifications introduced. The material of the building is volcanic rock combined with pine logs from which the bark has been removed. The general outlines of the building are very satisfactory, and the way in which the exterior is studied out in relation to the interior bespeaks an amount of careful thought only equalled by the care for the details of the interior. Thus there are open fireplaces and mantels, all of rough timber and tufa, which are really charming. The rough but artistic mantel on the stair landing of unpolished plank has a general symmetry of outline and proportion, which lifts it very far above the commonplace. No inappropriate feature even in small details is introduced. The doors are, many of them, of one heavy plank of cedar not sawed but split, and the hardware on them consists of long spear-heads for hinges and a bowie-knife for the handle. The use of the knife in this place is especially ingenious. The handle of the weapon itself serves on one side for the handle of the door, while the blade, passing through the plank, has its point bent down in a curve forming an almost conventional-shaped latch-handle. At one of the fireplaces bear-traps are so arranged as to serve for andirons, and even the furniture itself though of pleasing and comfortable shape is made out of crude material. Part of the State exhibit hangs on the walls in the shape of skins, beautiful stags' heads, etc., carrying out in part the details of the excellent whole. Report has it that this building has already been purchased by an Englishman. Certainly nothing could be more suitable for a hunting-box than this structure, and it is to be hoped this will be its fitting use. More applications have been made to learn the price and ultimate destination of this building than of any on the grounds.

Farthest removed from this building in character though not in location in the grounds is that from New Jersey. This is an unostentatious wooden structure whose good taste in the exterior is more than equalled by that of the interior. The entrance-hall is in the form of a good-sized square room, which is two stories in height, a circular gallery enclosing it on the second story from which open the sleeping-rooms. The effect is very pleasing, but the practical advisability of such a plan, although modelled after an actual colonial house, might be for every-day use very questionable.

Equally different in character and one might also add equally charming, though bearing not the slightest impress of any local characteristic, is the Vermont structure. This is a perfect little Pompeian house, built of staff. Up the short flight of steps you enter the closed court in which a fountain splashes. On either side is a recessed portico while at the back under a lintel supported by caryatides you pass into the general assembly-room of the building, in which prevails a good deal of the feeling of Pompeian architecture, half Greek, half Roman, with the pure and brilliant colors of the decoration.

Massachusetts House has been so often described that words concerning that become trite. It is as charming as all reports have given it credit for, and, in its flower-bordered terrace, stands a unique feature among the State buildings.

Next to it, New York, in the style of the Italian Renaissance, lets no chance escape to appeal for notice in loud though indeed not inelegant accents to every passerby. The exterior of the building is excellent in its strict adherence to the style which has been chosen for it, while the interior is equally faithful to its principles; but there is a certain bombastic grandeur about the whole which is amusing to the unprejudiced eye. Rumor has it that this building has been given to the permanent organization for women which, after the close of the Fair, is to have headquarters in Chicago. What the women can ever do with such in many respects beautiful but altogether unpractical quarters for a permanent abode it will be interesting to note. The banqueting-hall is carried out in the most extreme manner of a style far from simple, and is interesting simply as a specimen of this kind of work.

Next to the New York Building stands that of Pennsylvania, a copy to a very limited extent of old Independence Hall. The exterior, of buff brick, is entirely satisfactory for such a building, but the interior attractiveness is much lessened by the awkward shape of the rooms, necessitated by the plan.

Florida is represented by a copy of the old Fort at St. Augustine. Externally, it promises to offer features of interest, but these features are not numerous enough to hold one's attention long, especially as no aid is given by the interior, which contains nothing but a bazaar of Florida curiosities.

California's building has as well known a reputation as that of Massachusetts, and, in a combination of the old Spanish mission features, forms a most pleasing building so far as the exterior is concerned.

Near this, Indiana has a very good building in a French fifteenth-century Gothic structure, very well carried out as to its style both inside and out, and well suited for such a club-house as it was intended to be. Several of the fireplaces and mantels in the house are exceptionally successful; one furnished with blue tiles, decorated in gilt *fleurs-de-lis*, is especially attractive.

Most of the foreign buildings have been spoken of in these letters, and late as it now is for first impressions, and well known as most parts of the Fair have become, Sweden's most attractive structure ought not to be passed by unnoticed. The building in itself is rather a combination of the old Swedish ecclesiastical and domestic architecture, and is much of it made of material that constitutes the building exhibit. It is very successful, in spite of this rather unusual variety in its parts. In the plan, a hexagon is inscribed between the sides of the triangle of the floor-plan, and the boundary of the figure decides the shape of the main hall of the building. The corner spaces of the structure form each a separate room of considerable size, and galleries run around the building. The hexangular main hall is about sixty feet square, and surmounted by a towering cupola. The entire Swedish exhibit is housed in this building: an interesting display of Swedish furniture in characteristic interiors here appears.

Spain's building, not far distant from Sweden's, is not devoid of interest, though there is but little attempt at a display of any kind inside. It is a three-fourths reproduction of a section of the Silk Exchange at Valencia, Spain, whose erection was commenced in the very year Columbus sailed on his great voyage of discovery. The part shown here represents the column-hall and the tower where all defaulting and bankrupt merchants were confined. A circular stairway, approached from an inside entrance, is the means of reaching the top of the tower. A very interesting collection of photographs is here displayed of old Spanish pictures, as well as some few architectural drawings.

At the last meeting of the Illinois Chapter of the American Institute of Architects, the advisability of founding a permanent architectural museum here in the city was discussed. A committee was finally appointed to look into the matter and report at the next meeting. It seems as if there would be much of architectural interest in many of the exhibits that at the close of the Fair would either be willingly given to such an institution, or would be obtainable at a trifling cost. Such collection would not include the architectural casts from the Trocadéro, which are to go to the Art Institute. It is hoped that some one of the foreign buildings could be obtainable for at least the temporary home of such a museum, and a nucleus could thus be formed for a collection which, though small, would be of interest to the profession.

SOCIETIES

ENGINEERING ASSOCIATION OF THE SOUTH.

AT the meeting in Nashville, Tenn., September 14, Mr. W. G. Williamson discussed the relations of the City Council, the Board of Public Works and the City Engineer. He concluded that in small cities the existence of both the Council and the Board causes needless complications, though in large cities the great amount of public work makes the Board more efficient than a committee from the Council; that the engineer should be appointed by the Board, but should not be embarrassed by their appointing any of his assistants; that orders to the engineer should come from but one authority, and, if these orders are contrary to the engineer's judgment, he should be allowed to put his objections on record; and that it is not good economy to bind an engineer to let work to the lowest bidder.

The paper of Mr. Walter G. Kirkpatrick described "A Triangulation System for River Surveying." The field-work consists of reading four angles at each of a series of stations along one bank of the river, the distance between the first two stations and that between the last two being measured with a tape. The computation is simple, a connected series of sine proportions, so that the addition of logarithms is cumulative, each addition evolving the length of a line in the system. The platting is by chords, affording a good check against errors. The system, though accurate, requires but little more work than the ordinary transit and stadia survey; the computation can be framed from the field-notes; then all the logarithms taken from a table, then all the additions made, evolving all the necessary distances, with which the platting proceeds in a connected chain.

Mr. J. S. Walker discussed the roof-trusses of the World's Fair buildings. Mr. Hunter McDonald outlined the methods and progress in sinking caissons, forty feet, for the foundations of the Johnsonville Bridge, now being constructed across the Tennessee River for the Nashville, Chattanooga & St. Louis Railway.

The Association will meet next on October 12.

WALTER G. KIRKPATRICK, *Secretary.*

ST. LOUIS CHAPTER OF THE AMERICAN INSTITUTE OF ARCHITECTS.

THE third annual meeting of the St. Louis Chapter of the American Institute of Architects, was held on the evening of September 26.

The following gentlemen were elected to serve the ensuing year: *President,* Thomas B. Annan; *Vice-President,* William B. Ittner; *Treasurer,* Charles K. Ramsey; *Secretary,* Alfred F. Rosenheim.

The Chapter numbers now 30 members, divided as follows:

Regular..........	17
Associate.........	9
Honorary.........	4

A. F. ROSENHEIM, *Secretary.*

ILLUSTRATIONS

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

THE EDISON BUILDING, 42 BROAD ST., NEW YORK, N. Y. MESSRS. CARRÈRE & HASTINGS, ARCHITECTS, NEW YORK, N. Y.

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

HANCOCK CONGREGATIONAL CHURCH, LEXINGTON, MASS. MESSRS. LEWIS & PAINE, ARCHITECTS, BOSTON, MASS.

THE building sits directly opposite the historic spot where the first shot was fired in the American Revolution. The dimensions are 65′ 0″ × 130′ 0″. The walls are of field stones with undressed granite trimmings. The interior, below the plates, is finished in quartered-oak, the hard-pine roof trusses being exposed, and the ceiling finished with narrow strips of beaded cypress. The building is thoroughly heated and ventilated by the Sturtevant-blower system. The entire cost, including heating, ventilating, pews, decorating, fixtures, etc., but not including the memorial windows, was about $32,000.

COMPARATIVE PLANS OF FIVE INTERNATIONAL EXHIBITIONS.

FROM *Engineering News* for January 30, 1892, we adapt the accompanying plans of the last five international exhibitions, drawn to the same scale, and condense some of the statistics.

The Vienna Exhibition in 1873 was held in the Prater, a park of some 4,000 acres, the four main buildings covering an aggregate area of 34.88 acres. The main building or Industrial Palace was 2,953 feet long by 83.6 wide crossed by sixteen transepts 572 feet long by 51 feet wide, while the rotunda at the centre had a diameter of 354 feet. The financial failures of this exhibition was largely due to the prevalence of cholera in Vienna during the summer.

The Centennial Exhibition, held in Fairmont Park, Philadelphia, in 1876, was contained in exhibition buildings having an aggregate area of 57.53 acres, increased to a total of 71.47 by smaller structures.

The Paris Exhibition of 1878 was held in the Champ de Mars, the main building covering an area of 46 acres, increased by other buildings to 60.

The Paris Exhibition of 1889 was held on the same site with additional buildings along the quais and in the Esplanade des

Invalides, aggregates an area under roof of 75.50 acres. The Machinery Gallery measured 1,378 feet long by 475.5 feet wide.

	Open, Days.	Total Visitors.	Highest in One Day.	Expenditures.
1873. Vienna........	186	7,254,687		
1876. Philadelphia..	159	10,000,000	274,919	
1878. Paris..........	194	16,159,719	200,613	
1889. "	164	32,354,111	387,877	$5,886,395
1893. Chicago.......	145[1]	14,658,808[2]		

[1] To October 1.
[2] Paid admissions to October 1.

THE MARY S. F. SEARLES SCIENCE BUILDING, BRUNSWICK, ME. MR. HENRY VAUGHAN, ARCHITECT, BOSTON, MASS.

THE Searles Scientific Laboratory for Bowdoin College is the gift of Edward F. Searles, Esquire. The exterior walls are of light-red pressed brick with trimmings of cream-buff Amherst sandstone. All interior walls are of brick without plaster, and all the staircases are of iron. The building consists of three separate departments for the study of chemistry, physics and biology, each having a separate entrance, staircase, etc. The Chemical and Physical Departments occupy the first and second floors and the Biological Department has the whole of the third floor, each having store-rooms, etc., in the basement. The length of the building 172 feet and the depth from front to rear of the two wings is 107 feet. Each department has a general laboratory 60′ x 31′, a lecture-hall 60′ x 31′, a small laboratory 35′ x 32′, a professor's private laboratory and office, apparatus rooms, research rooms, etc. It is expected that the building will be completed in July, 1894. Woodbury & Leighton are the contractors.

HOUSE AT TARRYTOWN, N. Y. MR. MANLY N. CUTTER, ARCHITECT, NEW YORK, N. Y.

THIS house is true colonial in type and very well suited for a suburban residence. To be finished throughout in white-wood. Exterior clapboarded and shingled roofs. The veranda extending nearly around three sides will give plenty of shade in summer. Every room has a large closet and good light.

CENTRAL PAVILION OF THE FISHERIES BUILDING, JACKSON PARK, CHICAGO, ILL. MR. HENRY IVES COBB, ARCHITECT, CHICAGO, ILL.

[Additional Illustrations in the International Edition.]

CHORAL BUILDING, JACKSON PARK, CHICAGO, ILL. MR. FRANCIS M. WHITEHOUSE, ARCHITECT, CHICAGO, ILL.

[Gelatine Print.]

SOUTHWEST CORNER OF THE LIBERAL ARTS BUILDING AND THE AGRICULTURE BUILDING, JACKSON PARK, CHICAGO, ILL. MR. GEORGE B. POST AND MESSRS. MCKIM, MEAD & WHITE, ARCHITECTS, NEW YORK, N. Y.

[Gelatine Print.]

CHURCH OF ST. SIMON AND ST. JUDE, HIGH PARK, SOUTHPORT, ENG. MESSRS. JOHN SUTTON AND HUON A. MATEAR, F. R. I. B. A., ARCHITECTS.

THIS church will shortly be opened. The walls are of Burnley bricks, with Bath stone dressings. The original drawing was hung in the Liverpool Autumn Exhibition.

HOUSE AT LISMOYNE, NEAR BELFAST, IRELAND.

THIS plate is a reproduction of a drawing by Mr. Frank L. Pearson, which appeared this year in the Royal Academy Exhibition.

A SMALL COUNTRY HOUSE. MR. GEORGE KENYON, ARCHITECT.

THIS house was designed for a picturesque and well-wooded site near Holmfirth, a small town in the West Riding of Yorkshire. It was intended to be built of local sandstone, of which there are very good quarries in the neighborhood. The half-timber work was to be of oak, and the roof covered with tiles. The cost was estimated at 1,800*l*. In the arrangement of the plans an attempt was made to obtain simplicity and workability without monotony. The original drawing was exhibited this year at the Royal Academy.

ARCADING IN THE LADY CHAPEL, LICHFIELD CATHEDRAL, ENG.

THE subject of the illustration is one of the finest examples of ogee canopied arcading in the country. The spandrels, being decorated with grotesque animal and floral forms, are extremely quaint. The upper portion of the buttresses have been restored and the Renaissance feeling exhibited in the neckings to finials points to the period when the lines of Gothic architecture were not followed in a spirit of eneration. The original drawing is by Mr. W. F. Edwards.

NOTES AND CLIPPINGS.

A STORY ABOUT CARPEAUX. — Every one knows the celebrated group which made Carpeaux famous, and which now adorns the Garden of the Tuileries — the "Mort d'Ugolin" — the man dying slowly of hunger, surrounded by his starving children. This group was to have been done in Rome, but unfortunately the official programme allowed only three figures at the utmost — *un groupe de trois figures* — said the by-laws. Young Carpeaux clung to his subject and Ugolin had four sons. High words and the ultimate flight of the artist from Rome were the quick consequences. The story came to the ears of the Empress, the Director in Rome fulminated, Carpeaux stood his ground, and finally, by imperial permission and, I believe, imperial generosity also, the sculptor was allowed, not to come to the Concours — the holiness of rules and regulations could never tolerate such madcap revolt — but he was at least privileged to execute at his own expense that wonderful drama of human agony, only to be equaled at the end of his career by that living poem in stone "La Danse." This, too, was nearly discarded for the same reason, the programme only allowing for a three-figure group, as shown in the other nonsensical manifestations that occupy the companion pedestals in front of the Opera House. These seem left there as an unanswerable reason for the transfer of the Carpeaux group to a safer niche in the Louvre, where it will certainly go some day when the art lambs lie down together in peace. If Carpeaux had been less willful and the Empress less kind or less powerful, the upshot of the famous incident would have been the nipping in the bud of a mighty flight of masterly genius, or, in any case, the burial for an indefinite period of one of the heroes of modern sculpture. — *N. Y. Times.*

THE EXCAVATIONS AT DELPHI. — The director of the French School at Athens, M. Homolle, is very much annoyed at the charges made in English papers in reference to the archæological work of the school at Delphi. The work, he says, has not been interrupted by order of the Greek Government, but has been suspended by the school. M. Homolle adds: "We have not violated the agreement nor the regulations, but we have been victims on the part of Greek agents of abuse of power, contrary even to the Ministerial instructions, as has been recognized by the Minister of the Interior, M. Ralli, with the utmost courtesy and the fullest justice, and which has led to the recall of the inspector. We have not concealed from the Greek authorities the discoveries, but every evening we have drawn up a double inventory witnessed by the Greek inspector and a member of the French mission. We have not shut up the antiquities in a mysterious storehouse, but we have set aside certain fragments, always duly noted, which it was necessary to have at hand in order to reconstruct the pieces as a whole. We have not concealed from foreigners either the statues or the inscriptions, and I appeal particularly to the English whom we have been glad to receive as guests. We have never had to interdict any foreigners copying the monuments, for the simple reason that none of them has ever had any intention of contesting our rights of first publication." — *New York Evening Post.*

THE INFLUENCE OF COLORS ON HEALTH. — A chemical authority classifies colors according to their influence upon health. Colors dangerous to health are orpiment, realgar, biniodide of mercury, turpeth mineral, arsenite of lead, white lead, litharge, minium, Naples yellow, oxychloride of lead, arsenite of cobalt, verdigris, Scheele's green, Prussian blue, Prussian green. Less dangerous are chromate of lead, vermilion, sulphide of tin, mineral lake or chromate of tin, chromate of copper, purple red, Thenard's blue, oxide of zinc, chromate of barium, oxychloride of antimony, sulphide of cadmium, smaltz, ultramarine. Colors not dangerous include sulphate of barium, yellow and red ochres, Venetian red, cochineal, manganese brown, raw and burnt umber and sienna, sepia, indigo and colcothar. — *Invention.*

A GOLD-PLATED RUSSIAN PALACE. — Just outside St. Petersburg the Czar has a palace known as Tsarskoe-Selo, which was built by Catherine the Great. It is of vast extent, and plated with gold. It is said that nearly £200,000 worth of bullion was used in doing the work, and when, owing to the dampness of the climate, the plating began to peel off, Catherine ordered it to be painted over. Some Russian speculators wanted to scrape off the old gold and melt it over again, and offered Catherine £100,000 for permission to do so, but she sent them to prison for insulting her with the proposition, and covered the palace with yellow paint. This palace has rooms walled with amber. It has a parlor covered with lapis lazuli, and the walls and ceiling of one drawing. — *Invention.*

CHURCH BELLS AND CANNON. — When Peter the Great ran short of metal for casting his cannon, he made no ceremony of appropriating church bells to his warlike purposes. Since the time of the "Iron Czar" the old order of things has changed, and, with a sort of poetic justice, the church in Russia is now receiving reparation for Peter's despoliation of her belfries. We are told that six bells, cast from copper cannon, captured by the army of the Caucasus, have just been landed at Petrovsk for the orthodox churches in Daghestan. The bell-founders are engaged in the conversion of a further large number of copper guns to the same laudable purpose. Thus does "the whirligig of time" bring about its revenges. — *Invention.*

CURIOUS ORIGIN OF A FIRE. — The other day a heavy delivery-wagon backed up in front of an Eighth Avenue furniture store. The smoothness and slant of the asphalt gave greater momentum than was expected, and the hind wheels struck the curb with a crash. The contact of stone and iron drew out sparks. Some of these flew into a wisp of packing hay, that soon gave forth smoke and flame. A bucket of water subdued the blaze, but, as a fireman remarked, it was an interesting object-lesson on one of the mysterious ways in which serious fires sometimes start. — *N. Y. Sun.*

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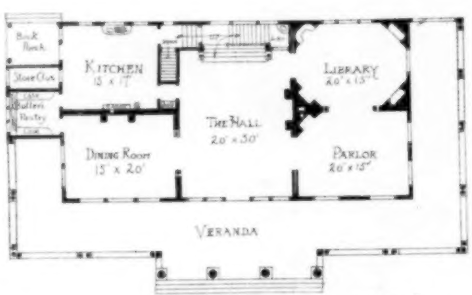
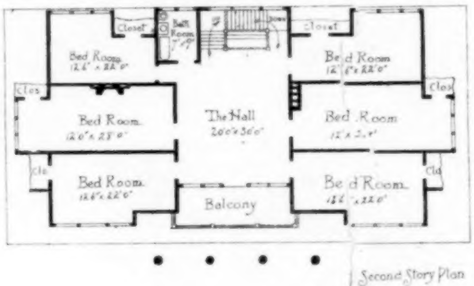


First Story Plan



Second Story Plan

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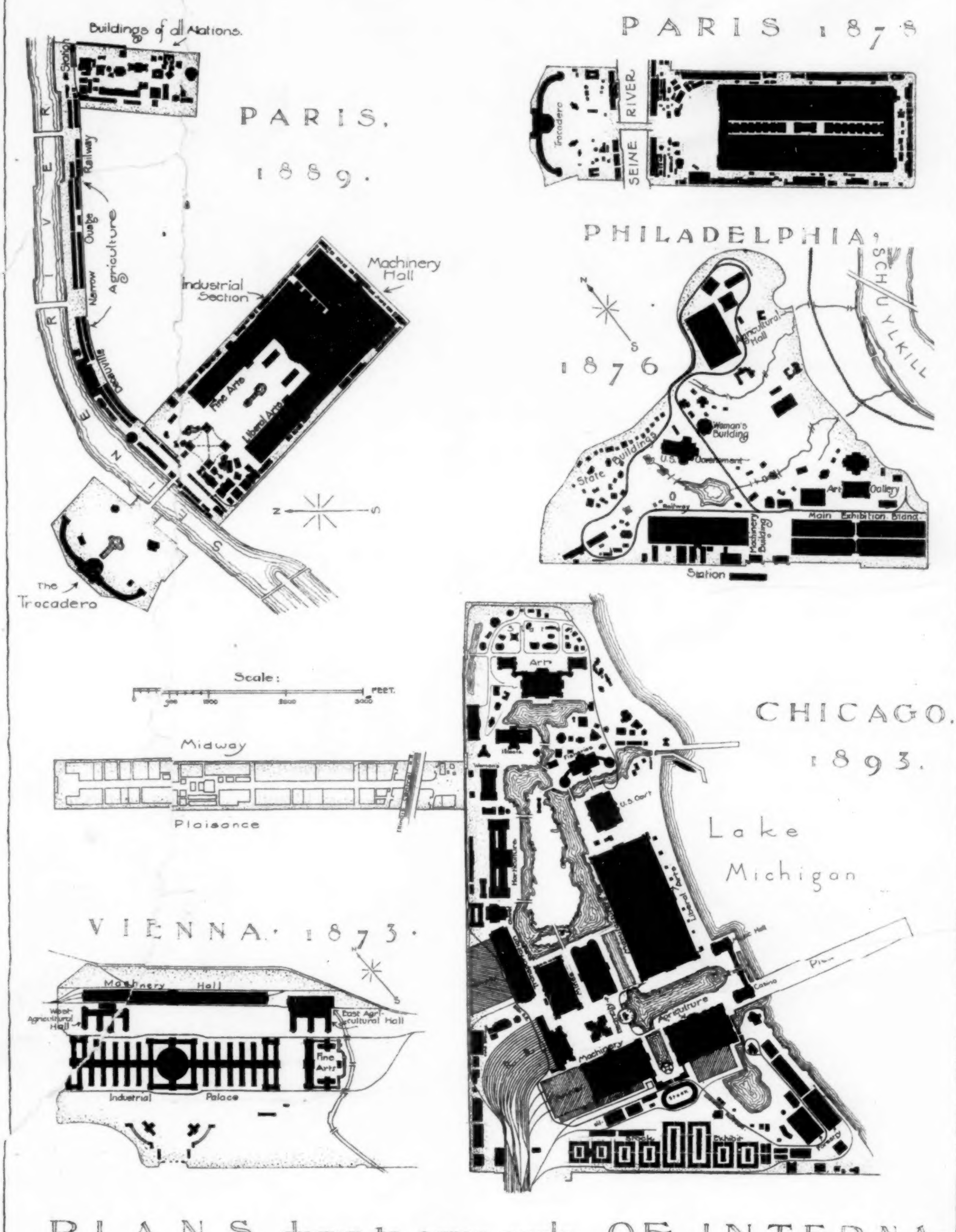

PLANS, drawn to same scale, OF INTERNATIONAL EXHIBITIONS, showing comparative areas.

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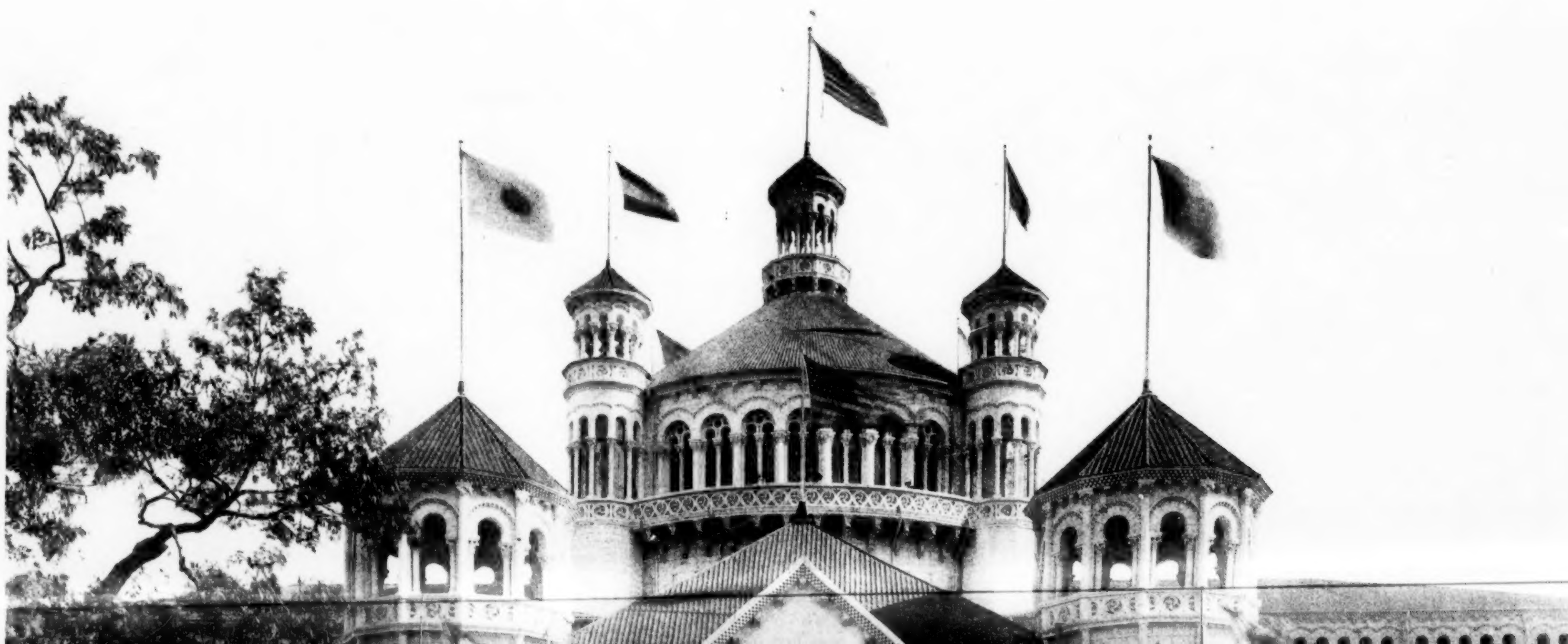

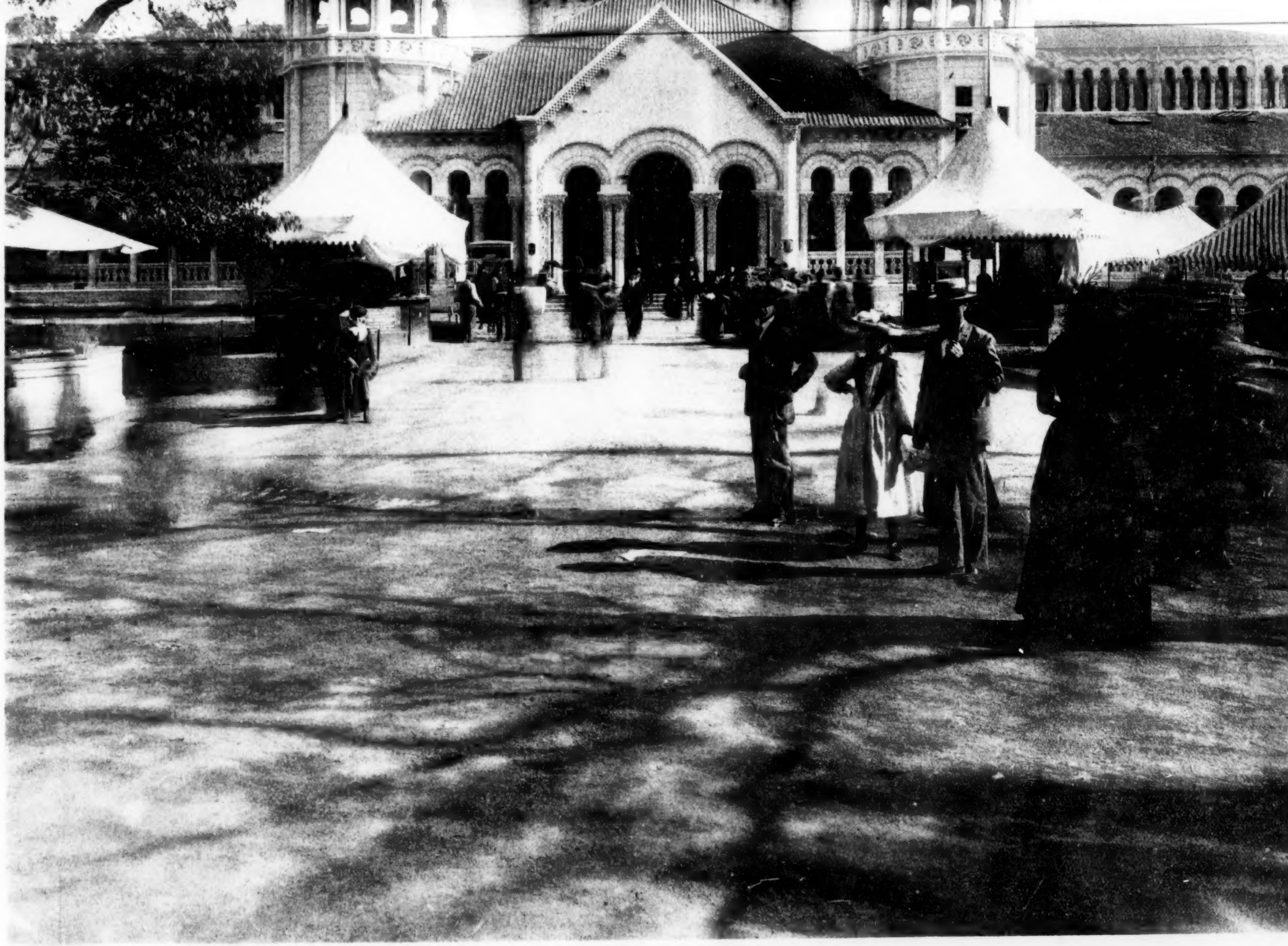

CENTRAL PAVILION OF THE FISHERIES BUILDING, WORLD'S FAIR, CHICAGO, ILL.

HENRY IVES COBB, Architect.

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