Heating, Ventilating and Air Cooling at the New York Stock Exchange.—I.

The new building of the New York Stock Exchange, besides being conspicuous as the central home of American finance and one of the architectural adornments of the city, contains an engineering equipment of exceptional interest. Heating is done by direct radiation, but some of its requirements are of a special character, owing to the necessity of warming the large board or trading room, which has a volume of 1,200,000 cu. ft. and two expanses of exposed glass walls, each 92x51 ft. in area. Ventilation is afforded by the usual mechanical means, but the apparatus is of an extensive character and of large proportions, with particular interest attaching to the details of the air distribution through the board room. The air-cooling system, however, is the most important feature of the mechanical installation, as it marks the introduction of a provision for comfort during hot weather that is the leading example of its kind in existence both from its magnitude and the exacting conditions of its service.

While there are some 13,000 sq. ft. of direct radiation, 8,170 sq. ft. of tempering coil surface and about 500 sq. ft. of supplementary indirect heating surface in the heating system, and eleven fans circulating about 225,000 cu. ft. of air per minute through some 2,675,000 cu. ft. of space in the ventilating system, the figure indicative of relative magnitude relates to the refrigerating plant, which, for cooling the air, delivered at a generous per capita rate to both the underground rooms and the board room, is of 450 tons' refrigerating capacity. It is intended, in the present study of the building, to discuss these plants at some length, but before so doing to describe the working plant in the cellar. The building was erected from the plans of Mr. George B. Post, of New York, and Mr. Alfred R. Wolff, of that city, was the consulting mechanical engineer and designer of the plant.

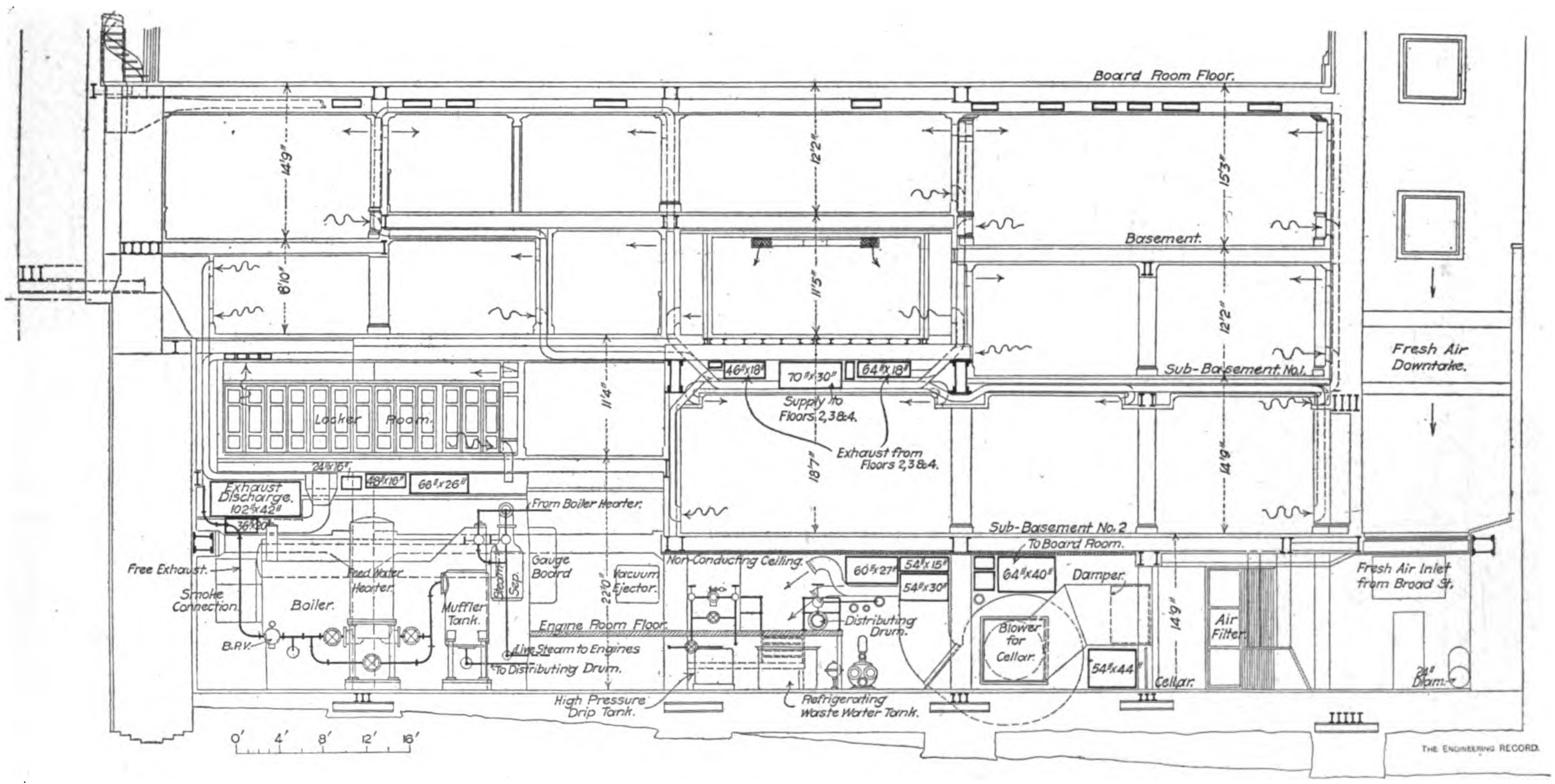
The building extends from Broad to New St., with a wing reaching to Wall St. In constructing its foundations caissons were sunk 54 ft. below the New St. curb or 42 ft. below ground water level, forming a cofferdam of concrete entirely around the site. It was decided to excavate the space so enclosed and to arrange for underground stories therein, largely for office occupation, except the lowest, which was reserved for the mechanical plant. There are accordingly above the cellar two sub-basements, Nos. 2 and 1, and the basement, the last only partly below street level. The location of the offices underground emphasized the value of providing cool air during summer, the importance of the idea for the comfort of the board room always having been realized.

The board-room floor is immediately above the basement, and above this, corresponding to the 86 ft. gross height of the room, are a gallery floor and four mezzanine floors, in the portion of the building at either end of the room. The next two floors are known as the bond and club-room floors, respectively, taking their names from the principal rooms in each case. Above the latter is the attic, and this, with the janitor's apartments on the roof, complete a total of fourteen stories from the cellar bottom upward.

The Mechanical Plant.—The arrangement of the mechanical plant, of which a plan is shown herewith, is in brief as follows: The location of the fresh-air shaft for the ventilating system, at one side of the building, resulted in reserving the larger part of that side of the cellar for the air filters and the blower units. The necessity for a relatively lofty space for the apparatus of the refrigerating plant determined its position along the New St. or rear wall of the cellar, where it rises through both the cellar and sub-basement No. 2. It was decided to place the boiler and electric-generating plants on the opposite side of the cellar from that occupied by the ventilating system, with the boilers toward the front or Broad St. end, and immediately under the shaft for the smoke flue. This left space in front of the ventilating apparatus, extending along the Broad St. wall, and a somewhat long and narrow space between the ventilating machinery and the boiler and engine rooms, in both of which spaces the rest of the plant is distributed. The elevator pumps were set along the boiler-room wall, and the house and fire pumps, the water filters, the sewage lifts, an auxiliary electric-generating unit and the compressor and tanks for the pneumatic tube service were distributed in the remainder of this space. The boiler-feed and other pumps, together with the ventilating blowers, were arranged along the area extending from the equipment just enumerated to the refrigerating room.

The boiler and engine rooms are partitioned off from the rest of the cellar, and at the front end of the former is a 150-ton coal bunker, directly underneath chutes dropping from street level. Alongside the engine room, between it and the adjacent building wall, a storage battery has been installed, and also one of the elevator pressure tanks for the elevators nearby.

A feature unusual in building plants of this description is the elevation of the engine-room floor above the general cellar bottom, an arrangement which provided a 5-ft. space for running the steam, exhaust and other pipes. The elevated floor was partly the result of erecting the generating-unit foundations upon the concrete floor existing over the entire building site. In order to get additional headroom in the engine room, however, the extensive locker room, required for the boys employed in the Stock Exchange, was located in the sub-basement No. 2, immediately above both the engine and boiler rooms. These could be given a reduced height and secured for the engine room about 15 ft. clear height, and for the boilers over 20 ft.; while the headroom of the general cellar is 12 ft. 9 in., insulated, it may be added, by means of a false ceiling consisting of Keasbey & Mattison 85 per cent. carbonate of magnesia blocks, 2 in. thick, placed to leave 3 in. dead air space.



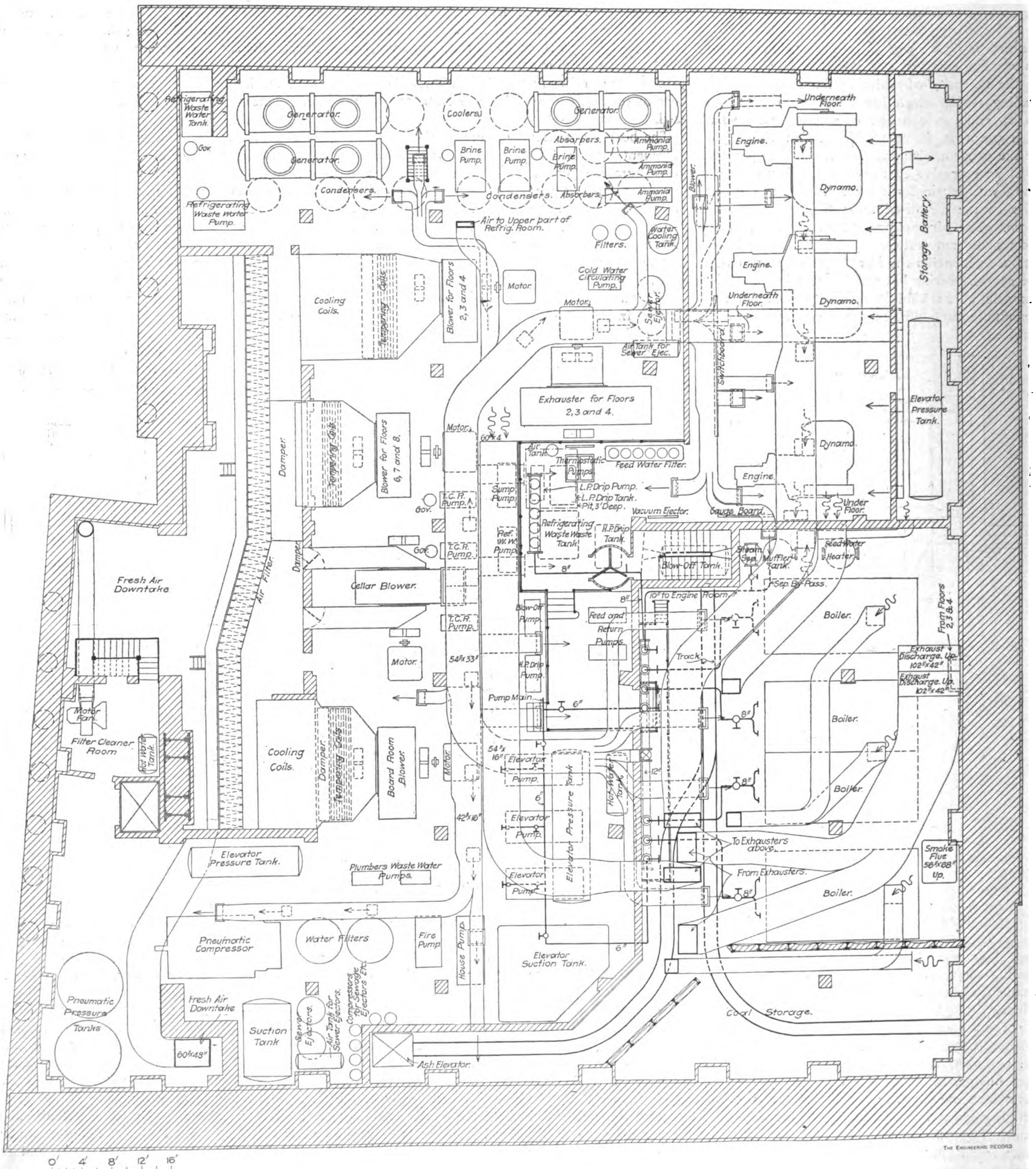
Vertical Section through Underground Rooms of the Building.

The boiler plant consists of four Babcock & Wilcox boilers of the water-tube type, set in three batteries, as indicated. They have an aggregate of 8,000 sq. ft. of heating surface, with 227.5 sq. ft. of grate surface, or a ratio of heating to grate surface of 35.2 to 1. One boiler has sixteen sections and each of the others 12 sections of tubes, each section of nine tubes 4 in. in diameter and 18 ft. long. The steam and water drums are 36 in. in diameter. The boilers are hand-fired and pea coal is used, brought from the coal store in cars on narrow-gauge tracking furnished by Mr. W. J. Haskins, of New York. The average steam pressure is 125 lb. The smoke flue starts 56x68 in. in size, is changed to an oval cross-section of substantially equivalent area, and is terminated above the roof about 215 or 220 ft. above the cellar level. The boilers have white enameled brick settings.

Steam is taken from the boiler drums at their front ends, owing to the somewhat limited headroom, and is carried horizontally across the firing space to a 12-in. steam header along the boiler-room side partition. The pipes from the boilers are equipped with two valves, one at the header, and the header itself is provided with a valve by which it can be divided into two parts, if, for any reason, it should become desirable to isolate the connections of either pair of boilers from those of the other pair. The controlling valves are thus removed from a place over or near the restricted and hot space over the boilers, and to render them readily accessible a light iron gallery has been suspended underneath the header.

From one section of the header are taken a 10-in. line to the engine room, an 8-in. line to reducing valves for the low-pressure systems for both heating and cooking purposes and a 6-in. pipe to the pump main; while from the other is run another 6-in. pipe also to the pump main, which is thus provided with a double supply. While there is a Potter mesh separator within each steam drum of each boiler, the steam going to the engine room is passed also through a Stratton combination receiver and separator, 36 in. in diameter and 9½ ft. high. From the pump main is supplied the auxiliary generating unit, which can thus be operated in the event of an accident to the engine-room system, because, as stated, the pump main can receive steam from both sections of the main header. The auxiliary set, however, is only large enough to operate the ventilating fan motors and a moderate amount of lighting, chiefly for such service as would be required after regular hours or during holidays and Sundays.

The main generating equipment comprises two 250-kw. and one 150-kw. units, each with a compound engine operated non-condensing, so that its exhaust is available for heating in winter and for the refrigerating plant in summer. The generators, built by the General Electric Co., are of direct current of 242 volts, which is desirable for the considerable number of motors in use throughout the building. The engines are Ball & Wood tandem compounds, 18 and 31x18 in. in



Cellar Plan Showing Machinery Layout and Cellar Ventilating System.

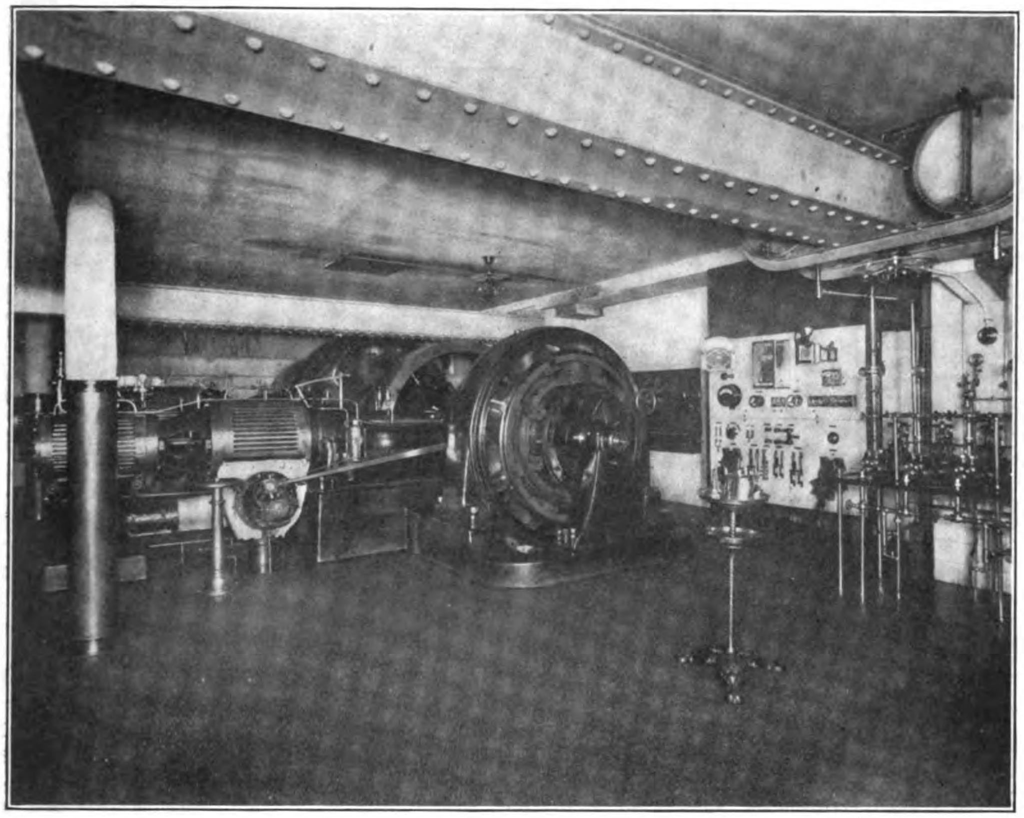
cylinder sizes in the case of the larger engines, and 13 and 23x16 in. in the case of the smaller engine, their normal speeds being 175 and 225 r.p.m., respectively.

The engines are operated 12 hr. a day, from 6 a. m. to 6 p. m., and the average load is 800 amperes, with a maximum of 1,000 amperes, when the ceiling arc lamps in the board room are required. To supply illumination and such other electric energy as may be required during the remainder of each day, a storage battery of 800 ampere-hours capacity, supplied by the Electric Storage Battery Co. is in use. The charging set is a 15-h.p. Western Electric motor-generator or booster outfit. The night load averages 50 amperes. The auxiliary unit is a General Electric marine set, of 50 kw. rating, with an 11x12-in. engine and a 244-volt dynamo, operated at 280 r.p.m. Its steam supply is passed through a Cochrane separator.

The engine room is floored with small dark red terra cotta tiles, and the room has a generally good appearance, which is enhanced by the method of enclosing the steam pipes. These are brought upward through the floor from the pipe space underneath and in 180 deg. curves are bent to the engines; their insulation, which consists of Keasbey & Mattison 85 per cent. carbonate of magnesia sectional covering, is wrapped in Russia iron, finished in turn with brass bands. Similar treatment has been accorded the Ward feed-water filter, which is located at the entrance into the engine room, as it is entirely enclosed by a jacket of brass-embellished Russia iron.

Besides the electric switchboards, the equipment of which includes wattmeters for recording the consumption of both the electric power and light installations, there is an extensive gauge board in the room with a gauge for each boiler, and gauges for the pressure on the lines to the humidity regulating coils of the ventilating system, on the lines to the kitchen, on the system for the refrigerating machinery and on the heating system, together with a recording steam gauge and clock.

The pressure system of lubrication of the Siegrist Lubricator Co. is employed, with the pumping equipment at one side of the room. There are four small pumps, being a duplicate set for both the engine and the cylinder oil, with two overhead pressure tanks, one maintained at 160 lb. and containing the cylinder oil, and the other maintained at 100 lb. for the engine oil. In connection with the latter, a White Star oil filter is used.



Engine Room Showing Steam Supply Pipe at the Left and Lubricating System at the Right.

The elevators are of the Otis hydraulic type and required three compound duplex pumps, of which one is a relay, and a jack pump for heavy duty. The main pumps are 14x20x11x15 in. in size, of the Worthington manufacture. The pressure piping, automatically maintained at 150 lb. pressure, delivers into pressure tanks of which one is placed directly over the water ends of the pumps and the others as near as convenient to the groups of elevators. An installation of six locomotive type Westinghouse air compressors, supported against the cellar wall, serve in part to supply the air in these tanks, but part of them are also used in connection with the sewage ejectors. These are of the Shone type, and were required to lift to the sewers such sanitary drainage as cannot reach the latter by gravity. The remaining important pumps of the plant are the 8x12x17 x10-in. compound Blake house pump, and the 12 x6x12-in. underwriters' fire pump. Near the latter are two New York filters, through which the city water is passed.

The pneumatic-tube system, which is another of the important adjuncts of the plant, is of particular interest in that the service afforded by the Exchange to the different cable companies must be identical. In other words, messages must carry from the main central tube station to the receiving points in the same duration of time, whether the receiving point is 50 or 250 ft. distant. There are altogether 97 lines of tubes and 4 sec. was the traveling time adopted for all tubes. The system was installed by the Lamson Consolidated Store Service Co., of Boston, and Foster reducing valves were fitted to each end of each tube, set to regulate the time of transit of the carriage. The compressed air is furnished at 30 lb. from an automatically operated duplex Ingersoll-Sergeant steam-actuated flywheel compressor, drawing air from the fresh-air supply intakes. It delivers into a pair of large storage tanks, from which in turn the tubes are supplied.

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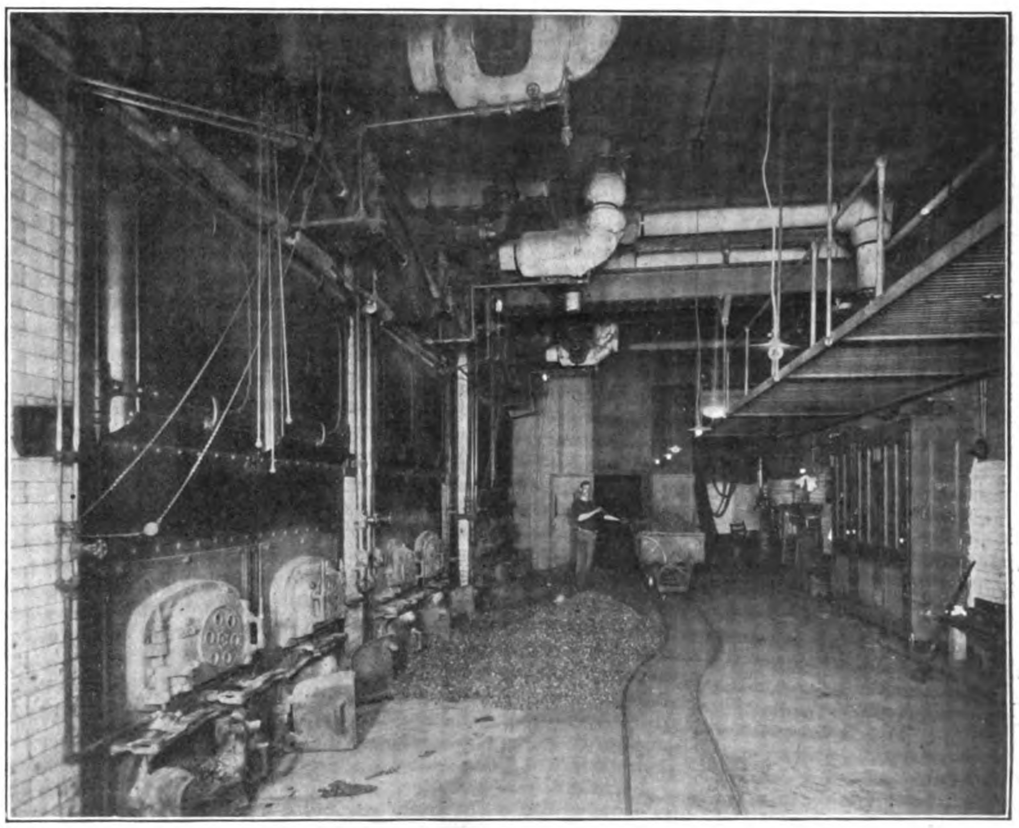


Boiler Room Showing Method of Taking Steam from Front Ends of Steam Drums.

Waterproofing Brickwork.

Waterproofing brickwork has been tested by the Engineering Department of Toledo recently. The experiments were made by immersing soft and sewer brick in various compounds of tar or asphalt for different periods and at different temperatures. After treatment in this way the brick were placed in water for 48 hours. It was found that the treatment had very little effect on the capacity of the brick to absorb moisture. Mr. E. F. Wallbridge, who conducted the tests, states that it has been decided that waterproofing brick by this treatment is not practicable.

could have been considered the outside finish, but in order to have a light buff finish, a second coat of lime and yellow sand was put on very thin, proportions being one part lime to four parts sand.

In doing the work over again, Mr. Matcham would only apply one coat composed of one part cement, one part lime, and five or six parts of white or yellow sand. The mouldings on the columns were finished by applying the coating of lime and sand with a brush. The adhesion of the coating to the concrete has made a perfect bond.

A house with the natural concrete finish, evenly roughed off, would make a neat finish, and, of course, be cheaper, but not as warm in appearance as the buff sand finish of this house.

The fireplace in the billiard room is made of ordinary red clay brick and gray cement brick, the mantle being moulded in one piece, cast out of sand and cement. The fireplace in the dining-room (see cut) is of sand and cement brick, and moulded mantle.

Much has been said as to the feasibility of plastering on solid walls without using lathing, there being doubt about moisture coming through the walls and plaster. Moisture will not penetrate a solid wall if a reasonably wet concrete is used; a dry concrete Mr. Matcham cannot vouch for, and water may penetrate it, although this is doubtful.

Claims are made that the different temperatures between the inside and outside of walls, particularly in winter time, cause sweating. Mr. Matcham denies this on the ground of experience with various kinds of buildings, all having varying temperatures; all have shown perfect dryness inside, irrespective of temperatures and weather.

As to the cost of construction, there were 400 cu. yd. of concrete in the walls and floors of the house, and taking into consideration the carpenter work, setting up framing, setting doors and window frames, and joists as the work progressed, the common labor, cement, sand and stone, totaled up to $2,600, which would make the concrete cost $6.50 per yard. Ordinary brick houses, with pressed brick face, cost from $10 to $12 per cubic yard.

In considering the cubic yards of concrete in this house, the hall and porch floors and roofs are figured in. If these had been figured separately, the main walls of the house would cost less per cubic yard, and, of course, the floors and roofs more, and it must further be taken into consideration no further carpentering was needed for roofing or flooring or slaters and painters, as would be necessary for a brick building. The cost of repairs to such a house are also brought down to a minimum.

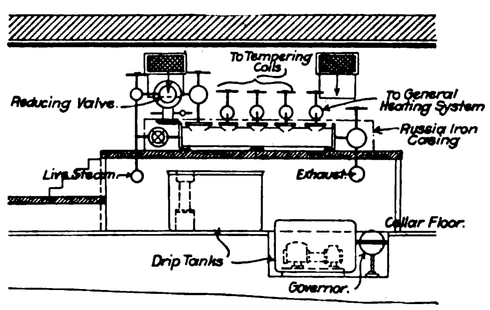
The following material was used to a cubic yard of concrete; 320 lb. of cement, 950 lb. of sand, 2,560 lb. of crushed stone, 290 lb. of water; total, 4,120 lb. The proportions were about one part cement, three parts sand, and eight parts stone.

LIGHTNING ARRESTERS WITH TELL-TALE PAPERS was the subject of an article by Mr. N. J. Neall in a recent issue of the "Electric Club Journal." Lightweight bond papers of uniform texture should be used, he says, and they should be inserted in the gaps to be investigated and so shaped as to make it impossible for a discharge to pass without puncturing them. Each arrester on the system should have several of these papers, carefully dated, marked with the location on the line and of sufficient size for any remarks as to the particular events registered thereon by a static discharge. The papers should be removed regularly from the gaps, except in time of disturbances, when they should be removed immediately after the storm. A file of the returns is to be kept so that the operator of the plant can collate information from them as to the behavior of the line as a whole.

Heating, Ventilating and Air Cooling at the New York Stock Exchange.—II.

Heating.—The heating of the building is accomplished almost altogether by direct radiation, as the fan equipment is only for circulating tempered air for ventilation; but the heating plant is of considerable interest, owing to the extensive use of enclosures for hiding the radiation and in respect to the calculations for the large board room with its proportionally large amount of glass surface. Exhaust steam from the mechanical plant is utilized in the usual way, and the radiation is connected on a two-pipe system with the supply and return mains distributing mostly in the cellar; the Paul system of extracting the air from the radiators by air lines from the radiator air valves to steam jet exhausters has been applied, and the radiation is controlled by the Johnson system of automatic temperature regulation. The only rooms warmed by the air supply are those which, on account of certain architectural considerations, made direct radiation impracticable, and the branch ducts from the ventilating system for these rooms are fitted with indirect surface supplementary to the tempering coils.

The supply of low-pressure steam for heating is controlled from a distributing drum, which is now not an unusual feature in the mechanical plant of the large building, for the convenient arrangement of connections between the different heating mains and the source of steam supply, both the exhaust and the auxiliary reduced-pressure live steam. The exhaust main from the electric-generating plant, 12 in. in size, is joined by an 8-in. main from the rest of the steam machinery of the plant, and the exhaust, in a pipe 14



Elevation of Distributing Drum.

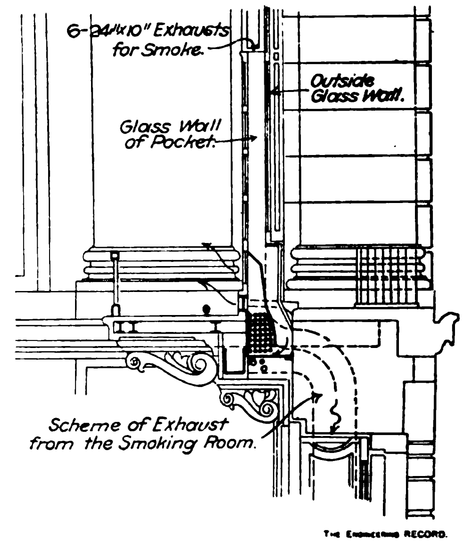
in. in diameter from the point of junction, is led successively into a muffler tank and the feed-water heater. Beyond the heater the pipe is continued full size to the distributing drum with a 12-in. branch with Kieley back-pressure valve opening into the free exhaust riser to the atmosphere.

The muffler tank is 48 in. in diameter and 7 ft. high, located at one end of the boiler room, and is of the Potter type, with 24 galvanized-wire disks to serve as an oil separator. The feed-water heater was furnished by I. B. Davis & Son, of Hartford, and is of the Berryman vertical pattern, 45 in. in diameter and 121 in. high, containing about 250 sq. ft. of heating surface of 2-in. brass tubing. It has, of course, a by-pass.

The distributing drum is of cast iron, 14 in. in inside diameter, with a flanged outlet at each end and a series of them on the top. To one end is brought the 14-in. exhaust connection, and to the other a 6 in. live steam connection. Ordinarily, however, the auxiliary live-steam supply is received at reduced pressure through an 8 to 14-in. Kieley reducing valve, which delivers into the drum through one of the top openings, the 6-in. pipe being a by-pass around the reducing valve. Three steam lines are taken to the three groups of tempering coils of the ventilating system, two 7 in. in diameter and the other, for the board room, 8-in. in diameter, and an 8-in. line serves the direct heating and the incidental supplementary indirect surface mentioned.

Altogether there are 8,170 sq. ft. of tempering coil surface, about 13,000 sq. ft. of direct radiation and about 500 sq. ft. of supplementary heating surface. The condensation from each of the three tempering coils is separately handled by a 7¼x4½x6-in. Blake duplex pump, operated under the control of a Kieley pump governor, and there are three other pumps of the same size, similarly controlled. One of the latter is regularly employed to handle the condensation collected in a high-pressure drip tank. The other two act as boiler-feed pumps with the suction connected to the system of direct radiation return pipes, which are kept submerged by the level maintained by the pump governors. All of these pumps are arranged to deliver into the boiler feed mains. Make-up water is received from the city mains and passed through coils for cooling the contents of the blow-off and low-pressure drip tanks,. the latter receiving grease laden water which must be cooled before it is pumped to the sewer.

The amount of radiating surface to be installed is determined on the lines usually followed by Mr. Wolff. The hourly heat losses for the bounding surfaces of each room are calculated for 70° indoors and zero outdoors, with allowance for ex-

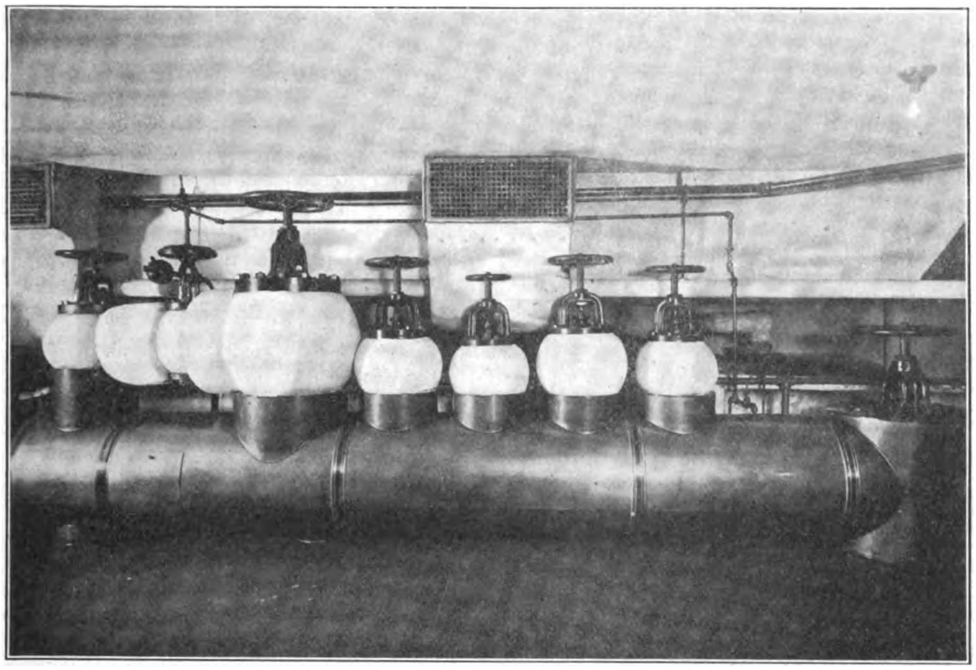


Glass Wall Pocket at Gallery Floor.

posure, and the number of square feet of radiation is ascertained on the basis of 250 B. t. u. supplied per hour per square foot of direct radiator. In the Stock Exchange building, however, some of the conditions are of a special character, as explained.

The board room is 110x139 ft. in plan and 78 ft. high, and the east and west walls are very largely of glass, each having an expanse of 92x51 ft. unbroken save for the structural steel framework supporting it. The north and south walls are within the building, and no transmission of heat through them is considered. An accompanying table shows the total values for the different classes of exposed wall in this room. The coefficients in each case are, of course, the number of British thermal units transmitted per square foot per hour for the 70° range. For exposure the east wall transmission figures are increased by 30 per cent., the west wall figures by 35 per cent., and the skylight figure by 10 per cent. The total amount of the hourly heat transmission to be overcome by the direct radiation is 1,264,000 B. t. u., so that at the given rate of 250 B. t. u. per square foot per hour, 5,000 sq. ft. of radiation are apparently required.

Under the severe weather conditions for which the apparatus is proportioned, however, the air for ventilation can be delivered into the room somewhat above 70°, and in that way assist the direct radiation in making good the heat losses through the walls. As a matter of fact, 3,960 sq. ft. of direct radiation are installed, and at the given rate of 250 B. t. u. per square foot will furnish 990,000 B. t. u. per hour. The remainder of the heat can be obtained by allowing the air introduced at the ceiling to cool 4°, say, from 74° to 70°, before reaching the occupants of the room, the volume being about 60,000 cu. ft. per minute. On the basis of the radiation required the ratio of contents to the heating surface is 240 cu. ft. to 1 sq. ft., while the amount actually installed gives a greater ratio owing to the dependence, under extreme conditions, on the ventilating plant to supply approximately one-third the heat.



Steam Distributing Drum from which Entire Heating Plant is Controlled.

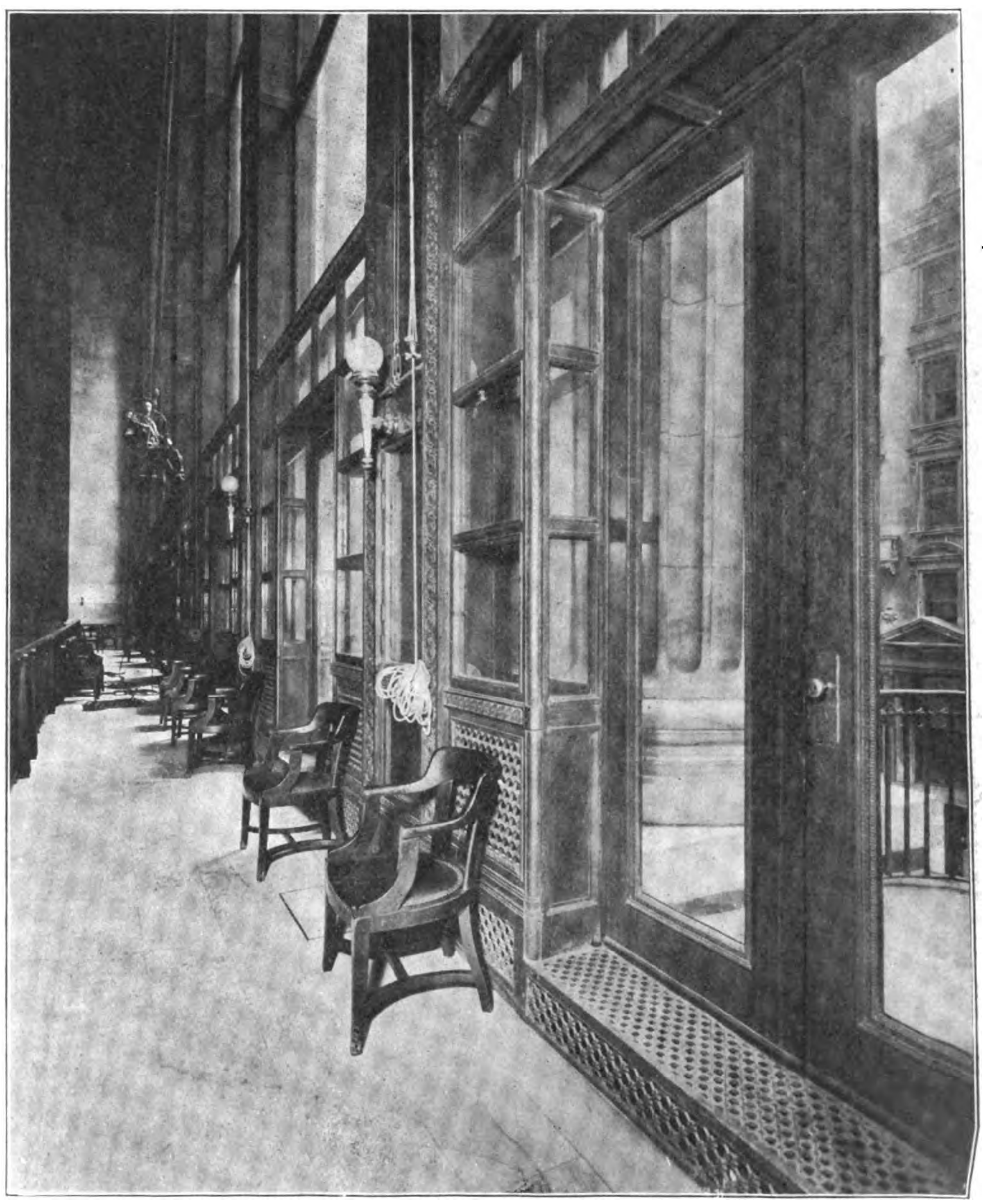
Hourly Heat Transmission, Board Room.

	Sq. ft.	Exposure factor.	B.t.u.
Window surface, coefficient, 85.			
East wall	5,015	0.30	555,000
West wall	4,840	0.35	555,000
Outside wall, coefficient, 5.			
East wall	3,681	0.30	24,000
West wall	3,688	0.35	25,000
Doors, coefficient, 100.			
West wall	168	0.35	22,700
Skylight, single, coefficient, 73.			
Ceiling	1,024	0.10	82,500
Total			1,264,200

The radiation is arranged along the two glass walls, part at the main floor line and part at the gallery level, which is 18 ft. above it. Practically all of it is of the enclosed type, with openings for circulating the air, except four coils, each of 150 sq. ft. of surface, for the skylight over the center of the room. The unobstructed glass walls start upward from the galleries and the radiation at that level is entirely to offset the losses through these walls. It is grouped in seven coils of 200 sq. ft. of surface in each case. The descending sheets of cooled air, as they approach the gallery, fall into a space formed by a double glass wall, and this glass pocket leads to a level below each steam coil where the air passes upward, is heated by the coil, issues into the room through registers at the gallery floor, rises on the inner side of the descending currents of air, and as it reaches the upper points, giving up its heat, joins the descending currents and thus completes a circulation of air. The object of this circulation is, of course, to supply the heat which must be provided to prevent drafts and undue cooling otherwise likely to occur with the large area of the glass. The glass pockets are about 10 in. deep, the inner glass wall, which rises 12 ft. above the gallery floor, being placed about that distance from the main glass wall.

The radiation is all controlled by thermostats, as stated. The coil surface for the large windows of the board room is, however, divided into two parts in each case. Three-sevenths of it is put under steam when the outside temperature drops to a predetermined temperature, and the remainder is controlled by thermostats indoors. One outdoor thermostat, set for 45°, controls all the three-sevenths sections of the Broad St. window coils, and, similarly, one thermostat controls the smaller divisions of the New St. coils. The larger divisions of the coils are controlled by three thermomstats in the case of each window, two for two coils each and one for three coils.

In applying the coefficients of heat transmission, the usual values were taken for windows and skylights, but for doors, owing to the avenue they offer for the escape of heated air, 100 B. t. u. were counted on per square foot per hour of the door area. The walls were regarded as equivalent to brickwork of the actual thicknesses, but for the larger walls, 54 in., 66 in. and 84 in., the coefficient was taken at 5 for all three. In a few of the rooms of sub-basement No. 1, a coefficient for the outside wall of 3 B. t. u. was taken, but the fact that moist earth surrounds the building and that the transmitting power of the concrete cofferdam, which constitutes the retaining walls, is unknown under the conditions, led to installing quite a little more radiation than given by the calculations. Another special case was a stairway located alongside the fresh air inlet shaft. Here double the regular values for transmitting coefficients for the outside wall of each thickness were employed, and the window surface was charged with 100 B. t. u. per square foot per hour. Practically no direct radiation was placed in sub-basement No. 2.



Gallery in Board Room Showing Air Pockets for Air Circulation.

The contractors for the heating and ventilating installation were Messrs. Baker, Smith & Co.

(To be continued.)

tions made two angles, back to back. All the web members of the trusses are zig-zag diagonals except two verticals in each truss which receive the connections to the light longitudinal lattice girders. The transverse trusses are field-riveted to the column flanges through vertical connection flange angles on the gusset plates at the ends of their top and bottom chords. The trusses in the middle and outside spans have their lower chords at a clear height of about 12 ft. above the ground; the intermediate trusses are 8 ft. higher so as to provide clere-story spaces for ventilation and illumination between them. The roof is of 1⅜-in. planks on 3x6-in. purlins 4 ft. apart carried by the roof trusses and by two intermediate transverse lattice-girders in every 25-ft. panel which are supported by the longitudinal girders.

Wide sidewalks in the center of the middle and outside spans have a concrete floor on No. 20 galvanized corrugated iron, laid transversely on 6-in. longitudinal channels, 3 ft. apart. The two outer sidewalks are not covered, but that on the center trusses is provided with a canopy having a board roof supported on arched plate girders with very thin webs and light flange angles riveted to extensions of the center vertical members of the trusses. Similar canopies on the center lines of the two intermediate panels serve as monitors for those parts of the roof.

The 95x250-ft. field stand is similar in construction to the grandstand except that it has no intermediate story, and that the tier of seats is uninterrupted and has no horizontal platforms, but is reached only by stairs from the front or lower side. The space under the seats is used for barrooms, lunch rooms, toilet rooms, etc. The front wall is of brick, and the rear and side walls are of corrugated galvanized iron glazed. As in the grandstand, the framework is divided into 50-ft. panels by transverse rows of four main and two secondary columns, the former supporting the roof trusses and the seat girders, and the latter supporting the seat girders only, as shown in the sectional diagram. In each panel there are two intermediate roof trusses and two intermediate seat trusses; the former are carried by two lines of longitudinal trusses connected to the tops of the two front columns and by intermediate full-height columns in the two rear longitudinal rows. The latter columns also support the rear ends of the intermediate seat girders which have their middle and front supports on short columns independent of the roof columns. The lateral and sway bracing, and the character of the details, is essentially like that of the grandstand. The seat trusses are all made with deep curved knee-braces at the lower ends and the rear trusses have them at both ends to stiffen the columns against the bending moments from wind pressure and provide sway bracing.

The front longitudinal roof trusses are 7½-ft. deep, and are divided into three equal parts by vertical members composed of single pairs of angles, back to back, but staggered and spaced far enough apart to rivet on opposite sides of the truss connection plates and to receive between their other flanges the field connections of the intermediate transverse trusses. The top chord is made with two 5x3½-in. angles, back to back, with a full-length horizontal cover plate, and the bottom chord is made with a pair of 5x3½-in. angles, back to back, with their 5-in. horizontal flanges reinforced by a full-length 12-in. channel. The diagonals are pairs of 4x3-in. angles, back to back, riveted to opposite sides of the connection plates. The transverse roof trusses have all their members made with T-shape cross sections composed of two angles back to back, and are connected to the columns by their top chord angles engaging the extended web plates, which also serve as gusset plates for the trusses, and by pairs of vertical flange connection angles riveted to the gusset plates at the ends of the lower chords and field-riveted to the column flanges.

The framework of the grandstand and of the fieldstand was erected by a pair of duplicate travelers, each of which consisted of a 30x30-ft. wooden tower, 30 ft. high, mounted on four double-flange wheels on a 30-ft. gauge track and X-braced on all vertical faces and in the horizontal plane of the top and bottom. A pair of stiff-leg derricks with 5-ton booms, 40 ft. long, were mounted on top of each traveler and handled all the steel work. The fieldstand was erected in the manner described for the grandstand, and before the latter was erected. Spencer surfacer paint was used for the shop-coat, and after erection, all steel work was painted two coats with "Cerion" paint.

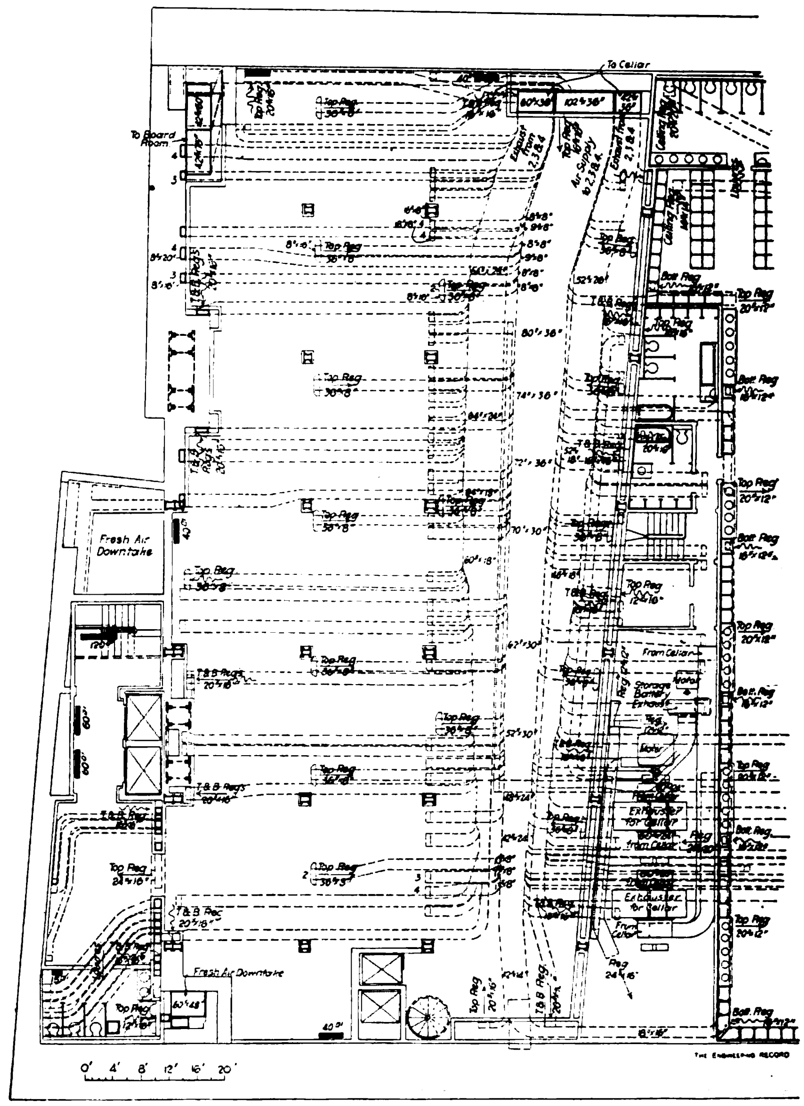
The engineering and architectural features and all buildings were planned by Mr. C. W. Leavitt, Jr., Engineer, who developed and directed all construction, and laid out the tracks and grounds. Mr. Mason R. Strong, M. Am. Soc. C. E., was called in consultation and for assistance on the structural steel. The contract for steel was awarded to the American Bridge Co., which executed the work under the direct supervision of Mr. J. H. Edwards, M. Am. Soc. C. E., assistant chief engineer in charge of building construction for that company.

The Manhattan Type of Engine, with vertical and horizontal cylinders, was forestalled by the engines built in 1869 by the Palmers Co., of Jarrow, England, for two ships of the Guion Line, according to Dr. A. W. B. Kennedy. These were compound engines, with the high-pressure cylinders placed vertically, and the low-pressure horizontally. They had Corliss valves worked by a wrist plate without trip-gear. Four sets of 5,000-h.p. engines, capable of 50 per cent. overload, are now being built for the London County Council. They have a similar arrangement of cylinders.

Heating, Ventilating and Air-Cooling at the New York Stock Exchange.—III.

The Ventilation in General.—The circulation of air through the building is maintained by eight centrifugal fans and three disk fans. For the rooms devoted to the transaction of business, the ventilating plant is designed to supply air under a slight plenum and also to exhaust it by mechanical means, the combined capacity of the exhausting apparatus for these rooms being somewhat less than that of the plenum apparatus. This is, of course, to provide that a positive outflow may take place from the spaces requiring ventilation without creating a tendency for an inflow of cold air through such openings as the building may possess.

For the purposes of convenience in operation,



Ducts over Ceiling of Sub-Basement No. 2.

the ventilating plant is so divided that each part serves one of the portions of the building into which the latter is naturally divisible. The parts of the building thus independent so far as their ventilating equipment is concerned are as follows: The board room; the rented floors below the board room floor; the cellar, given over entirely to the mechanical plant; the board of governors' room, together with the rest of the rooms on the upper floors; and the kitchen in the attic.

So far as possible the fan and heater units are placed in the cellar, and fresh air admitted through a large downtake dropping from the roof to the cellar. All the fresh-air fans, with the exception of a small disk fan for the kitchen, are located in the cellar, and they are distributed, so far as possible, in a line at the base of this air downtake. This made it necessary to provide a long common air chamber from which all fans could draw, and allowed for a long air filter, large enough to bring the velocity through the cheese-cloth to the specified ½ ft. per second. As shown in the cellar plan, there is a blower for the basement and sub-basements Nos. 1 and 2, a blower for the board room, a blower for the floors above the board room, and a blower for the cellar, all but the last having tempering coils on the suction side, between filter and blower.

The cellar is provided with exhaust ventilation and the exhausters are located in the sub-basement No. 2, no space being available in the cellar, and, moreover, ducts being conveniently carried upward to them. They are located in a room over the end of the boiler plant and discharge into a shaft near by. Two, mounted on the same shaft, were necessary, owing to the limited head room available. The exhaust from the floors lying between the cellar and the board room is carried downward to an exhauster in the cellar, which delivers, by means of the ducts shown, to a shaft alongside of that carrying the air from the cellar. The rest of the building from the board-room floor upward is exhausted by means of two large disk fans at the roof, a system of ducts in the attic conducting the air from vertical flues of this system to the exhaust air chamber containing the disk fans.

The accompanying table gives the sizes of the fans, together with the heating surface installed in the shape of tempering coils, the horse-power of the motors by which the fans are driven and the speeds at which the fans will give the air delivery for which the plant was laid out. The blowers were built by the B. F. Sturtevant Co., the disk fans are of the Blackman type, furnished by Messrs. Howard & Morse, of New York, and the motors are of the C & C Electric Co.'s manufacture, wound for specially slow speed. The differences in the depths of the tempering coils will be noted. Sixteen pipes were provided in the coils for the board room, so that air in this case might, under severe conditions, be supplied at a temperature high enough to assist the direct radiation installed in that room with its great amount of glass surface. A similar reason explains the difference between the depth of the coils of the upper floors and of those under the board-room level.

Each of the tempering coils is controlled by a pair of thermostats, one fixed in the cold-air duct and controlling two sections first encountered by the incoming air and the other in the hot-air duct controlling the remaining sections of the tempering coil. Each section of each group is, of course, fitted with a hand valve.

Summary of Fans Installed in Building.

	Fan size.		Tempering coils.		Fan motor.	
	Dia. ft.	Width, ft.	Sq. ft.	Rows deep.	H.p.	R.p.m.
Fresh-air fans:						
Cellar system	8	5	....	..	15	160
Lower floors system	10	4.5	2,200	12	20	120
Board room floor	11	5	3,470	16	24	110
Upper floors system	10	4.5	2,500	14	20	120
Kitchen, (disk fan)	3	..	....	..	5	300
Exhaust-air fans:						
Cellar (2 fans)	7	4	....	..	28	180
Lower floor system	10	5	....	..	20	120
Board room and upper floors (2 fans)	8½	..	....	..	30	150
Filter cleaner	3	1.5	....	..	4	500
Storage battery exhaust, No. 10 Monogram fan.						

An interesting detail is the provision in each chamber of a moistening pan for maintaining the air, under automatic control of a humidostat, at the desired degree of humidity. Each pan, which is placed on the inside or warm side of the tempering coil, is of the same length as the tempering coil, and built of 24-oz. copper. It is furnished with submerged steam pipe coils to set up evaporation, and with an automatic water-feed valve for keeping the coils submerged. This type of moistening pan was installed in the heating plant of Mr. Andrew Carnegie's residence, described in The Engineering Record of Oct. 3, 1903. In this case, it will be recalled, an evaporation of 10.85 lb. of water was obtained per square foot of the steam pipe coil surface. The humidostat controls the steam coil supply by means of a diaphragm valve taking air from the temperature regulating system.

In general the ventilating system is designed to effect a desired number of air changes per hour, the figures for the average case being six changes for the fresh-air side and one less or five for the exhaust-air side. The excess is largely disposed of through the doors to toilet rooms, which are ventilated at the rate of fifteen changes per hour without special fresh-air supplies. There are a few special cases where an excess of exhaust over supply is provided, on account of the relatively high degree of vitiation or the presence of disagreeable odors. One of the locker rooms, for example, has five changes on the fresh-air side, and eight on the exhaust side; and several hat and coat rooms, four and eight changes, respectively.

The total quantities handled by both the fresh-air and exhaust systems are given in the accompanying table, from which it is seen that on the basis of the gross contents of the building ventilation is obtained in terms of five changes per hour. While the board-room system has its own fresh-air fan, the exhaust, as stated, is handled by the fans serving also the upper floors.

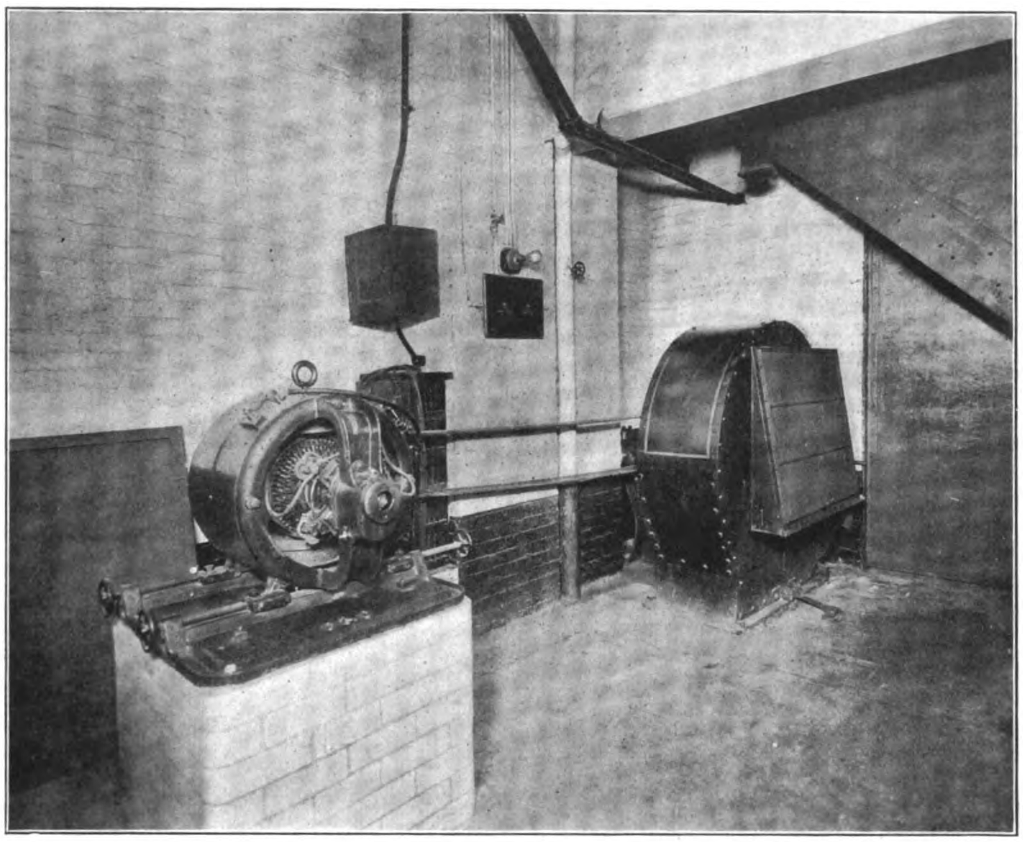
Table of Air Volumes by Floors.

	Contents, cu. ft.	Air supply, cu. ft. per min.	Exhaust, cu.ft.per min.
Cellar system	238,000	45,000	60,000
Lower stories:			
Sub-basement No. 2 ..	175,100	14,810	16,400
Sub-basement No. 1 ...	165,800	13,890	16,900
Basement	173,500	13,040	15,950
Board room floor	1,246,100	61,760	52,070
Upper floors:			
Mezzanine floors	174,600	10,120	11,570
Bond room floor	223,700	26,200	22,930
Club floor	183,600	13,650	15,060
Attic floor	120,600	1,840	13,660
Roof space	25,000	.....	.....
Total	2,706,000	200,310	224,540

The general features of the ventilating plant having been outlined, it will only be necessary to point out the special features of the different sections of the system. As regards the cold air supply, it may be pointed out that besides the large downtake, an additional source of supply was obtained by taking fresh air from Broad St., conducting this air to a short downtake 5x4 ft. in size, and connecting the bottom of this by an overhead duct in the cellar to the fresh-air chamber at the air filters. The cross-section area of the main downtake is about 150 sq. ft., and with all four fans in operation at the same time at full capacity, the velocity of the air in it would be approximately 20 ft. per second.

The air filters are of the usual cheese-cloth type, set in frames fixed in a zigzag fashion, with galvanized wire netting to support the cheese-cloth. The total area is about 5,400 sq. ft., so that on the basis of a total flow of 200,000 cu. ft. of air per minute, the velocity through it is 0.6 ft. per second. About fifty filter frames are taken out each day for cleaning, the reserved number in storage being equal to that in use, and this arrangement results in the entire filter being cleaned in a period of two weeks. Owing to the height of the filter and its unusual length, a permanent iron gallery has been built along it with steps to reach the gallery floor, so that the upper section of the filter screens may readily be handled.

For cleaning the filter sections, a special fan, noted in the table of fans, is installed in a room adjoining the cold-air chamber. To the suction side of this fan is built a special hopper inlet, which is large enough to receive one frame, and with the suction of the fan and the application of a broom, the particles of dust are loosened from the cheese-cloth and discharged finally out of doors.



Exhauster for Cleaning Air Filter Frames.

The Cellar Ventilation.—The cellar blower does not, of course, handle tempered air, as the air supply is furnished as much for cooling purposes as it is for ventilation, and the fan is placed end on toward the cold-air chamber, and is of the double inlet type, as indicated in the cellar plan. The discharge from this blower is divided into two ducts running in opposite directions, one 54x31 in. in cross-section and the other 54x29 in. These ducts are carried around throughout the mechanical plant, and deliver mostly through openings in the bottom of the duct itself. It will be of interest to add that the total area of the registers of this system is 28.4 sq. ft. for the larger duct and 25.7 sq. ft. for the smaller duct.

By another system of ceiling ducts with register openings generally in the bottom of them, air is carried from the cellar to the pair of exhaust fans in sub-basement No. 2. These ducts all lead to four short uptakes connecting with the exhauster inlets, the exhausters being of the double-inlet type. They discharge downward into a duct in the upper part of the boiler room, and the two ducts from the two exhausters are there joined and continued into the main exhaust shaft.

There are four registers through which fresh cold air is delivered into the boiler room, these distributed along the inner side over the firing space, and the outflow is provided for through a register over each of the boiler settings toward the rear and also one over the feed-water heater. Here for a total area of fresh-air registers of 1,920 sq. in. there are 3,600 sq. in. of exhaust outlets. Besides providing for ventilation in the engine room, the ducts take also from the pipe space underneath that room.

Ventilation of the Underground Rooms.—The blower for the floors between the cellar and the board room discharges most of its air through a short duct and flue carried to the level of the ceiling of sub-basement No. 2, where it is carried forward in a main duct over a suspended ceiling in that story. The air is then distributed by numerous branch ducts from this trunk duct to the individual flues. This system includes the basement, sub-basement No. 1 and sub-basement No. 2. The handling of the exhaust air is accomplished with a system similar to the fresh-air system, the flues from the vent registers dropping downward to the space provided above the false ceiling of sub-basement No. 2, and there connecting into a pair of main vent ducts. These deliver into large flues dropping to the cellar ceiling, where they are joined into the exhauster for these floors. This discharges into a duct 42 in. deep and 102 in. wide, which is carried from this point against the cellar ceiling to the main air discharge shaft, which, as stated, also receives the air from the pair of exhausters for the cellar.

Ventilation of the Board Room.—The board room is ventilated on the downward system, and an elaborate arrangement of ducts has been provided by which the air can be admitted at a large number of points spread over the entire area of the board-room ceiling. The air is delivered to this distributing system at two diagonally opposite points, and one of the cellar ducts from the double-discharge board-room blower connects into a 60x58-in. vertical flue rising from the cellar to the ceiling level of the board room at one corner, and the other cellar duct terminates into a 60x52-in. flue, which rises at the diagonally opposite corner.

The system of distribution is briefly this: The decorative ceiling, through the inconspicuous openings of which the air is admitted into the room, is divided naturally into six transverse lines, and in each of these are spaced a number of galvanized-iron boxes, each receiving air through a branch duct and delivering it through the ceiling openings which each box groups together. At opposite ends of each pair of these six lines of boxes is a similar box considerably longer, however. The boxes may be regarded as forming three rectangles; one rectangle and the half of the middle one is supplied from one of the main fresh air flues from the cellar, and the third rectangle and the remaining portions of the middle rectangle from the other fresh-air flue.

The boxes are all 24x10 in. in cross-section. Those in the six transverse lines, with seven boxes in each line, are 120 in. in length. The end boxes of one of the rectangles are 300 in. long, those of the center rectangle are 444 in. long and those of the third rectangle, 312 in. Each of the smaller size boxes is supplied from the distributing ducts above the board-room ceiling by a single branch duct, while the longer boxes are supplied by three branch ducts.

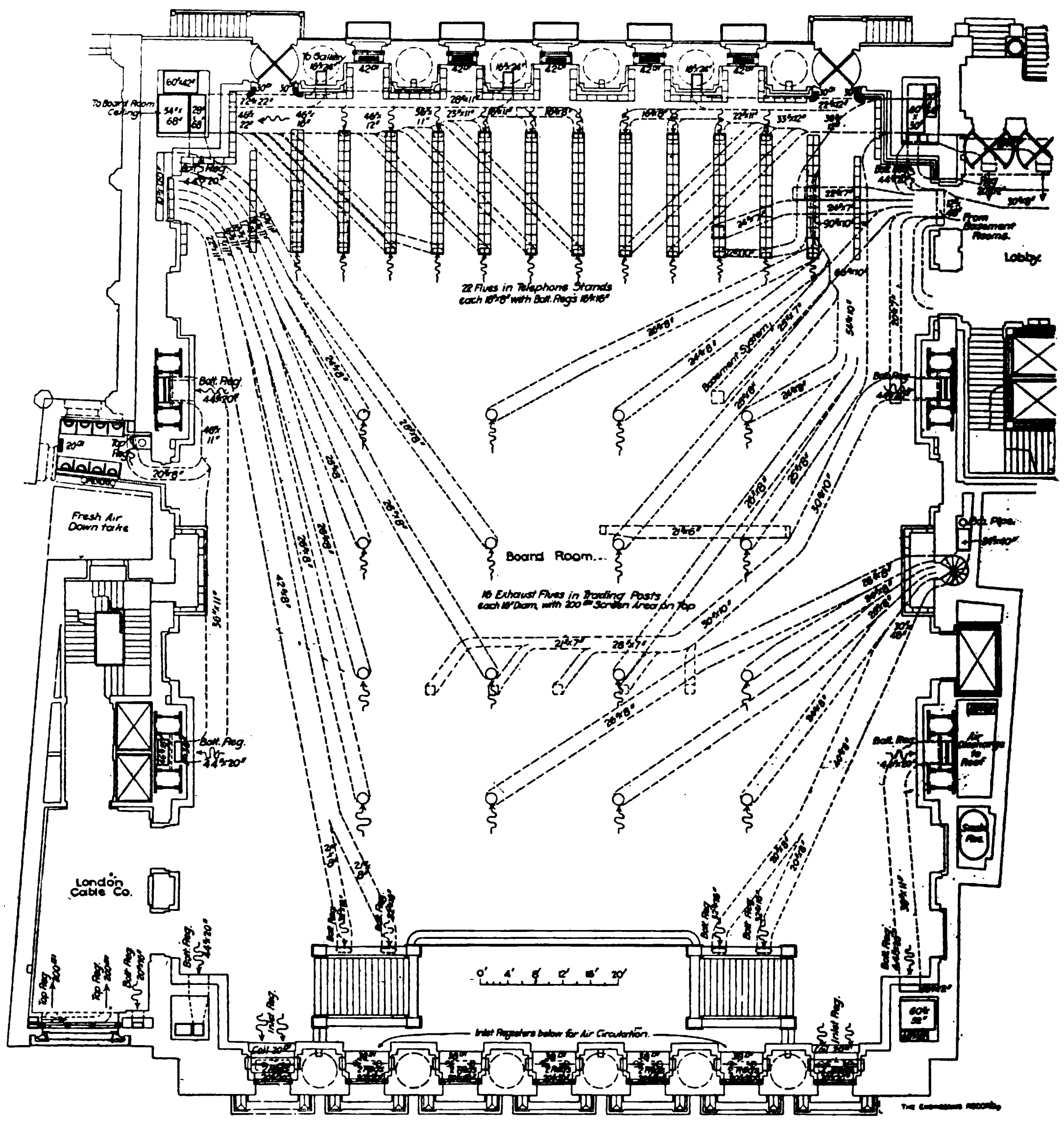
The interesting point is the provision made in the proportions of the entire system for equalizing the resultant pressure in all of the boxes, so that there will be an equal distribution of air over the entire ceiling. All other dimensions being equal, the discharge of air through the boxes is proportional to their length. It will be found that there are 3,324 lin. ft. of boxing connected to the northeast flue, which is the one 60x52 in. in cross-section, while a greater number, 3,828 ft., are served by the southwest shaft with a cross-section area not proportionately as large. While the reference to the matter in the following terms is not to be taken as an explanation of the method by which the design was developed, the analysis may be regarded as an approximate check to substantiate the dimensions chosen.

The southwest flue, on the given assumption of delivery proportional to the linear feet of the box work, carries thereby 15 per cent. more air than the northeast flue, but has a cellar duct that is but 3 per cent. larger than the northeast duct. This makes the relative velocities for the southwest and northeast ducts, 1.115 and 1, respectively. The length of the southwest duct, however, which is not shown at all on the cellar plan, is, including horizontal parts, 90 ft., while that of the northeast duct is 100 ft. As the loss of pressure in ducts is proportional both to the length of the duct and to the square of the velocity, and therefore to the product of the length and the square of the velocity, the relative loss of pressure in the southwest and the northeast ducts is $1.115 \times 1.115 \times 90 = 112.5$ and $1 \times 1 \times 100 = 100$, respectively.

For the flues themselves, the figures check up as follows: The southwest flue through the lower part, or 45 ft., of the building is 60x58 in. in size, and through the remainder of the distance, about 80 ft., is 54x68 in. It will be found that its relative velocity, as compared with the northeast flue, is 1.03 through the 45 ft. and 0.98 through the 80 ft. The relative pressure loss through the 45 ft. is accordingly 47.7, and through the 80 ft., 76.8, making a total for the 125 ft. of 124.5 as compared with 125 for the 125 ft. of the northeast flue.

The delivery of the northeast flue, as determined by the proportionate length of box work is 28,000 cu. ft. of air per minute, making the duct and flue velocities, 1,575 and 1,300 ft. per minute, respectively. The delivery of the southwest flue is 32,000 cu. ft., and the duct and flue velocities figure out at 1,750 ft. and 1,250 ft., respectively. By successively reducing the velocity in the system of distributing ducts above the board room ceiling, it is calculated to equalize the pressure at the delivery end of the branch ducts into each box. This provision for velocity reduction is indicated in the proportions of the small branches themselves, varying from 10x12 in., in the case of the branch nearest the flue, to 11x16 in. in the branches most distant.

The air is drawn from the board room near the floor line through register openings in the sixteen trading posts distributed over the floor, through registers at the bottom of each line of telephone stands, 23 registers altogether, through four large bottom registers in the four corners of the room, each 44x20 in. in area, and through



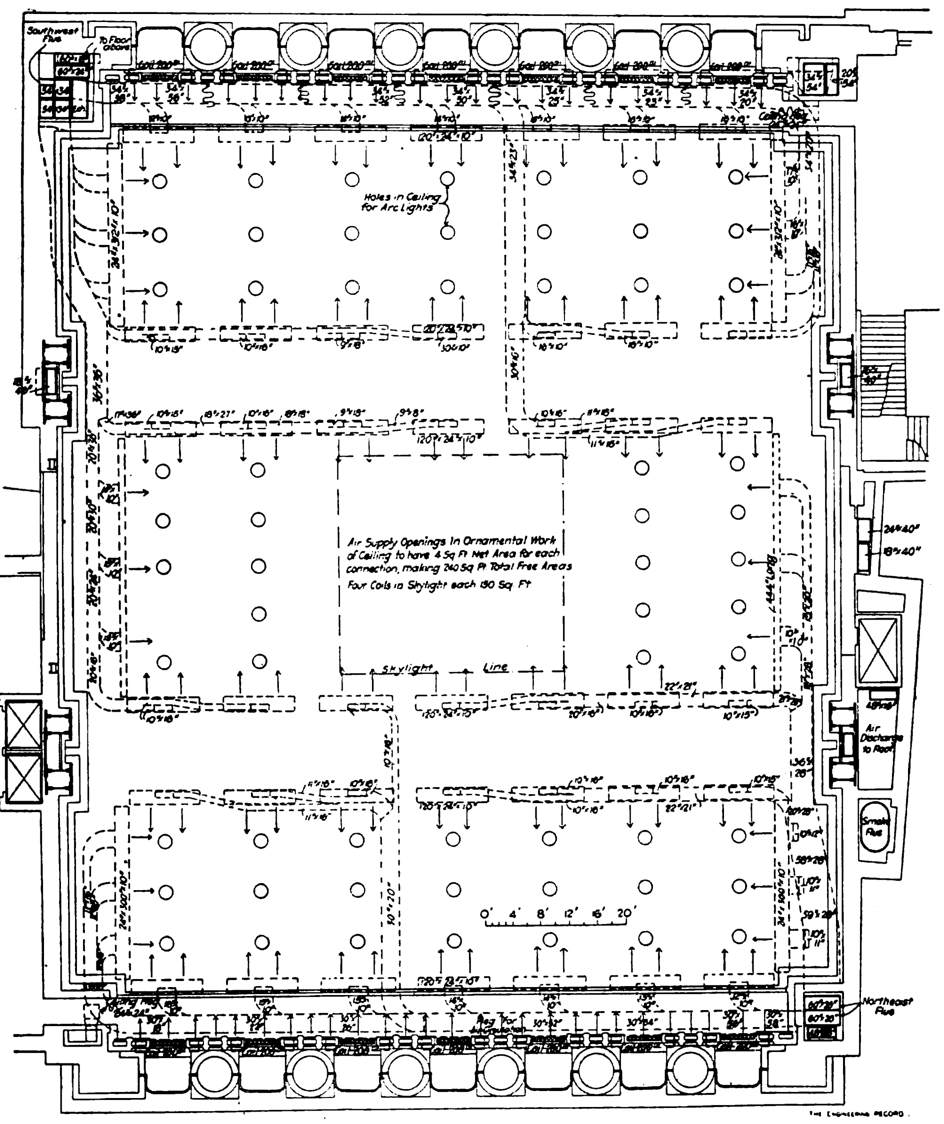
Main Floor Plan of the Board Room Showing Air Exhaust System.

four similar size registers in the inside walls and four 32x16-in. registers near the Broad St. wall, at the opposite end of the room from the telephones. These all connect into ducts over the basement ceiling, which lead, as shown, to a few large-size flues; and the latter are carried vertically upward to the attic space, where they are joined together and led to a central point to the chamber with the two Blackman fans.

The registers at the trading posts consist of a 200-sq. in. circular screen at the top, with a 16-in. flue connecting into the horizontal duct under the floor. The cross-section area of the vent registers distributed along the Broad St. front amounts to 26.7 sq. ft.; the cross-section area of the vent registers serving the opposite end, along New St., amounts to 51.3 sq. ft.; the combined cross-section of the screens conducting the air from the trading posts is 22.2 sq. ft.; the area of the registers in the south wall, 12.2 sq. ft., and the area of the registers in the north wall, 12.2 sq. ft.

The blower serving this room is calculated on the basis of 60,000 cu. ft. of air per minute, which is equivalent to three changes of air per hour, the volume of the room being about 1,200,000 cu. ft. As the calculations are also based on an occupancy of 1,000 persons, it will be noted that 3,600 cu. ft. of air can be admitted per capita per hour. There are 1,200 cu. ft. of space in the room per person, so that more than sufficient air is delivered for continuous occupancy on the basis of each person giving off 0.6 cu. ft. of carbonic acid gas per hour, and allowing 6 parts of carbonic acid gas in 10,000 parts of the air. A calculation shows that the supply is sufficient for continuous occupation if each of the 1,000 persons is charged with 0.72 cu. ft. of carbonic acid gas per hour, which is the amount given off by males during repose, according to some authorities.

The Upper Floors.—The system above the board room includes some interesting cases of ventilation, namely, the bond or board of governors' room, and the club dining room on the clubroom floor. The air is delivered from the cellar fan serving this system through a number of large flues and the distribution is effected by ducts hidden above suspended ceilings. The exhaust outlets lead to flues, which, together with those from the board room, terminate in the attic roof space, where they are joined to the fan room already referred to. The fan room is some 16 ft. wide and 31 ft. long. The fans are each set in a transverse partition in the room forming a common discharge chamber, which is open to the atmosphere through a 10x10-ft. discharge covered with a copper cap.



Gallery Plan of the Board Room Showing Air Supply System.

The club dining-room on the floor above the bond-room floor is 39½x68 ft. in plan with a 9x16-ft. alcove containing a large fireplace, and is 18 ft. 2 in. in inside height. Here fresh air is delivered through five openings, in the ornamental cornice work in the inside wall, while the exhaust is withdrawn through top and bottom openings in both the outside and the inside walls, the exhaust openings in the latter being located midway between the inlet openings. The five inlet openings are located above each of the five doors in the inside wall, and each has a net area of 300 in. The fresh-air duct to them is run from a flue in the adjacent corner of the building above a suspended ceiling.

The fresh-air supply is calculated on six changes per hour, and the corresponding volume of air, 5,250 cu. ft. per minute, shows that the velocity at entrance is about 8.4 ft. per second. This relatively high velocity is designed to obtain a discharge along the ceiling as far as possible toward the outside wall, so as to secure a satisfactory distribution and circulation within the room. Of the eight pairs of exhaust outlets, four in each long wall, the lower ones in each case have 36x8-in. registers and the upper ones have an equivalent area in the ornamentation of the cornice. Air is also withdrawn from the dining room through the louvers in the doors to two closets at one end of the room, each closet having a 12x12-in. register. With the five changes an hour provided by the exhaust system, the average velocity is less than 2¼ ft. per second, both bottom and top vent registers being open.

The supply of air to the kitchen in the attic consists in the delivery of air through ten spouts dropped through the kitchen ceiling along the hood over the kitchen range. The air is taken from above the roof or from the room by the disk fan noted in the table and the ducts are run in the roof space, with branch circular downtakes to the 10-in. discharges at the range hood. These branches are varied in size by half inches from two 8 in. in diameter nearest the fan to two 10 in. in diameter farthest from it. The downtakes are spaced on 4 ft. centers and their discharge openings are about 6 ft. above the floor. The duct from fan to last outlet is not more than 45 ft. long. Corresponding with each air inlet is an exhaust opening in the underside of the kitchen hood. These are connected by a duct to the main exhaust chamber. Their total area is about double that of the inlets.

A Refinement in Machine Tool Manufacturing.

An example of the refinements toward which the manufacture of modern machine tools is tending is to be noted in the methods of testing the frames of iron planers by the Pond Machine Tool Co., Plainfield, N. J. It is essential in making a planer frame for accurate work that the side-frames or housings, on which the cross-rail, with its cutting tool heads, has its vertical adjustment, shall, when erected, come in perfect alignment with each other, and also have their edges absolutely at right-angles with the table of the planer on which the work is carried. Every completed pair of planer side-frames is mounted in a test-block of great accuracy of construction, which supports them in the same relative position they will occupy when erected on a planer bed. The sides of this test-block have been very carefully scraped and fitted for supporting the frames in parallel position, and provisions are made for quickly clamping them rigidly into position for testing.

The testing is done with a micrometer gauge carried on a long and rigid arm, pivoted to swing in an absolutely vertical plane, and measuring the distances from this true vertical plane to all points of the front faces of the side frames. These faces must all be parallel to the vertical plane, and a variation of more than 0.002 in. from the true vertical in either side frame is considered at the Pond works to require refitting it on its base in order to bring its face vertical. With the faces of these side frames adjusted vertically within this limit of accuracy, practically perfect work is insured, as the cross-rail and side-cutting tools will then be fed upward or downward in a plane at right-angles to the planer table. Similar precautions are taken in the fitting and adjustment of the cross-rail and other tool-carrying parts.

THE UGANDA RY. was operated at a loss of £10,000 last year, exclusive of the loss of £50,000 interest charges. The steamers on the lake more than pay running expenses.

The Mosman Septic Tanks, Sydney, N. S. W.

Four septic tanks, a grit chamber, eight filter beds and two gear chambers have recently been completed for the Mosman district of the Sydney sewerage system. The works were constructed under the direction of Mr. L. A. B. Wade, from whose official report concerning them, the following notes have been taken:

The site is protected from the action of the waves, which at times is considerable, by means of a wall of solid sandstone ashlar masonry 3 ft. thick and 9 ft. high. The works are designed to serve a population of 3,500, the maximum flow of sewage and rain water provided for being 50 imp. gal. per person per diem. The main 16-in. sewer discharges first into the grit chamber, which is 7x4x5 ft. deep. From this chamber a 24-in. pipe leads the sewage into the tanks by means of a specially constructed 9-in. junction leading into a small chamber, which is provided with a stop-board made in two pieces, the sewage flowing under one piece and over the other, and which can also be made to direct the sewage into any tank, or into any number of tanks, at the same time. Leading away from the grit chamber is also an overflow 16 in. in diameter, which is intended to come into action should the flow of sewage at any time exceed the maximum for which the works are designed. As a precaution, the overflow is marked by a dripping slab, arranged to prevent the escape of any floating solids, all of which will pass into the tanks. The tanks are 68 ft. 6 in. x 28 ft. 6 in. x 6 ft. deep, and they have a gross capacity of 290,370 imp. gal. They are roofed with tiles, under which is a covering of half-ply ruberoid over 4x½-in. tongued and grooved kauri lining; the lining and the inside timbers of the roof are covered with two coats of kerosene tar. Access is gained by means of three doorways, and a small inspection opening is provided on each gable end. The doorways and the openings are sealed with sugar-pine doors fastened with dog-bolts, and they shut against a layer of felt ¼ inch thick.

After the organic matter in the sewage has been acted upon by the liquefying micro-organisms, by which it is broken down into substances capable of being dealt with by filtration, the tank effluent thus freed from solids passes under tarred hardwood baffle-boards and onwards through four openings which are provided with stop-boards, and into the effluent channel. This channel connects with all of the tanks, which can be worked separately by means of the stop-boards and the effluent conducted on to any filter bed. The tanks are also ventilated, and special means are provided for taking the accumulated gases out of the roof into the shaft leading to the ventilation tower.

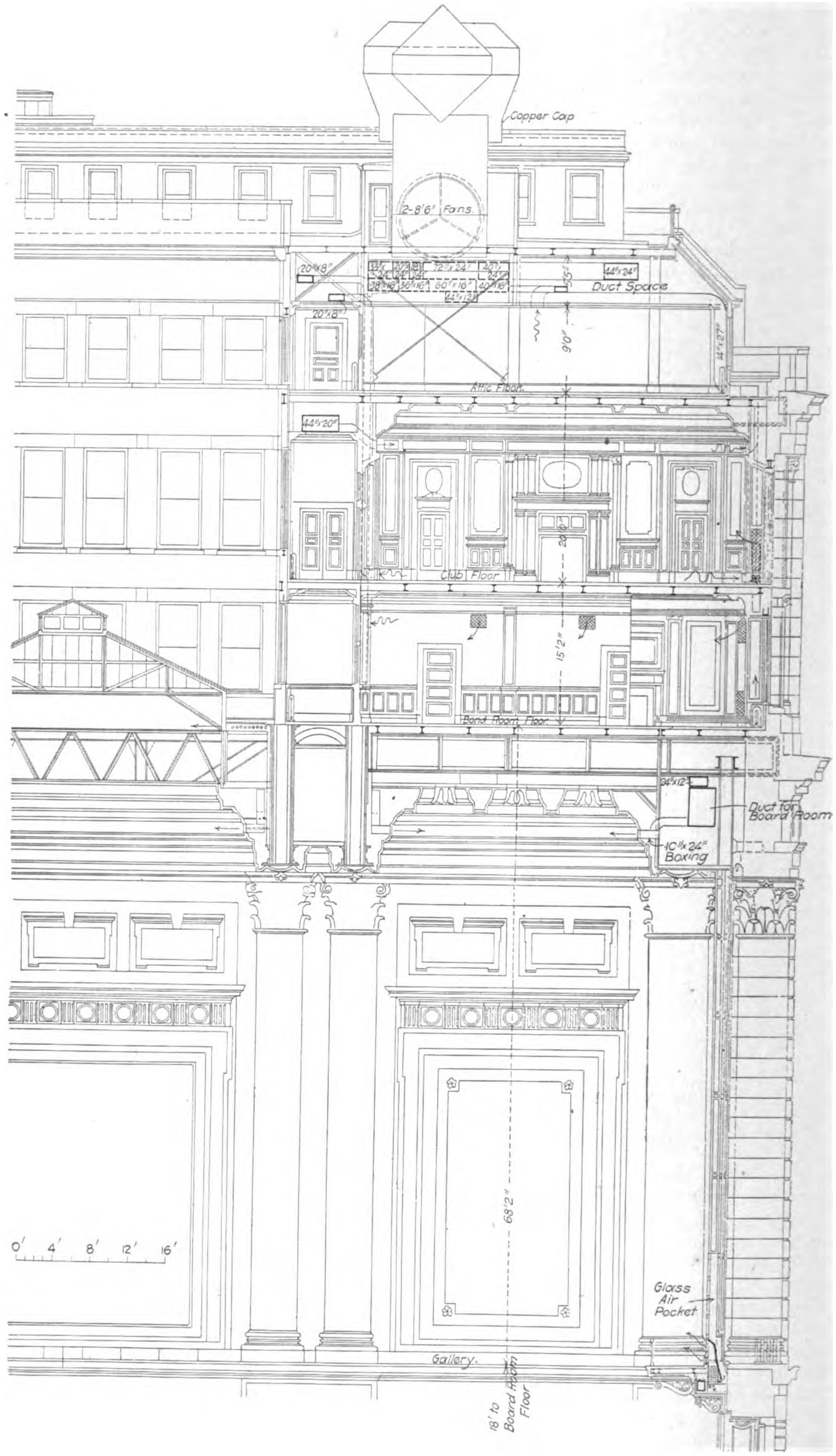
Any material detritus which may escape from the grit-chamber, together with any insoluble residue from the sewage solids, will accumulate slowly in the tanks. This residue will not require to be removed for a considerable period.

The tanks are connected with a rock-faced sandstone ventilating tower, 50 ft. high, erected on the southern side of this site, with its base 30 ft. above the tanks. Between the tanks and the tower is a cutting in the face of the cliff, built up with rubble masonry, forming a shaft in which is built a baffler, and communication to which is obtained by means of a small door for the purpose of testing the volume of air passing through.

The effluent channel from the tanks discharges direct into the automatic gear by means of 12-in. pipes. This automatic alternating hydraulic machinery, which was supplied by the Septic Tank Syndicate, is erected in gear-chambers, 15 ft. x 4 ft. 6 in., roofed with tiles, and ventilated by means of wooden louvres in each gable end, with doors on either side for access.

The alternating machinery fills and empties the filters automatically. There is one set of gear for each filter. The lever from which the admission valve and the discharge valve are suspended is attached to an actuating bucket at one end and a counter-weight at the other end. As soon as the filter is full, a small quantity of filtered effluent will overflow into the actuating buckets, thereby closing the admission valve, and remaining until the next tank is filled, when the discharge valve is opened. The discharge of the filter will bring about the emptying of the actuating bucket of the next filter by means of a syphon; the counter-weight will then come into play, by closing the discharge valve and opening the admission valve. In order that this cycle may go on continuously, the overflow pipes from all the filters are joined into a continuous connection of 2-in. galvanized iron piping around the bottom of the gear-chamber, and having a four-way cock placed at every junction with the overflow. The cutting-out or throwing-in of a given filter is effected by merely giving either cock a quarter turn. The whole of the alternating gear cost £596.

The contact filters are 68 ft. x 32 ft. x 5 ft. deep, having a superficial area of 17,408 sq. ft. The filtering material is 4 ft. deep, having 6 in. of



Half Vertical Section through Building above Board Room Floor, New York Stock Exchange.

¾-in. gauge bluestone screenings on the top of the filtering material. In the bottom of each filter are two lines of 6-in. perforated pipes laid longitudinally, and three lines of 4-in. perforated transverse pipe, which lead into one longitudinal flagged drain, 15 x 8½ in., and one cross-flagged drain, 9 x 6 in. These pipes and drains are covered first with sandstone metal broken to a 2½-in. gauge to a depth of 6 in. At the end of the drains cleaning chambers are built.

The filtering material consists of ⅝-in. coke breeze having voids of 51.4 per cent.; coke, with voids of 50 per cent.; and destructor clinker, with voids of 53 per cent.; the metal screenings have voids of 50 per cent. The sewage from the alternating gear is distributed over the surface of the filters by means of four longitudinal lines of 6-in. half drain-pipes, and gradually fills the filters by means of downward filtration.

Four filters in each set come into operation alternately. On the opening of the discharge valve in the gear-chamber the filtered effluent will escape, drawing down after it a supply of air into every crevice of the filter; the filter will then drain and aerate, while the remaining filters of the set are filling. The discharge from the filters runs direct from the alternating gear into the outlet pipes, and where the junction is effected a chamber is built for the purposes of cleaning and attention. In this chamber also is fixed a cast-iron inspection eye, with a blank flange bolted on with muntz-metal nuts. This eye is placed at the end of the cross-flagged drain in the bottom of the filters. The flange can, therefore, be removed and the drain cleaned during the progress of the filtration and without stopping the continuous action of the filters.

The works required 12,000 cu. yd. of concrete and 2,041 cu. yd. of filling material for the filters. They were built by day labor and the expense in connection with the tanks alone was over £13,000.

Simple Mechanical Filters.

Simple mechanical filters are employed in the plant of the Rochester & Lake Ontario Water Co. The water passes through 3 ft. of sand into perforated brass pipes connected with a center manifold having a branch bolted to the bottom of the filter shell. The sand is of a size designated in the trade as between 14 and 20, and is very uniform. The perforated pipes rest on a level bed of concrete. No agitating devices are used, the washing being done by simple reversal of current. There is no sedimentation basin, and the coagulant, sulphate of alumina, is fed into the 24-in. suction pipe of the pumping station several hundred feet from the suction well. This type of plant is believed by the builders, the American Pipe Mfg. Co., Philadelphia, to give results about as good for ordinary cases as can be obtained with any other.

Interior of the Board Room, New York Stock Exchange.

The New Works of the Ingersoll-Sergeant Drill Co.—II.

Power Station.—In this plant the power generation problem proved to be of considerable magnitude. Not only is electrical power to be used largely, but also compressed air is utilized to such an extent in manufacturing as to require the operation of two large air compressors. It was decided to provide a large power station centrally located with reference to the various buildings to which the power was to be transmitted through subways. The power plant is, as indicated in the layout plan of these works printed last week, located between the compressor erecting shop and the blacksmith shop, where the track connections are convenient for the handling of the coal supply and the subway system for pipes and cables could be most conveniently cared for.

The brick and steel building has the usual arrangement of parallel engine and boiler rooms, which is found not only convenient in operation but also favors extensions without alteration of the present plan. The engine and boiler rooms are 52 and 48 ft. wide, respectively, and both are 190 ft. long. The roof trusses are 30 ft. above the floor. In the boiler rooms the span of the trusses is considerably shortened by the arrangement of the coal hoppers and the monitor for the conveyor system. The elevated section has a clear height from floor to eaves of 49 ft. A light structure is also provided outside one end of the boiler room for the storage of ashes; this hopper arrangement is illustrated in a part exterior elevation of boiler room at one end.

Boiler Room.—The boiler room is laid out for five batteries of two boilers each, so as to provide an eventual capacity of 2,500 b.h.p.; at present, however, only three batteries are installed, each comprising two 250-h.p. Stirling water-tube boilers; the batteries at each end of the room are at present left vacant, although it is intended to install an additional battery in the near future. The chimney, which is a 200-ft. Custodis stack, rated at 2,500 h.p., is located approximately in the center of the building; the foundation is octagonal, 17 ft. in diameter, while the inside diameter of the flue is 8 ft. 6 in. The elevated coal storage consists of a system of hoppers of the Berquist suspension type, providing a total capacity of 1,300 tons. The hoppers have a total width at the top of 24 ft. and a depth of 14 ft., the full load capacity amounting to 7.56 tons per running foot. The coal hoppers are located over the boiler fronts, and are arranged to discharge directly through spouts into the hoppers of the stokers.

A convenient method of measuring the coal is used in this connection in that the delivery chutes have a measured capacity, and shut-off valves are provided at both ends; thus a single filling of each chute delivers a definite amount (about 450 lb.) of coal. In this way the coal consumption is accurately recorded by merely counting the chutefulls of coal delivered to the stokers. The coal is elevated from the receiving hopper and crusher in the basement up to the bunkers by a McCaslin self-dumping bucket conveyor, arranged to handle either coal or ashes. The ashes are received on the conveyor in the basement, and are dumped through a special chute at the top to the outside elevated hopper. The conveyor is operated by a motor in the basement, and geared to drive the buckets at 40 ft. per minute.

The boilers have Roney stokers arranged for the burning of anthracite slack, which is successfully accomplished by mixing with it a small proportion of bituminous slack in the proportion of about one to six. The further equipment of the boiler room consists of a Green economizer at

Heating, Ventilating and Air-Cooling at the New York Stock Exchange.—IV.

The Air-Cooling System.—The plant for cooling and extracting moisture from the fresh air supply during warm summer weather is unquestionably the largest installation of its class in existence. When it is stated that the board room with its 1,200,000 cu. ft. of space and 10,879 sq. ft. of outside glass walls out of a total of 18,416 sq. ft. of exposed wall surface has, during the warmest weather, been maintained at 10° to 14° Fahr. below outside temperature with a humidity indoors averaging 55 per cent., an idea of the magnitude of the system may be gained. Moreover, some 440,000 cu. ft. of space in rooms underground are also artificially cooled; while in the case of these rooms there is not the large amount of exposed wall through which a transmission of heat from the outside air can take place, it is to be remembered that underneath them is the cellar with its steam boilers and steam-actuated machinery. Before explaining at length the make-up of the refrigerating plant by which the cooling is effected, it will be of interest to trace through briefly the calculations on which it is proportioned.

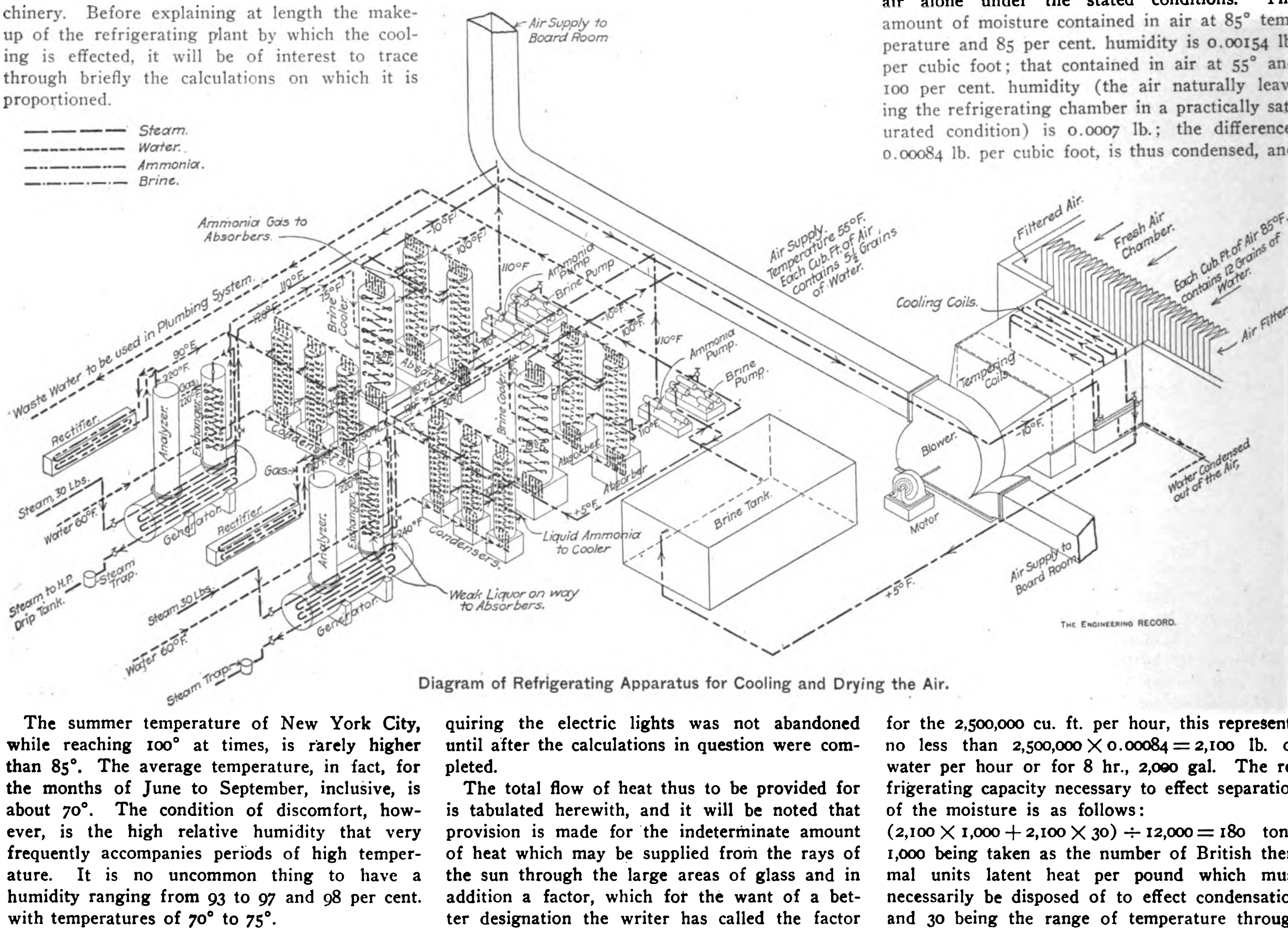


Diagram of Refrigerating Apparatus for Cooling and Drying the Air.

The summer temperature of New York City, while reaching 100° at times, is rarely higher than 85°. The average temperature, in fact, for the months of June to September, inclusive, is about 70°. The condition of discomfort, however, is the high relative humidity that very frequently accompanies periods of high temperature. It is no uncommon thing to have a humidity ranging from 93 to 97 and 98 per cent. with temperatures of 70° to 75°.

It was accordingly decided to calculate on a basis of 85° outside temperature. The records of the local United States Weather Bureau show that at this temperature the humidity is seldom greater than 85 per cent., and this factor was employed as the practicable upper limit to be considered. It was determined to maintain a temperature within the board room of 75°, and accordingly to provide for the delivery of the air into the room at 60° to 65°, and to proportion the cooling coils so as to cool the air to 55°, allowing for 5° increase in temperature during the passage of the air from the cooling coils to the room.

The problem then resolved itself into a calculation of the amount of air which introduced at 60°, and allowed to attain a temperature of 75°, would succeed in carrying off the heat supplied by transmission through the walls from the outside, as well as that given off by the occupants themselves and by such artificial illumination as is necessarily maintained at various points. Having ascertained the volume of air required, it is then necessary to calculate the refrigerating effect necessary to cool the air and also the moisture it contains.

The heat transmission through the outside walls is calculated on the basis of the 10° range assumed, that is, 85° to 75°, so that the coefficients of the transmission expressed in British thermal units per square foot per hour are about one-seventh of the corresponding coefficients employed in the calculations for the heating system, which, of course, is based on a 70° range (70° indoors and 0 outdoors). For the heat given off by the occupants, 400 B. t. u. are allowed per capita per hour and for the lights, 250 B. t. u. The latter are those comprehended in the signal system as first proposed, and while a different signal system was finally installed, the one requiring the electric lights was not abandoned until after the calculations in question were completed.

The total flow of heat thus to be provided for is tabulated herewith, and it will be noted that provision is made for the indeterminate amount of heat which may be supplied from the rays of the sun through the large areas of glass and in addition a factor, which for the want of a better designation the writer has called the factor of security, to provide for unforeseen contingencies.

HEAT UNITS TO BOARD ROOM HOURLY IN WARM WEATHER.

	B.T.U.
Window surface, 9,855 sq. ft. at 12.5 B.t.u.	122,200
Doors, 168 sq. ft. at 14.5 B.t.u.	2,440
Outside wall, 7,369 sq. ft. at 0.7 B.t.u.	5,270
Skylight, 1,024 sq. ft. at 11 B.t.u.	11,264
	142,174
Allowance for heat from the sun through windows 20 to 25%	32,826
Total transmission through walls	175,000
Animal heat from 1,000 persons at 400 B.t.u.	400,000
120 signal lamps at 250 B.t.u.	30,000
	605,000
Factor of security, 10 per cent.	61,000
Total heat from all sources	666,000

One cubic foot of air introduced into the room at 60°, or 15° below the room temperature, will take up in being warmed to the room temperature, $0.238 \times 0.075 \times 15 = 0.267$ B. t. u., 0.238 being the specific heat of air and 0.075 being the weight, in a fraction of a pound, of 1 cu. ft. of air. For the 666,000 B. t. u. to be disposed of in one hour, this means, $666,000 \div 0.267 = 2,500,000$ cu. ft. per hour. As one ton of refrigeration capacity per day of 24 hr. means $142.2 \times 2,000$ B. t. u., the one-hour equivalent is $142.2 \times 2,000 \div 24 = 12,000$ B. t. u. The required capacity of refrigerating apparatus to cool 2,500,000 cu. ft. of air per hour from 85° to 55°, or through 30° is thus

$$2,500,000 \times 0.019 \times 30 \div 12,000 = 119 \text{ tons},$$

the factor 0.019 being the commonly used value for the product of the specific heat and unit weight of air.

The refrigerating capacity needed for cooling the moisture contained in the air and for absorbing the latent heat given off on the condensation of that moisture is, however, 50 per cent. greater than that sufficient to effect the cooling of the air alone under the stated conditions. The amount of moisture contained in air at 85° temperature and 85 per cent. humidity is 0.00154 lb. per cubic foot; that contained in air at 55° and 100 per cent. humidity (the air naturally leaving the refrigerating chamber in a practically saturated condition) is 0.0007 lb.; the difference, 0.00084 lb. per cubic foot, is thus condensed, and for the 2,500,000 cu. ft. per hour, this represents no less than $2,500,000 \times 0.00084 = 2,100$ lb. of water per hour or for 8 hr., 2,000 gal. The refrigerating capacity necessary to effect separation of the moisture is as follows:

$(2,100 \times 1,000 + 2,100 \times 30) \div 12,000 = 180$ tons, 1,000 being taken as the number of British thermal units latent heat per pound which must necessarily be disposed of to effect condensation and 30 being the range of temperature through which the moisture is cooled, from 85° to 55°. The total amount of refrigerating capacity is thus:

For cooling the air	119 tons
For extracting the moisture	180 tons
Total	299 tons

The resulting humidity in the board room can be arrived at as follows: The 2,500,000 cu. ft. of air discharged into the room in an hour carries under the conditions assumed $2,500,000 \times 0.0007 = 1,750$ lb. of moisture, while the 1,000 occupants give off $1,000 \div 15 = 66$ lb. per hour, the per capita capacity of the individual to produce moisture being taken as 1/15 lb. per hour. This makes a total of 1,816 lb. of water per hour at a temperature of 75°. At this temperature air in the saturated condition can hold 0.00134 lb. of water per cubic foot, or for the total hourly quantity could carry through the room, 2,500,000 $\times$ 0.00134 = 3,350 lb. The actual quantity is thus apparently but 55 per cent. of the maximum amount. In brief, therefore, a 300-ton refrigerating plant is sufficient to cool air at 85° temperature and 85 per cent. humidity to 75° temperature and 55 per cent. humidity for the board room.

The cooling of the underground portion of the building is considered in a similar manner, except that the slight inflow of heat from the outside atmosphere through the confining walls and that from the mechanical plant were so indeterminate as to defy of specific estimate. There is a total of 443,300 cu. ft. of space in the three stories between the cellar and the main floor level so served. They are supplied with air by one of the fans of the mechanical ventilating plant, and this volume of space can be cooled by means of a group of cooling coils placed on the suction side of the fan in question.

The system is based on a total occupancy of 150 persons, who at the rate of 400 B. t. u. per capita generate 60,000 B. t. u. per hour. There are 800 lights distributed in the underground rooms thus cooled, and these at 250 B. t. u. give off 200,000 B. t. u. per hour, making a total supply of heat to be counteracted of 260,000 B. t. u., which increased by the factor 10 per cent., as provided for in the previous calculation, makes a grand total of 286,000 B. t. u. per hour. One cubic foot of air taking up 0.268 B. t. u. in being warmed through the assumed 15°, 286,000 $\div$ 0.268 = 1,070,000 cu. ft. are required per hour. In this amount of air drawn from out of doors there are accordingly 1,070,000 $\times$ 0.00084 = 900 lb. of water to be condensed. Consequently the total refrigerating capacity needed for the underground rooms is

For cooling the air 1,070,000 x 0.019 x 30 ÷ 12,000 =	51 tons
For condensing the moisture 900 x 1,000 ÷ 12,000 =	75 tons
Total	126 tons

The resulting humidity for these rooms is, of course, to be calculated in the manner applicable to the board room, the difference being the relatively less number of persons present to give off moisture. With the required air delivery it will be found that 749 lb. of water are brought into the rooms in an hour, while 10 lb. are added in that time by the occupants themselves, making a total of 759 lb. The total amount of water which the assumed volume of air is capable of holding at the point of saturation is 1,434 lb., so that the humidity is about 53 per cent. after the air in the rooms has been completely changed.

The refrigerating plant is, however, also required to cool water for drinking and for cooling cold storage boxes in connection with the kitchen and dining-rooms maintained in the upper part of the building. The former is based on a demand for 400 gal., or 3360 lb., of water per hour, cooled through 45°, thereby requiring 151,200 B. t. u. per hour, which at 12,000 B. t. u. per hour (the equivalent of the hourly rate of 1 ton of refrigerating effect over 24 hr.), makes a total of 12.6 tons for the drinking water. A 150-ton machine was accordingly specified for cooling the air supply to the underground portion of the stock exchange and also for cooling the drinking water and for cooling the cold-storage boxes, leaving the remaining 11.4 tons to be available for the last mentioned service. Altogether, therefore, three refrigerating machines, each of 150 tons' capacity, were decided on, for combined use with both the board room and the underground rooms. It may be added that the apparatus adopted on the basis of the foregoing calculations has proved fully capable of meeting the maximum demand made upon it.

The ammonia absorption class of machine was adopted, and the machines and incidental equipment were installed by the Carbondale Machine Co. In general characteristics the refrigerating plant is a usual one in its make-up, the noteworthy feature in this connection being, as explained, the successful application of a refrigerating plant of 450 tons' capacity almost altogether for cooling air for ventilation.

Each machine includes a horizontal generator, 52 in. in inside diameter and 18 ft. long, containing 1,300 sq. ft. in twelve coils of 2-in. extra-heavy steam pipe together with an analyzer and an exchanger superposed on it, the analyzer being 39 in. in inside diameter and 12 ft. high, and containing sixteen trays, and the exchanger being 36 in. in inside diameter and 10 ft. 6 in. high and containing 900 sq. ft. of extra-heavy pipe coil surface. The overhead rectifier for each machine consists of three coils of 3-in. extra-heavy pipe encased in an open top tank; the two condensers are each 44 in. in inside diameter and 10 ft. high, containing 1,350 sq. ft. of surface in extra-heavy pipe coils; the one brine cooler in each case is 52 in. in inside diameter and 10 ft. 10 in. high, containing 1,800 sq. ft. pipe coil surface; and the two absorbers are each 44 in. in inside diameter and 10 ft. 10 in. high, containing 1,350 sq. ft. of pipe coil surface.

The machinery is all located at one end of the mechanical plant in the cellar and is extended through both the cellar and sub-basement No. 2. There are three 16x7x16-in. direct-acting single steam-actuated ammonia pumps, one for each refrigerating machine, and two main duplex steam-actuated brine circulating pumps, of the Blake make, 14x12x12-in. in size, and one auxiliary brine pump, 10x7x12 in. in size. The pressure of water from the city mains is sufficient to force itself through the apparatus and thence into the sewer, which is considerably above the cellar-floor level. However, after passage in succession through the condensers and absorbers, it is delivered into a 1,200-gal. closed waste or storage tank at one end of the refrigerating machine room, built of ¼-in. steel plate, and from this tank it is ordinarily taken by a 16x12x10-in. steam pump and lifted, under the control of a Ford governor, to a tank in the attic for flushing purposes in lavatories and the like throughout the building. Any excess of water over what is taken by this house or waste-water pump, is sent to the sewer.

The capacity of each refrigerating machine, as defined in the specifications, is as follows: It must cool 250 gal. of chloride of calcium brine at a specific gravity of 1.25 from a temperature of 5° above zero to a temperature of 10° below zero Fahr. in every minute. The hourly consumption of steam in the generators is required not to exceed 40 lb. for each 1,500 gal. of brine cooled 1° Fahr., and the hourly water consumption for the same cooling effect, the temperature of the condensing water being assumed at 60°, is not to exceed 105 gal. The refrigerating generators are designed for either live or exhaust steam, and as a matter of fact it has been found that the exhaust from the electric lighting and pumping plant at 2 lb. pressure proved to be sufficient at all times to operate the ammonia generators without expense on the score of live steam.

The brine circulating mains include 8-in. suction lines from the brine storage tank to the pumps and same size connections to inlets on the brine coolers, a 6-in. main from the coolers to the corresponding bunker coils and a 6-in. return to the brine tank. The main discharge from the coolers to the bunker coils is provided with a 2½-in. tee, where the supply is taken for the refrigerator boxes, this connection being carried to the auxiliary pump, which is employed for delivering it to the top floor of the building where these boxes are located. A 2½-in. return is brought to the brine tank. The brine tank is built of ¼-in. steel, and is 38 ft. long, 6 ft. 8 in. wide and 9 ft. 4 in. high. When the air-cooling plant is not in operation, the refrigerating plant is operated a few hours a day to cool down the brine in the brine tank, and the auxiliary brine pump is connected to draw from this during the whole of the day.

There are two coil bunkers, or stacks of coils, for cooling the air supply, made up of 1¼-in. galvanized iron pipe. The bunker for the lower floors contain roughly 10,000 lin. ft. of pipe, which is equivalent to about 4,350 sq. ft. of surface, and the group for the board room, about 20,000 lin. ft., or 8,700 sq. ft. The 300 tons capacity needed for the board room, for example, are equivalent to the hourly transfer of 3,600,000 B. t. u., which, for the 8,700 sq. ft. of surface, means a transfer of 415 B. t. u. per square foot per hour. As the cooling coils are made to pass brine only long enough to get the rooms at the desired temperatures during the working day, the frost that collects on the outside of the coils during operation is melted after the brine circulation is stopped, and a 16-oz. copper drip pan is furnished under each stack with waste connection for this purpose.

The drinking water system is supplied ordinarily from the return brine from the cold-storage boxes, the brine being circulated in 1¼-in. coils in a galvanized iron cooling tank. The system is designed to cool and filter 400 gal. of water from 80° to 35° per hour. A Loomis-Manning filter of 15 gal. per minute capacity is provided, and a 6x4x6-in. pump serves to deliver the water to the different faucets through galvanized iron mains. There are two risers to the top of the building, one fitted with 10 and the other with 12 faucets, and three risers to the board room with two faucets to each riser. There are circulation pipes returning to the cellar.

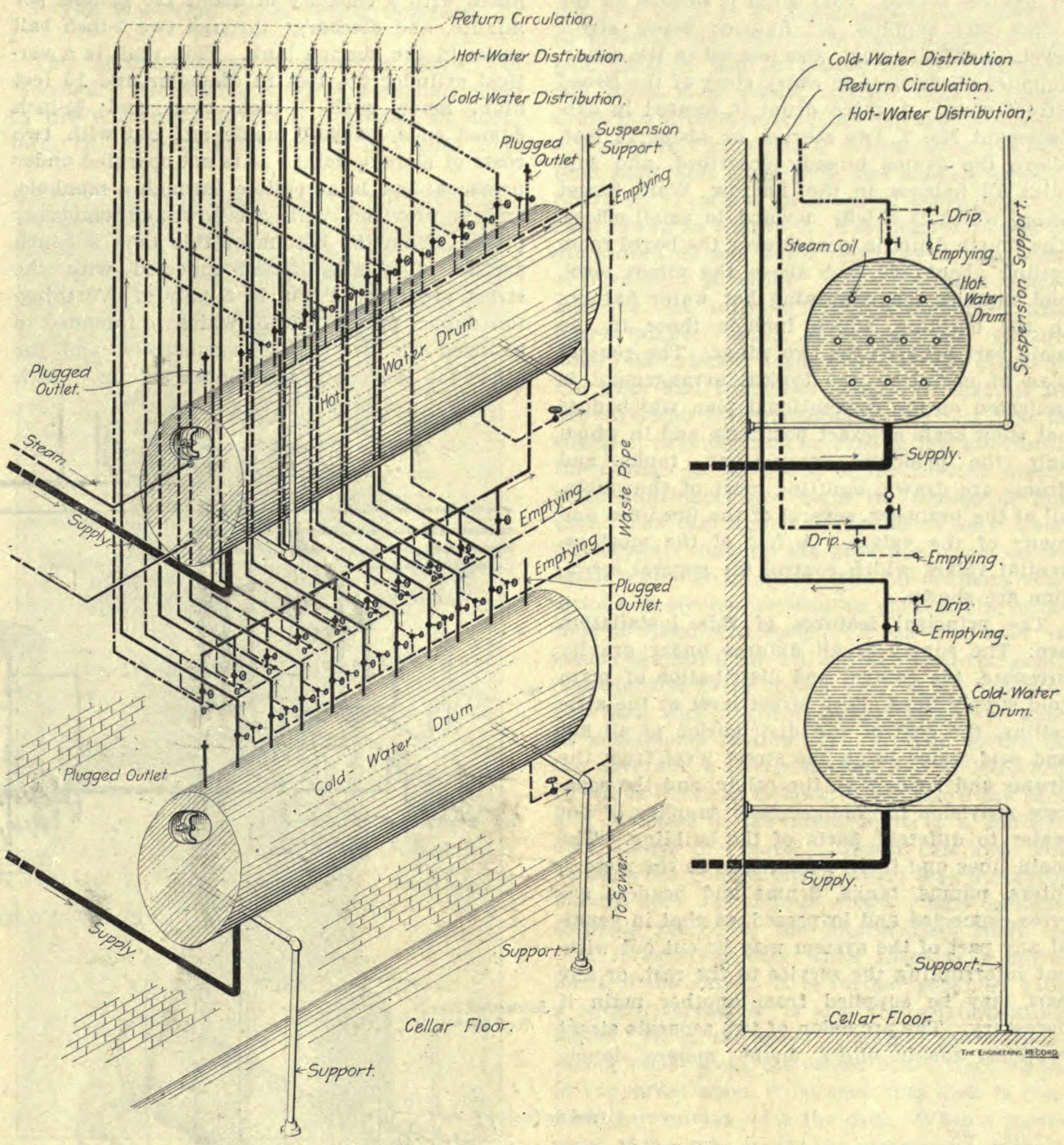
The accompanying isometric perspective diagram has been included among the illustrations to show at a glance the essentials of the air cooling system, and, on the ammonia, brine and water systems, the temperatures under normal conditions and at different stages of the process are noted. Two condensers were actually installed for each generator and not three, as shown in the diagram.

THE FAILURE OF A BRIDGE in Indianapolis while the construction car of a street railway was passing over it was discussed by the Indiana Supreme Court in City of Indianapolis v. Cauley, 73 N. E. Rep. 691. The bridge had previously been condemned by engineers representing the city and the railway company, and had been repaired under the inspection of employes of the board of public works. The failure occurred early in the afternoon of the day on which the bridge was again opened for traffic. The court's comments on the action of the board read as follows: "In the selection of inspectors, the diligence required of the board of works, to be accounted reasonable, must be measured by the known importance and difficulty of the work to be performed. . . . When it comes to the selection of a skilled man to inquire into and determine the true condition of a bridge of great magnitude, more than 400 ft. in length, and of questionable safety, over which heavily loaded cars, vehicles of every description, and thousands of people pass every day, the law is not satisfied with the finding of a professional civil engineer of good repute and creditable employment. Before it can be said that the board of works was justified in the appointments it made, it must appear that it not only believed the appointees were competent, but it must be able to show that it had good grounds for entertaining such belief."

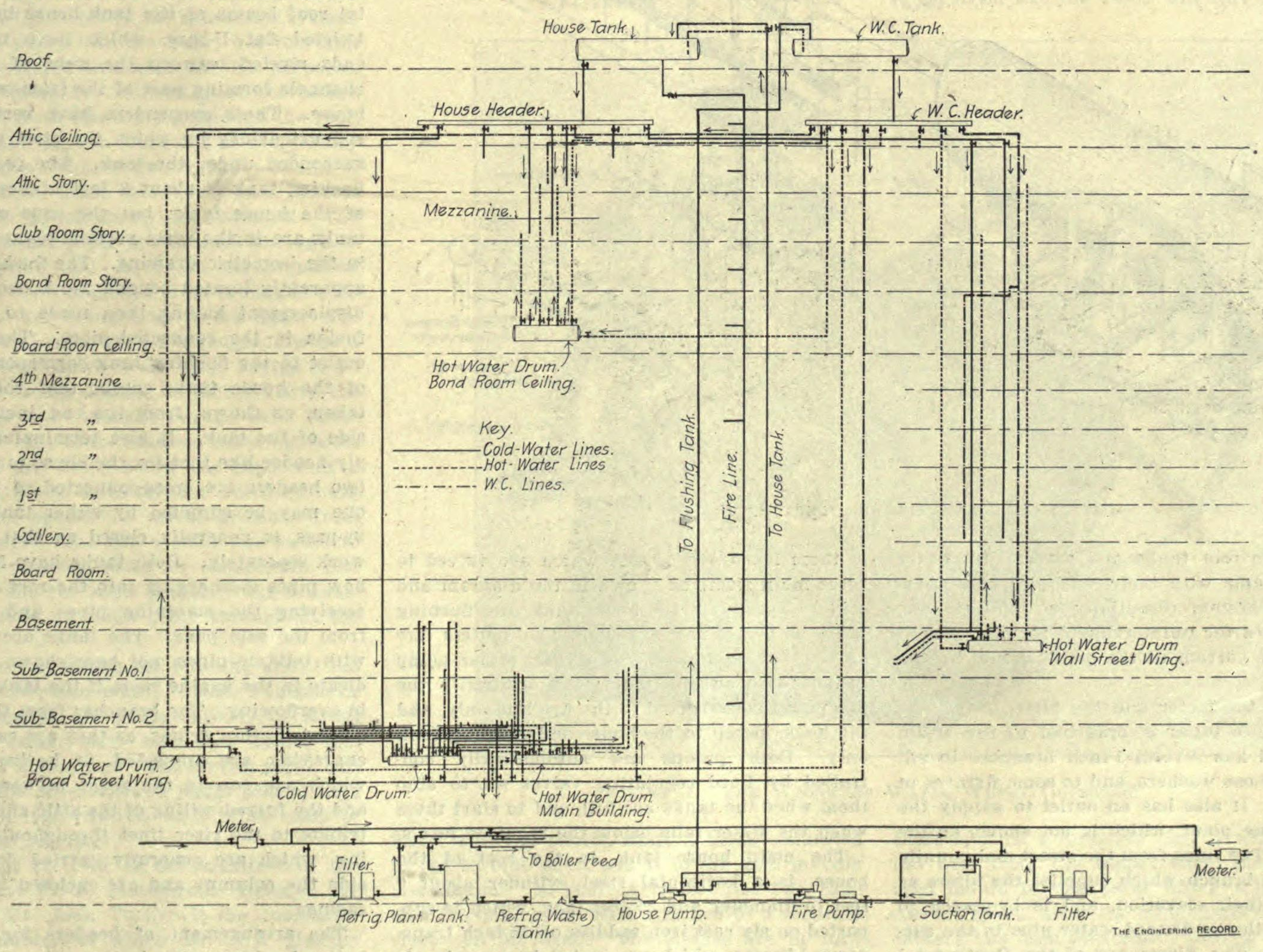
Water Supply and Distribution in the New York Stock Exchange.

The New York Stock Exchange building, on Wall Street, is a large, tall steel building, remarkable for the height and width of the board room which occupies most of the area of the building through several lower stories, and for the great depth of the cellar excavation, which gives four full stories below the curb. Machinery, storage rooms, safe deposit vaults and some offices are located below the street level, and there are offices above the board room, 100 feet above the street. There is also a long and narrow wing with offices almost isolated from the main building.

The water supply is drawn through two 2-inch service pipes from different street mains, and, after being metered and filtered, all except that which is used cold below street level, is pumped to two horizontal cylindrical steel tanks in an attic house about 200 feet above the street, or 250 feet above the pumps. One of these tanks, called the flushing tank, is marked "W. C. Tank" in the general diagram, and furnishes the supply for all flushing valves and for hot water service. This arrangement is made because the water pumped to this tank is first run through the refrigerating plant for cooling purposes and is warm when pumped to the W. C. tank. All the other water used above the street level is supplied from the second or house tank. Distribution lines from these tanks are run above the attic ceiling and from them vertical lines are dropped, with branches to the different groups of fixtures. The hot water system is divided in four parts serving different portions of the building independently; but all of them being operated under roof tank pressure. Each division has a horizontal cylindrical steel drum containing a steam coil and provided with from six to ten outlets, through which the hot water is distributed to the risers for the different groups



CELLAR DISTRIBUTION DRUM.



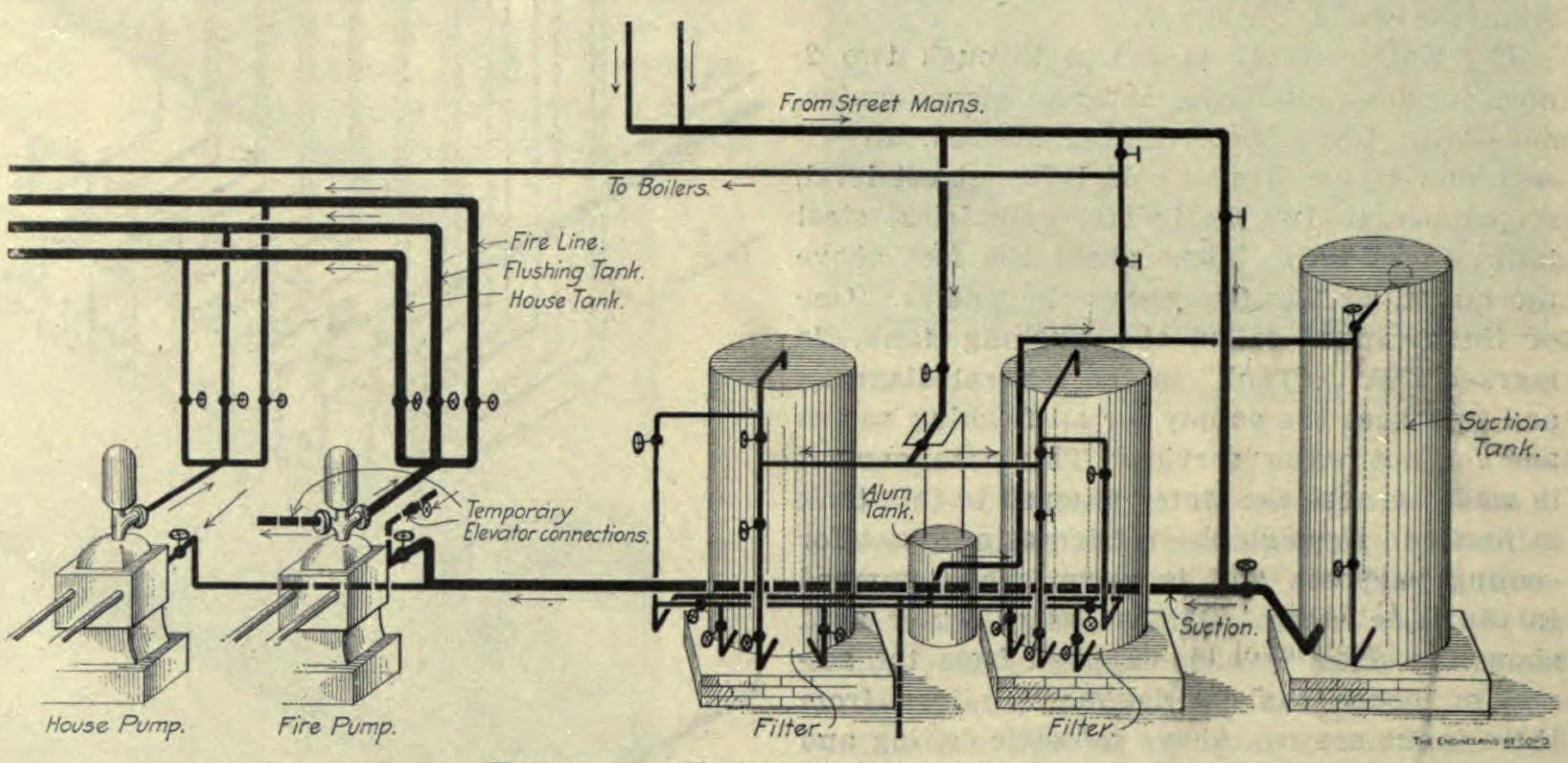
CONVENTIONAL DIAGRAM OF WATER SUPPLY.

of fixtures served. One drum is located in the cellar and supplies all fixtures below street level. Another drum, also located in the cellar, supplies all fixtures in every story of the Broad Street wing. A third drum is located in sub-basement No. 1, two stories, or about 25 feet, above the drums already described, and supplies all fixtures in the narrow Wall Street wing, which is chiefly devoted to small offices. The fourth drum is located over the board room ceiling about 100 feet above the street level, and supplies the remaining hot water fixtures in the building, which include those in the main part between the two wings. The general plan of operation and typical arrangement is indicated on the conventional plan which does not show scale or exact positions, and in which only the principal connections, tanks and drums are drawn, omitting most of the risers, all of the branches, several of the fire lines and many of the valves. A few of the most essential valves which control the general operation are shown.

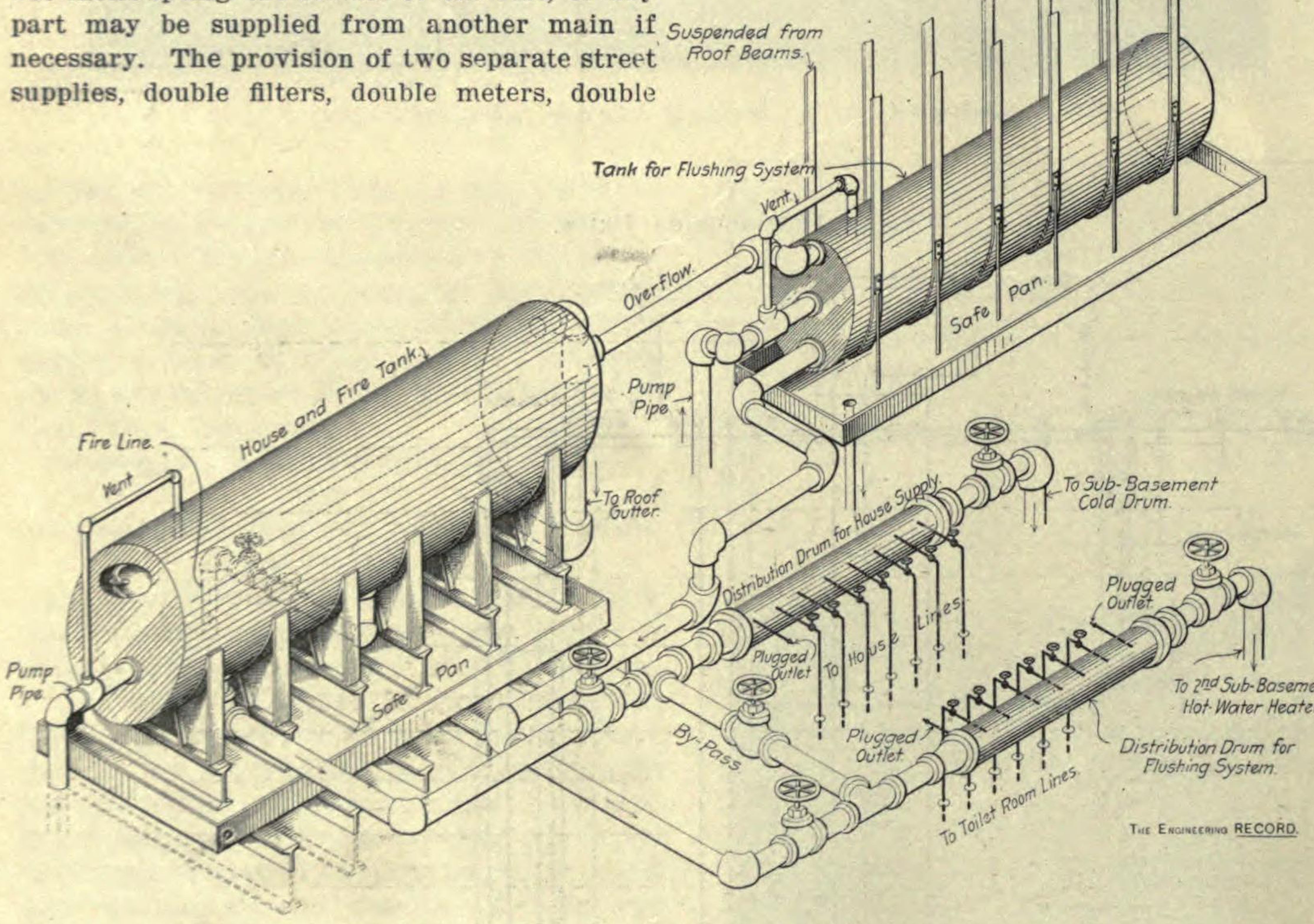
The principal features of this installation are: The supply to all fixtures under gravity pressure, the control and distribution of main cold supply lines above street level at the attic ceiling, the control and distribution of all hot and cold water below the street level from the drums and headers in the cellar, and the separate provision for independent supplies of hot water to different parts of the building. The main lines and their connections to the meters, filters, pumps, tanks, drums and headers are cross-connected and by-passed, so that in general any part of the system may be cut out without interrupting the service to the rest, or any part may be supplied from another main if necessary. The provision of two separate street supplies, double filters, double meters, double pumps, two roof tanks and several hot water heating drums with their multiple connections make the system essentially a duplicate one and provides for uninterrupted service, even if almost any portion of the plant should be disabled.

Between the meter and the filter, one of the street service pipes is branched to the steam boilers and has several 1-inch branches to sill cocks and hose washers, and to some fixtures in the cellar. It also has an outlet to supply the refrigerating plant, which is not shown on the diagram. The lines from the street mains unite in a 5-inch branch which supplies the filters as shown in their elevation, and is by-passed to connect with the filtered water pipe to the suction tank. The filters are of the Continental make with a capacity of about 150 gallons per minute, and discharge through two 2-inch ball cocks in the suction tank. This tank is a vertical cylinder 6½ feet in diameter and 10 feet high, made with ¼-inch steel and ⅜-inch domed ends, painted inside and out with two coats of Eureka paint. It is not operated under pressure; but is accessible through a manhole, and is provided with overflow and emptying pipes. From the bottom of this tank a 5-inch suction pipe also direct-connected with the street pressure, is run to a pair of Worthington duplex pumps, one of which is intended to be used for fire service exclusively, and the other for the continuous house service. Each of them has three outlets which are valved to three main risers as shown in the diagram and serve respectively the house tank, the flushing tank and the fire system. The outlets are valved outside these mains so that either pump can be used on any main; but ordinarily the fire pump is connected to the fire line only, and the house pump to the house and flushing tank only. Both pumps are automatically controlled by Ford regulating valves set to stop them when the tanks are full, and to start them when the water falls below the required levels.

The main house tank, in the roof of the house, is a horizontal steel cylinder about 6 feet in diameter and 25 feet long, which is supported on six cast iron saddles on 15-inch transverse I-beams, which are seated in a steel safe pan. The pan itself rests on the top flanges of corresponding transverse girders, which have their lower flanges and part of the webs enclosed in the concrete of the roof surface, as indicated in the general diagram. The 4-inch supply pipe enters the end of the tank near the bottom, but rises inside to the upper part where it discharges through two ball cocks accessible through a manhole. The tank outlet is from the lowest part, and consists of an 8-inch pipe valved to a 10-inch header 5 feet long, which is made of extra heavy steel pipe with cast steel reducing ends. Its thickness is such that the distribution lines from it are tapped through the sides of the header without reinforcement. The header is supported horizontally a few inches above the floor of the roof house, without saddles or standards, by the stiffness of its vertical pipe connections.



Pump and Filter Connections.



Roof Tanks and Distribution Drums.

The other gravity tank which is devoted to the service of the flushing valves and the hot water drums is about 3 feet in diameter and 25 feet long, and is suspended from the horizontal roof beams of the tank house by means of twisted flat U-bars, which have their upper ends riveted between the webs of the double channels forming part of the framework of the house. These suspenders have vertical screw rod extensions by which the steel safe pan is suspended under the tank. The center of the flushing tank is about 3 feet higher than that of the house tank; but the ends of both the tanks are in the same vertical planes as shown in the isometric drawing. The flushing tank is apparently located beyond the house tank, this displacement having been made to avoid confusion in the connected pipes. The inlet and outlet to the flushing tank correspond to those of the house tank, except that the latter is taken, as shown, from the end instead of the side of the tank. It also terminates in a supply header like that for the house tank, and the two headers are cross-connected so that either one may be supplied by either tank; but the by-pass is generally closed so that the tanks work separately. Both tanks have 5-inch overflow pipes discharging into the roof gutter and receiving the emptying pipes and the drips from the safe pans. The tanks are also fitted with tell-tale pipes, not here shown, which indicate in the engine room if the tanks are filled to overflowing. The branches from the headers, or distribution drums, as they are called in the engraving, are connected to horizontal pipes which are run in the space between the roof and the furred ceiling of the attic and there distribute to the riser lines throughout the building, which are generally carried down alongside the columns and are enclosed in fireproof casings.

The arrangement of headers for the main hot and cold supplies in the cellar is very neat and symmetrical, and they are simple in operation, although apparently complicated on account of the large number of pipes concentrated in a small space. The operation can be readily followed in the detail drawing which shows the cold water drum below the hot water drum with its outlets connected to pipes run on the wall between those of the hot water drum. Both drums are supplied from the roof tanks by means of pipes entering them at their lowest points and which are controlled by valves in the roof house and do not have valves at the drums. The outlets are all valved and provided with emptying and drip pipes so as to enable any riser line to be cut out and emptied independently of the rest. Each hot water riser has according to its length, from one to three horizontal expansion loops, 2 feet long and terminates at the upper end with a ¾-inch return circulation pipe that is brought back parallel with it, and is connected under the drum to a header as shown in the diagram through which the water is discharged to the drum. Each drum is provided with plugged outlets to allow for additional connections in the future. The other three drums correspond essentially to this one and are of the same size, namely, 30 inches in diameter and 72 inches long, made with 5/16 inch shells and ¾-inch welded heads and tested to 200 pounds pressure. Each contains a coil with ten lines of 3-inch seamless drawn brass tubing for the special supply which is regulated with thermostats. The drum over the board room ceiling is provided with a 16-ounce copper safe pan 4 inches deep which drips into the cellar sink through a brass flap cover. This safe pan also receives the drip from an open copper gutter laid under the water and drain pipes which cross the board room ceiling.

From the fire pump five 6-inch vertical stand pipes are run to the attic ceiling where one of them is connected with the check valve to the house tank so that when the fire engines are connected in the street to the stand pipe system, they cannot pump into the tank; but the tank supply is rendered available for fire purposes. Two anti-freezing fire hydrants and valves are connected to these stand pipes through the roof, and each stand pipe is connected at every story with a 2½-inch Kennedy gate valve to 75 feet of 2½-inch white linen hose in three 25-foot lengths with ⅝-inch nozzle and stop cock. The feet of the stand pipes are drained through 1-inch drip pipes and valves to the plumbers' waste tank. The branches from the stand pipe to the street are brought up to the under side of the sidewalk and extend through it with a 4-inch seamless drawn brass tube, having a 90-degree bend facing upward 12 inches above the sidewalk line and 6 inches from the wall. These outlets have cast brass Siamese couplings with checks, and are fitted below the bend with a check valve, set so as to be kept closed by tank pressure and opened by street pressure from the fire engine. The fire system was tested to 300 pounds pressure after all connections had been made, and the same pressure was successfully applied to all water pipes throughout the building.

All valves throughout the building are of the Ludlow or Chapman make. Those 2 inches or less in diameter are made entirely of steam metal, and larger sizes have iron bodies and steam metal mountings. The service pipes outside the walls have screwed joints packed with red lead and are covered with three coats of hot Trinidad asphalt.

Mr. George B. Post is the architect of the building, Mr. H. A. Hottenroth designed the work, and Mr. John Tucker is the contractor for the plumbing of which Mr. J. J. Herlihy was foreman in charge.

The Woodward Water Wheel Governor.

The accompanying illustrations show the Woodward friction water wheel governor, made by the Woodward Governor Company, of Rockford, Ill. The governor shown in Figure 1, is

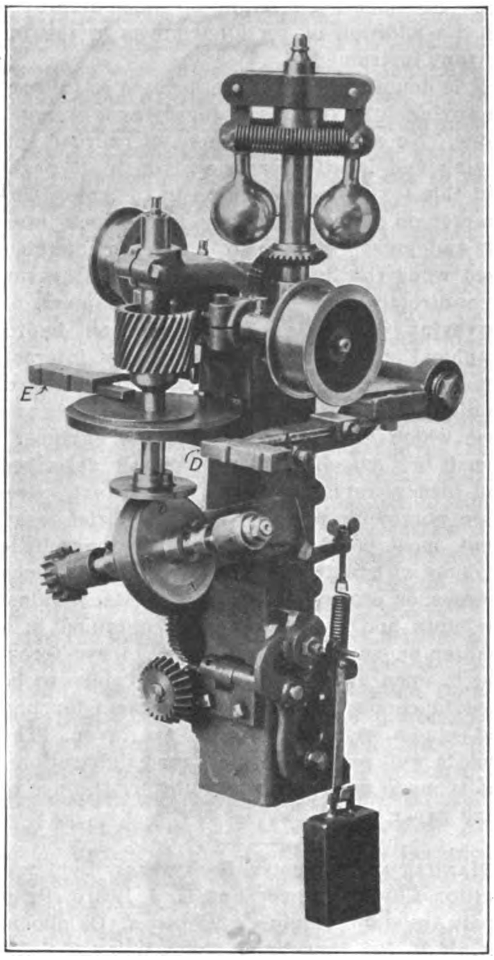


FIGURE 2.

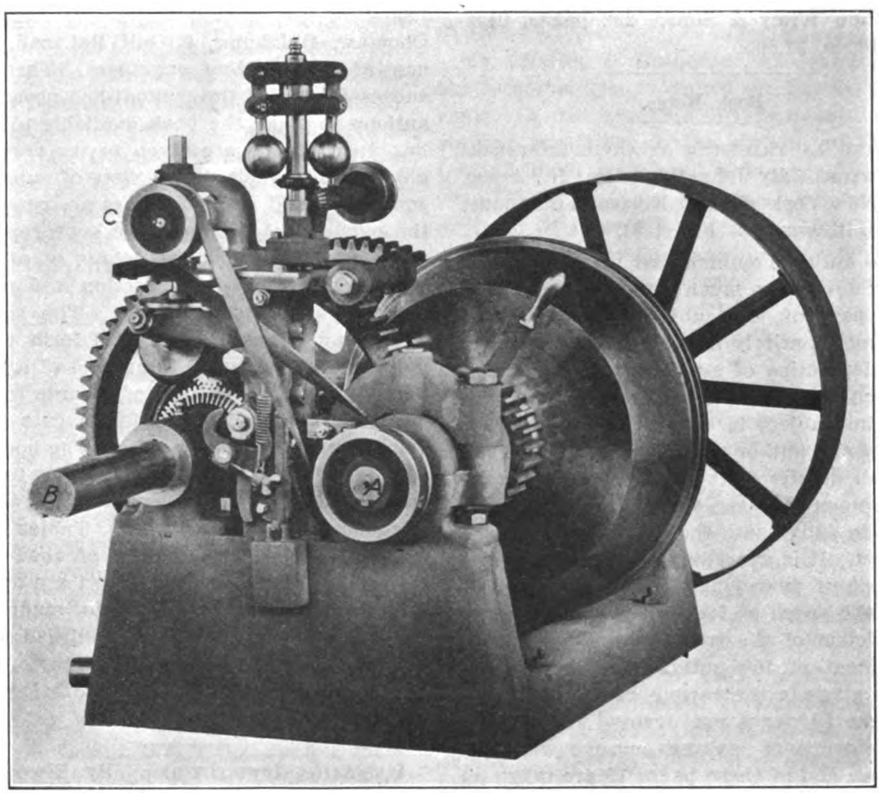


FIGURE 1. THE WOODWARD WATER WHEEL GOVERNOR.

fitted with two shafts, shaft A being connected to the turbine shaft and B to the gate moving mechanism. On shaft A is mounted two pans of a friction clutch each attached to a separate sleeve on the shaft. The sleeves are in turn connected to shaft B by two gears. Between the two pans is a compressed paper friction so adjusted that when it is pressed against one pan, shaft B will be turned in one direction, and when it is moved against the other pan shaft B will be turned in the opposite direction.

The fly-ball governor is driven from the turbine shaft and shaft C in the manner shown. Shaft C, by means of a spiral gear, drives a cam shown in Figure 2. The tappets D and E are moved up and down vertically by the stem of the fly-ball governor. When the speed is normal the cam revolves between the upper and lower tappet. When it engages one or the other, the friction engages one or the other of the pans and transmits motion to shaft B in the direction corresponding to the pan that is engaged, thus opening or closing the gate until the change in the speed of the turbine disengages the tappet and stops the motion of the gate. The cam action is capable of very close adjustment, enabling the governor to act on so small a change of speed, that for ordinary conditions of electric service no perceptible variation of speed will occur. When the load is steady the governor will not act upon the gate; consequently there is less wear on the mechanism than with a governor that keeps the gate in continuous motion. To prevent racing of the governor, a device is used that is described by the builders as follows: "Just below the cam and fastened to the same shaft is a concave disk, shown in Figure 2. Below this disk will be seen the compensating wheel which travels loosely upon an oblique shaft. This oblique shaft is geared to the intermediate shaft so that it revolves only when there is a movement of the gates. It is further provided with a square thread as is also the compensating wheel. When the speed is normal the compensating wheel seeks the center of the disk which is supported upon it because this disk is constantly revolving with the cam. When a movement of the gate occurs the compensating shaft is revolved, and the wheel will travel along its shaft in such a direction that it will separate the cam from the tappet when the gate has been moved to that point which will give the correct speed, after the momentum of the machinery has been overcome. During this interval the disk will return the compensating wheel

ENGINEERING REVIEW
A CONSOLIDATION OF
Heating AND Ventilation AND THE Sanitary Plumber.

NEW YORK: 1123 BROADWAY. DECEMBER, 1902. CHICAGO: 120 RANDOLPH STREET.

Plumbing in the New Stock Exchange, New York

"*The lambs play always, they know no better.*"

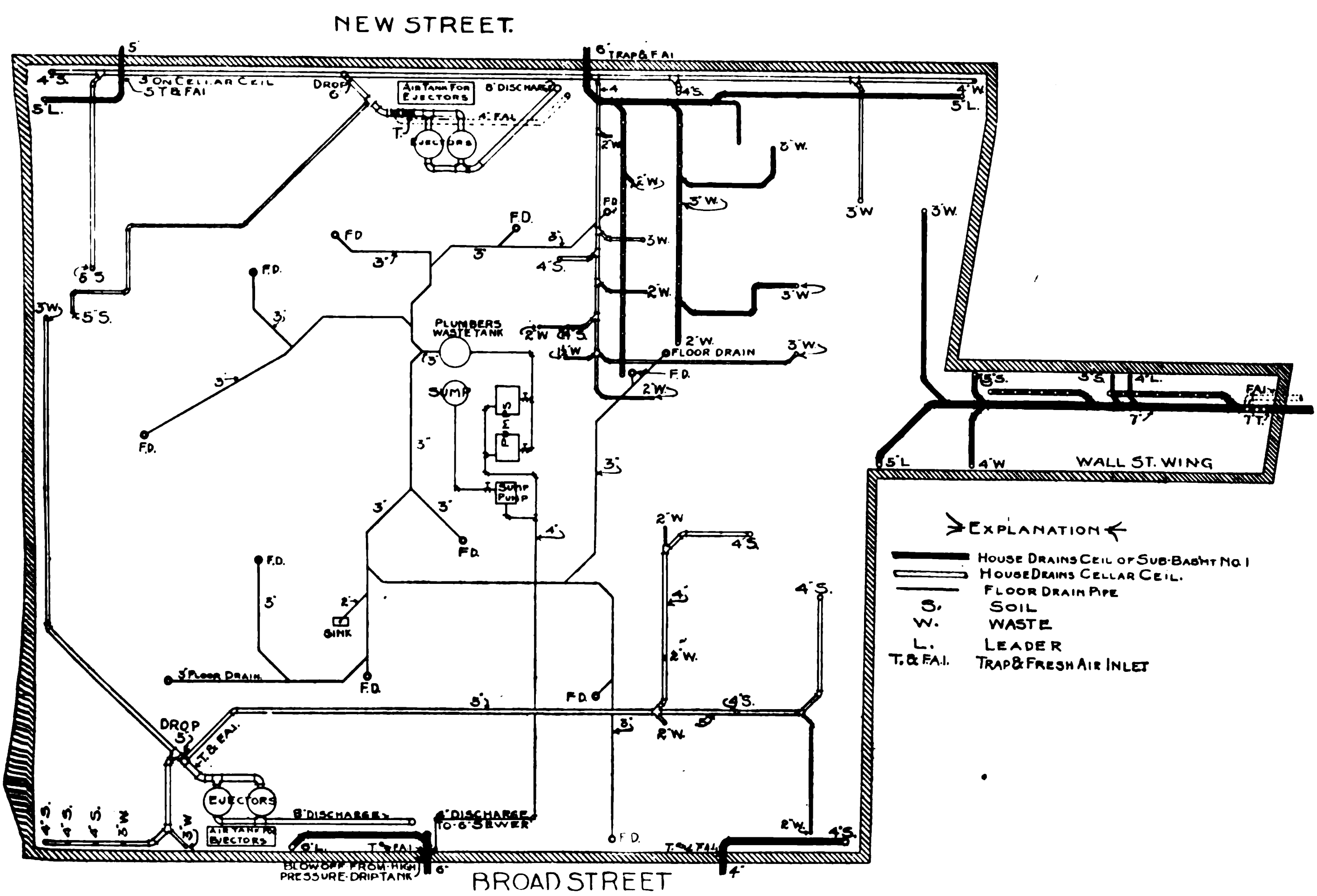
The advance of modern buildings is slowly but surely effacing old landmarks in New York. In no portion of the city is this transformation so marked as in the Wall street district, where comparatively few of the old buildings in which the financial history of the district was made, are still standing.

By far the most imposing and beautiful building in the financial district is the new Stock Exchange, which will stand pre-eminent among the bourses of the world. It occupies the old site which for more than thirty years has been the home of the New York Stock Exchange.

President Rudolph Keppler announced in December, 1899, that the Board of Governors had made arrangements for the erection of a new exchange, On May 1, 1901, the work of demolition of the old exchange began, the members removing to temporary quarters in the Produce Exchange. The building is now nearing completion and by the first of the year will be ready for occupancy.

The building is of marble. Above the main entrance, on Broad street, is a magnificent range of six Corinthian columns. Entrances are also provided on both New and Wall streets. A portion of the floor below the board room is devoted to two enormous steel vaults; on the same floor are located the telegraph, telephone and cable offices and quarters for the messengers.

Not differing materially from the old one, except that it will be very much larger, the board room in its interior finishing is magnificent, the scheme of decoration being largely achieved by a variety of marbles. A gallery extends along the Broad street side of the room. The present system of general public admission has been done away with, and no one will be admitted unless provided with a card of admission from some member of the exchange. The offices of the exchange are on the floor above the board room, the other floors being utilized for a variety of purposes. The building has a frontage of 147 feet on Broad street, a depth of 150 feet, an L of 14 feet on Wall street and a frontage of 152 feet on New street. The value of the land is estimated to be nearly $3,000,000, while the cost of the building will be $3,000,000 additional.



Plumbing in the New Stock Exchange, New York. Fig. 1

SEWERAGE

The drainage of the building is divided into three separate systems (Fig. 1).

The gravity system comprises five main drains, which are used principally for the reception of rain water, the exceptions being the Wall street drain, which receives two 6-inch and one 5-inch soil pipe and a 4 and 3-inch waste; the New street drain, which receives the soil and waste lines from the members' toilet in the basement and a 3-inch waste from eight sinks in the attic; and the Broad street drain, which receives the discharge from the plumbers' waste tank and sump and the blow off from the high pressure drip tank. It will be noticed that the last mentioned lines are branched into the Broad street drain outside the trap.

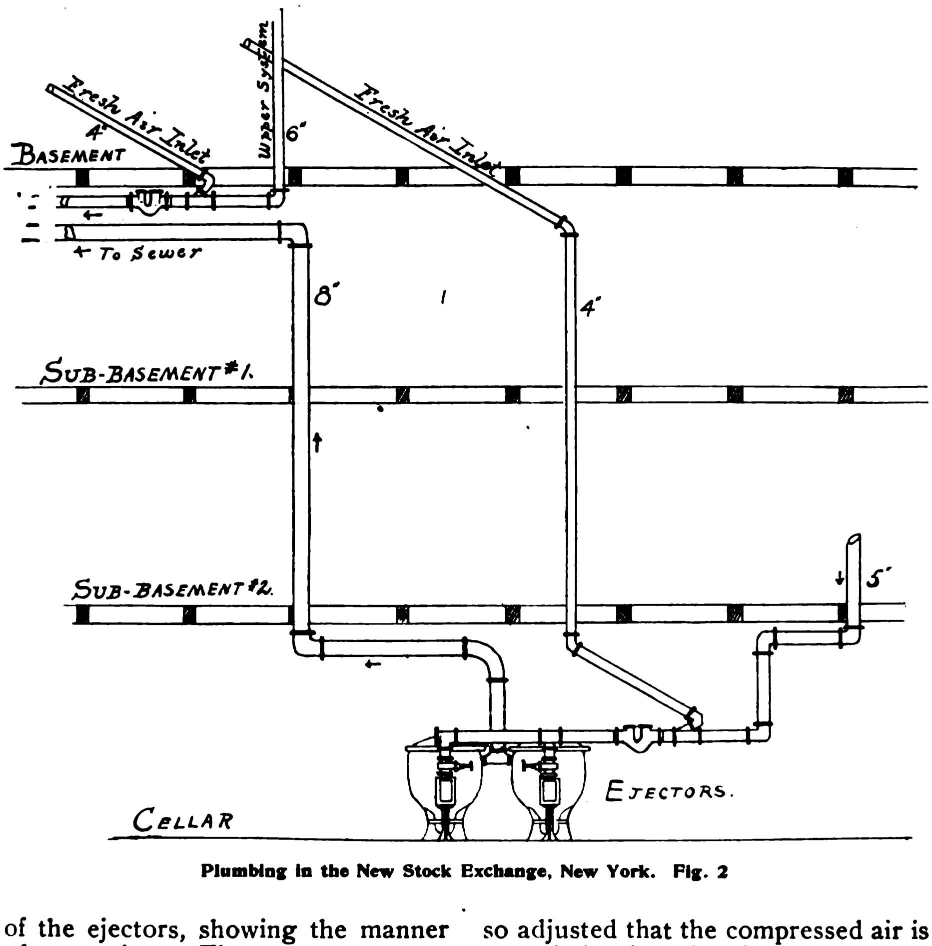
The drains are suspended from the ceiling of sub-basement No. 1.

For the disposal of all other fixtures in the building, a separate system is utilized, having sewers independent of the main gravity system.

The soil and waste lines are connected into three 5-inch main drains on the ceiling of the cellar, and run to the Shone ejectors located on the Broad and New street fronts. The ejectors have a capacity of fifty gallons each and are arranged in duplicate sets, being pneumatic in operation; the motive power is compressed air.

Fig. 2 shows the ejectors on the Broad street side of the building, those on New street being connected in a similar manner. Attention is called to the fact that there is no trap on the 8-inch drain running to the sewer. It seems that the trap on the inlet pipe is also useless, as the ejectors are always half full of water and are the best kind of trap themselves. The plumbing law requires a trap on the line, however, so it was put on.

Fig. 3 is a sectional view of one

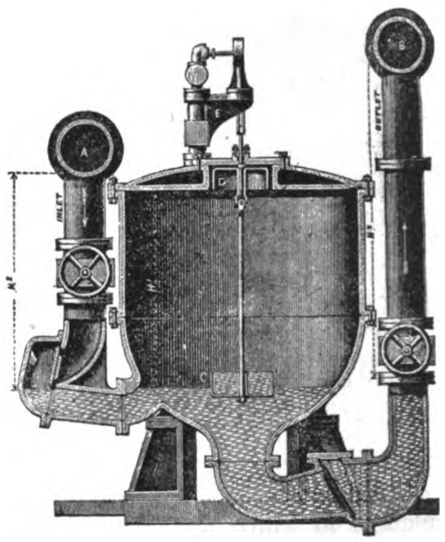


Plumbing in the New Stock Exchange, New York. Fig. 2

of the ejectors, showing the manner of operation. The sewage enters from the main drains through the inlet pipe A into the ejector and gradually rises until it reaches the under side of the bell D. The air at atmospheric pressure inside this bell is then inclosed and the sewage continuing to rise, the buoyancy of the bell is sufficient to lift it, which opens the compressed air valve E. The compressed air thus automatically admitted into the ejector presses on the surface of the sewage, driving the whole of the contents before it through the opening at the bottom, and through the outlet pipe B, into the iron sewage discharge pipe. The sewage can only escape from the ejector in this manner, as the instant the air pressure is admitted upon the surface of the sewage the valve in the inlet pipe A falls on its seat and prevents the fluid escaping in that direction.

The sewage passes out of the ejector until its level falls to such a point that the weight of the sewage retained in the cup C, which is no longer supported, is sufficient to pull down the bell and connecting parts, thereby reversing the compressed air valve, which first cuts off the supply of compressed air to the ejector, and then allows the air within the ejector to exhaust down to atmospheric pressure. The valve in the outlet pipe then falls on its seat retaining the liquid in the sewage discharge pipe, and the sewage again flows through the inlet commencing to fill the ejector once more, and so the action goes on as long as there is sewage to flow.

The position of the cup and bell is so adjusted that the compressed air is not admitted to the ejector until it is full of sewage, and the air is not allowed to exhaust until the ejector is emptied down to the discharge level; thus the ejector discharges a specific quantity each time it operates.



Plumbing in New Stock Exchange. Fig. 3

To work the ejector two Westinghouse compressors automatically coupled up are attached. The compressor delivers air into a tank or receiver and from this the compressed air is conveyed to the ejector by means of a wrought iron pipe of about 2 inches diameter. When steam is turned on to the compressor the whole apparatus is automatic. When the pressure requisite to discharge the sewage is attained the compressor stops, automatically starting up again when the pressure of air is reduced in the receiver by reason of the discharge of the ejector.

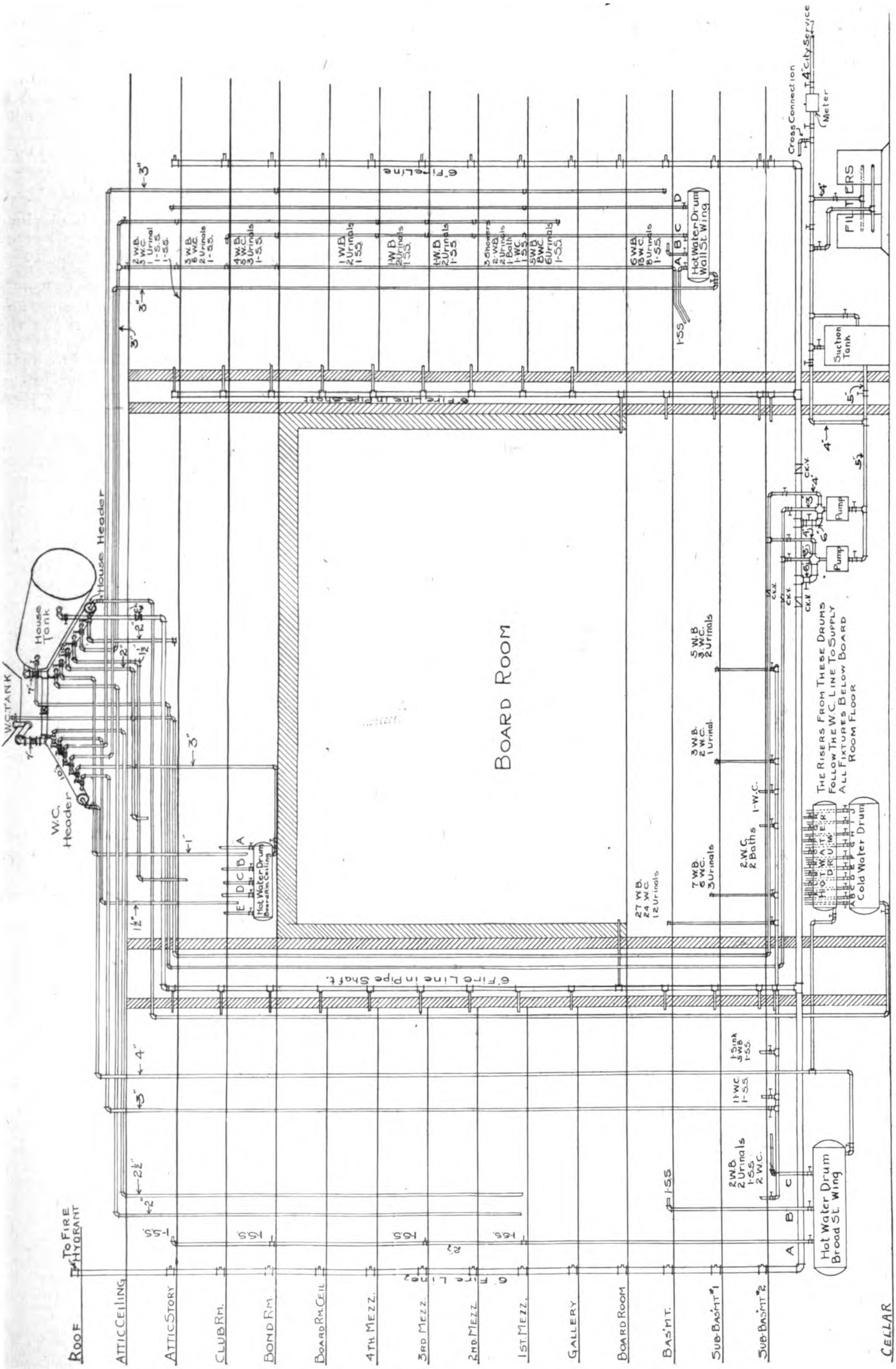
A plumber's waste tank set in the cellar floor receives the discharge from all the floor drains, drips from the tanks and cellar sinks.

The tank is 30 inches in diameter and 48 inches high and is connected with two waste pumps, by which it discharges into the 6-inch Broad street sewer, outside the trap, as before mentioned. All the floor drains are Tucker's, manufactured by the J. L. Mott Iron Works, except those in the storage battery room, New York Telephone Co.s room and Western Union sidewalk vault. These are made entirely of cast lead (Tucker pattern) and connected with the plumber's waste tank by 2-inch earthenware pipe. (This line is not shown on the plan Fig. 1.)

COLD WATER SUPPLY

The water supply to the building is furnished through two 2-inch connections with the Broad and New street mains, which are increased to 4 inches after entering the building. The line from the Broad street main, after passing through the filters, discharges into the suction tank, having a by-pass from the main service pipe to the steam pumps; the piping is arranged so that the filters may be cut out also, if desired (Fig. 4).

The New street line, after passing through its filters, which are ar-



Plumbing in the New Stock Exchange, New York. Fig. 4

ranged in the same manner as on Broad street, is cross connected into the Broad street line. It is from this line that the refrigerating plant is supplied; it also has taps for supplying the boiler feed, elevator discharge tank, ice water plant and three temporating coils. This line and connections are not shown on the plan (Fig. 4).

The pumps have 5-inch suction and 4-inch discharge pipes and are valved and cross connected at the cellar ceiling on the branches of the discharges to the roof tanks.

As will be seen from the plan (Fig. 4) the main portion of the building consists principally of the board room. This room is of immense proportions, being 120 feet by 105 feet and 85 feet high. Indeed, it is the key-note of the whole structure, for everything has been subordinated to it. As no piping of any kind was allowed to pass through this room, the pipes were run in brick shafts in the side walls. The manner in which this was done is clearly shown in Fig. 4.

A feature of the building is the control of the water supply to the various fixtures from the roof house. Here are located the house and water-closet tanks with their respective headers.

The house tank is 6 feet by 24 feet, and is supplied through a 4-inch pipe. The water-closet tank is 3 feet by 24 feet, with a 3-inch supply. These tanks have 5-inch and 4-inch overflow pipes respectively (not shown), connected together and discharging on the roof over a rain-water leader. A 2-inch sediment pipe is also provided for each tank, and a 2-inch safe waste for each safe, connected into the overflow pipe.

The water supply to the tanks is controlled by ball cocks connected with a Ford regulating valve placed on the pumps in the cellar. Both of these tanks, as well as the suction tank in the cellar, which is 6½ by 10 feet, are made of ¼-inch plate iron and were manufactured by Albert Smith & Son, New York.

The house and suction tanks are placed on cast-iron cradles on a brick foundation 2 feet above the floor, while the water-closet tank is suspended by hangers from the roof of the roof-house.

The water-closet tank is used to supply the water-closets and the various hot water drums, while the other fixtures and the cold water drum in the cellar of the main building are supplied from the house-tank.

It will be observed that the slop-sinks are furnished with gravity valves supplied from the water-closet tank, thus dispensing with independent overhead tanks.

In the half-tone (Fig. 5) the house tank is shown on the right; only the safe of the water-closet tank can be seen in the center, while the tank to the left is the elevator tank, with which we are not concerned.

The house supply headers are each 10 inches in diameter and 60 inches long, set 12 inches above the floor, and connected with the tanks by 7-inch pipes. The headers are cross-connected as shown.

While the main supply of the building is regulated in the roof-house, a secondary system has been utilized to supply fixtures, other than water-closets, located in the basement and lower floors, by the installation of a cold water drum in the cellar of the main building. As before mentioned, this drum receives its supply from the house-tank on the roof.

A further description of this drum will be given in connection with the hot water supply.

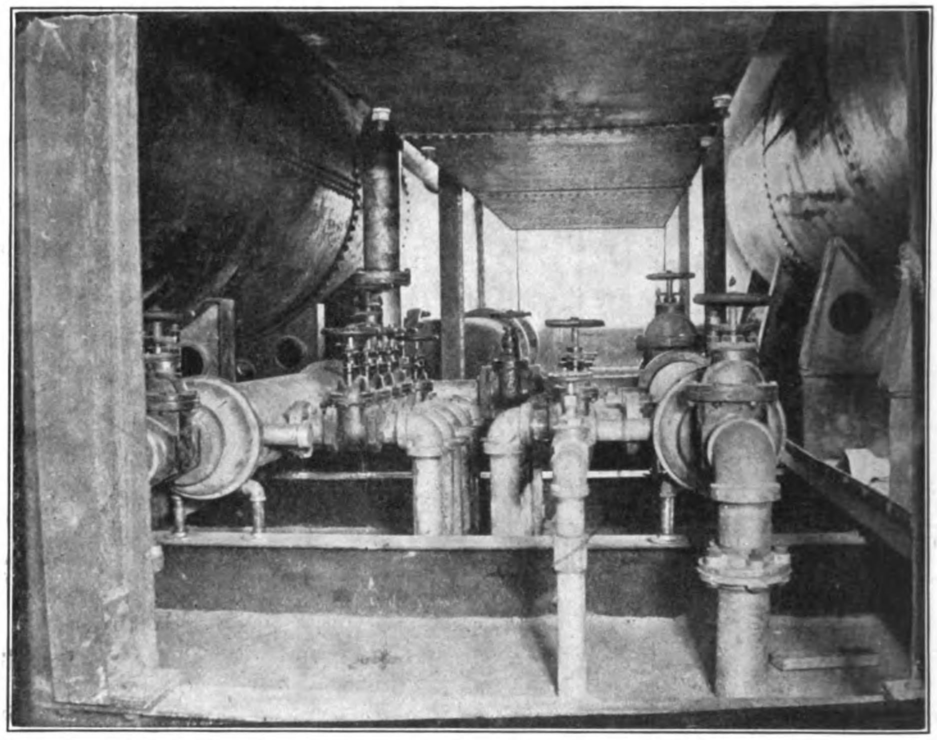
The arrangement of the fire lines is shown in Fig. 4. The extra check is run to the plumber's waste tank in the cellar.

A new design of hose rack has been placed in the building. These racks are in the shape of a half circle, allowing the hose to hang down on each side in loops. They are made to hold 75 feet of 1½-inch Simmons hose. In addition there is 50 feet of ¾-inch hose supplied for each street connection.

HOT WATER SUPPLY

The hot water supply is obtained from four hot water drums located in various parts of the building, viz., in the cellar of the main building, in the cellar of the Broad street wing, in the ceiling of the board room, and in the sub-basement No. 1 of the Wall street wing.

The drum in the cellar of the main building is 72 inches long by 30 inches in diameter and is located above the cold water drum before referred to, which is of the same dimensions. The arrangement of these drums, with their various rising lines, is shown in Fig. 4.



Plumbing in the New Stock Exchange, New York. Fig. 5

on the line running to the house tank is so arranged that normally the pressure from the tank keeps it open, but the pressure from a street fire engine against the tank pressure, closes it.

Three 4-inch connections are taken out of the main fire line on the cellar ceiling and extended, one to Broad, one to Wall and another to New street (not shown), for fire engine service. Each branch to the street connection, before turning up to the sidewalk, is provided with a check valve acting in the opposite way from the valve near the house tank; that is to say, the pressure of the fire line keeps it closed until the pressure from the fire engine throws it open.

The outlets have heavy cast brass siamese, with checks at each outlet.

At the foot of each stand-pipe and street connection a 1-inch drip pipe

KEY TO FIG. 4

COLD WATER DRUM

A. Sub-basement, No. 2.
B. 1 inch, coupon room, sub-basement, No. 1.
C. 1½ inch, Western Union, sub-basement, No. 1.
D. 1½ inch, 3 sets wash basins, sub-basement, No. 2.
E. 1 inch, engineers' toilet, sub-basement, No. 2.
F. 1½ inch, employees' toilet, sub-basement, No. 2.
G. 2½ inch, members' toilet, basement.
H. 1½ inch, 3 sets wash basins, sub-basement, No. 2.
I. 1 inch, Anglo America Telegraph Co., sub-basement, No. 1.
J. 1 inch, sink in cellar, near Broad street.

HOT WATER DRUM

K. 1½ inch, 3 sets wash basins, sub-basement, No. 2.
L. 1 inch, engineers' toilet, sub-basement, No. 2.
M. 1½ inch, employees' toilet, sub-basement, No. 2.
N. 2 inch, members' toilet, basement.
O. 1 inch, hot water relief to roof.
P. 1½ inch, 3 sets wash basins, sub-basement, No. 2.
Q. 1 inch, Anglo America Telegraph Co., sub-basement, No. 1.
R. 1 inch, sink in cellar, near Broad street.

The drums are set at a sufficient distance from the wall to allow the rising lines from the cold water drum to pass easily behind the hot water drum. (Fig. 6.) All the lines, both hot and cold, have a rise from their drums of about three feet, from whence they pass across the boiler room ceiling to their various fixtures.

The waste headers which receive the drips from the various lines, as well as the circulation header, are all connected into a 1½-inch waste line discharging over a sink in the cellar.

A valve is placed on the circulation header just before it is branched into the waste line. This valve is for the purpose of emptying the line when desired.

This system is used exclusively to supply the fixtures (except water-closets) in the basement and lower floors in the main portion of the building.

The drum in the cellar of the Broad street wing is 54 by 30 inches and supplies three rising lines. Line A, slop sink line; Line B, slop sinks in basement and sub-basement No. 2; Line C, wash-basins in Western Union Telegraph Company's office and coupon-room.

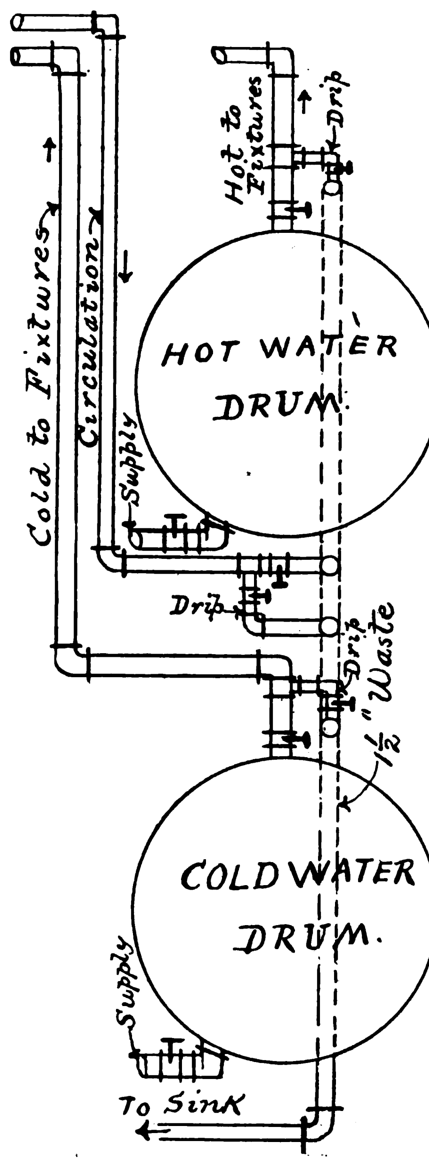
The drum in the board room ceiling is 72 inches by 30 inches and is placed near the wall adjoining the shaft. It supplies the following lines: A, 3 sinks in kitchen in attic; B, pot sink and dish-washing sinks in bar-room, etc.; C, janitors' and ladies' toilets; D, wash-basins and sinks, club room floor; E, two sinks on mezzanine and 2 toilets in attic.

For the purpose of protecting the board room ceiling a 16 oz. copper safe pan, 4 inches deep with stiffened edges, is set under the drum.

From the pan are run half circle copper gutters, hung under, and depending from the water drainage lines. The hot water lines are kept together and follow the lines of drainage, the gutters being made large enough to take in the combined pipes. These gutters are laid out with the high points near the rising lines and the low point opposite the drum. They discharge into the drum pan. The pan is drained by a 1-inch drip pipe, discharging over a sink in the cellar.

The drum located in sub-basement No. 1, Wall street wing, is 66 inches by 30 inches. It supplies, A, slop sink, sub-basement No. 1; B, wash-basins in basement; C, line of wash-basins and slop sinks; D, slop sink line.

A departure from common practice in connecting the supplies from the hot water lines to the fixtures is necessitated by the great length of the lines and their consequent unusual expansion. These connections are not made direct, but are made with special double elbow fittings, to allow for expansion in the rising line; by connecting them in this way when the line expands, there is no danger of the branch breaking.



Plumbing in New Stock Exchange. Fig. 6

All the drums, as well as the two headers in the roof-house, are provided with two additional plugged outlets.

The drums are made of C. H. shell and flange iron 5-16 inches and ⅜ inches thick, tested to 200 lbs. per square inch hydraulic pressure, and are supported on ⅜-inch by 2-inch wrought iron hangers from the ceiling beams; and, in the case of the hot water drums, are provided with brass coils of 3-inch seamless drawn brass tubing, with 1½-inch steam connection. A pet cock water gauge and a Hohmann & Maurer thermometer is also attached to each hot water drum.

The expansion pipes from the hot water drums are carried to one point near the top of the chimney on the roof.

The circulation pipes (¾ inch) of the system are not shown. They are connected in the usual manner just below the supply to their fixtures and returned to their respective headers. The hot water supply and circulation lines are provided with loops, 2 inches long, three on the lines which run the full height of the building, two on the half lines and one on the short lines, placed at equal distances, to allow for expansion. The lines are securely fastened at the middle stories only, leaving the ends free so that the expansion of the pipe will be up and down from these fastenings.

FIXTURES

The fixtures in the building comprise 92 "Prompto" syphon jet water closets, supplied through 1½-inch flush pipes, with Mott's "Simplex" flush valve; 63 "Newport" urinals, supplied from cisterns; 19 "Richmond" porcelain slop sinks, with flushing rim; 112 lavatories, oval porcelain bowls, with patent overflows, supplied through ½-inch spring basin cocks "Syphono."

There are also in addition four bath tubs, three showers, a set of wash tubs and three sinks.

All the fixtures were supplied by the J. L. Mott Iron Works, New York.

White marble is used throughout in the toilet rooms.

All the piping for the drainage system and water supply is wrought iron, except for the continuation of the main house drains and ejector discharges from the house traps to the sewers, which is cast iron.

The architectural plans for the construction of the building were awarded to George B. Post, 33 East Seventeenth street, New York. Mr. Post's plans were selected in a competition in which designs were submitted by more than a score of the most distinguished architects in the country. John Tucker, 248 Fourth avenue, was the plumbing contractor.

Heating a Twenty-Story Building by the One-Pipe System

The heating of a building by steam, using the same pipe for both flow and return, was common practice in several western cities for a number of years before it became generally adopted by heating engineers and contractors throughout the country. The simplicity of it and the saving of cost in the installation have made it so popular that its general features are known to everybody. When, however, it was proposed to install it in a twenty-story building there were many who regarded it as a doubtful venture.

Such a plant may be seen in the Jewelers' Exchange, a twenty-story business and office building at the cor-