THE AMERICAN ARCHITECT

VOL. CII. WEDNESDAY NOVEMBER 20, 1912 No. 1926

HEATING AND VENTILATING PRACTICE

PART I

By D. D. KIMBALL

Member American Society of Heating and Ventilating Engineers; American Public Health Association; Chairman, Section on Ventilation, American Museum of Safety; and Chief Referee on the subject of Ventilation, XV International Congress on Hygiene and Demography.

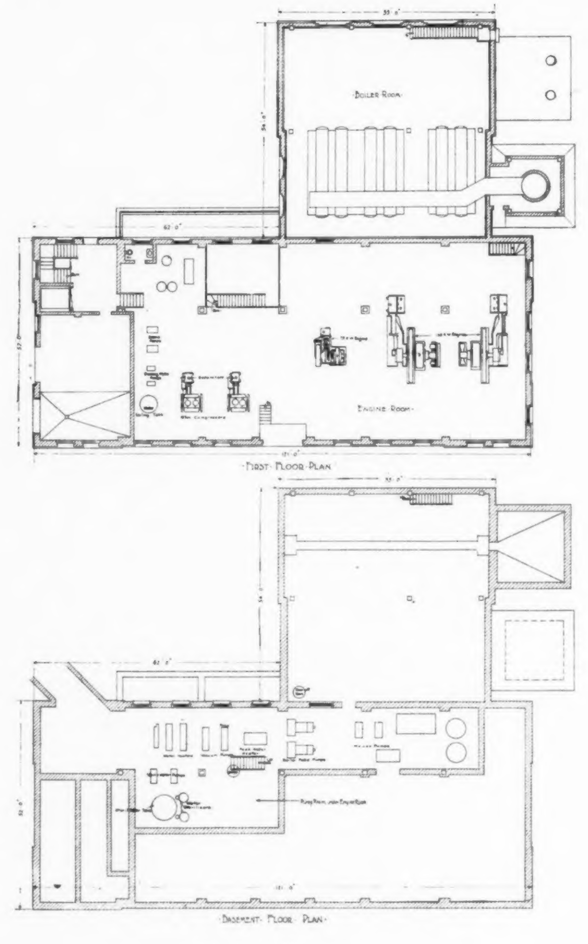
THIS series of articles is not intended to include rules or formulæ for the design of heating and ventilating plants, for an abundance of reliable data in the forms of rules and tables may be found in such desirable books as Carpenter's "Book on the Heating and Ventilation of Buildings," Snow's "Principles of Heating and Principles of Ventilation," Baldwin's, Meier's and other similar books, but it is rather intended to indicate general principles governing the arrangement and equipment of plants in order that they may be as complete and inexpensive in installation as possible and efficient in operation.

Too often the only object in the design of a heating and ventilating plant seems to be the assembling of the different portions of the necessary equipment in the space allowed, or in the smallest space possible with little or no reference to the inter-relation of the different portions of the plant, viewing the different pieces of apparatus as building blocks of various sizes and designs, which are to be so placed as to look pretty on the plan or when located in position.

The purpose of each part or unit of the plant and the utility of the whole should be given first consideration.

Assuming that the same problem be given to two different engineers for solution, two entirely different designs will invariably be the result. Occasionally the two different plans worked out by the two designers will be of equal merit, but usually one will prove to be a complicated arrangement of the apparatus and piping, with many cross-over pipes and by-passes and no continuity of the passage of the air, water or steam, and no concentration of control of apparatus, valves, and dampers, the other design being so arranged that plenty of room is allowed about each piece of apparatus for its operation, examination and repairs, while its piping will be so simple that its purpose is manifest, and yet it will be complete in every respect and ample provision will have been made against break-down. The air, water and steam in the latter case will pass consecutively through the different pieces of apparatus in natural sequence, the operation of the plant is thus simplified and a minimum of skill and service will be required.

The design of every heating and ventilating plant is in the nature of an invention and like an invention usually first emerges in simple form. A duplication of apparatus and connections is next included to insure against break-downs, cross-over and by-pass connections are included as an added security or to make possible the double use of certain parts of the plant so as to prevent the necessity of useless duplication of apparatus, all of which may bring about complications of designs and consequent confusion in the plant. The thorough engineer then proceeds by careful study to rearrange and simplify all of the apparatus, piping, fitting or valves (especially in the case of the piping system) until every essen-



ORIGINAL·DESIGN·
·SCALE 1/16"=1 FOOT·
·Area=3260 Sq Feet per Floor·

tial of the plant operation is provided with a minimum of apparatus and piping, if not always with a minimum of space.

Not always does the most desirable arrangement of a plant mean the least space. It is recognized that every foot of space in a building, particularly in a building erected within the city limits, is equivalent to a certain amount of money, but the space once provided involves little or no expense for upkeep, beyond interest charges, while a cramped or ill-arranged plant may involve extra labor, or labor of greater skill and cost, more fuel or additional maintenance charges.

No piping or equipment not essential to the maximum efficiency and uninterrupted operation of the plant should be permitted because anything beyond this needlessly involves increased interest and depreciation, fuel and labor charges, nor should anything be omitted which is necessary to insure the uninterrupted operation of the plant.

The equipment or piping of a large building, or group of buildings, includes the heating system, electric system, elevator plant, plumbing system and vacuum cleaning system, while institutional work involves also refrigeration, sterilizing, drying and warming devices, as well as cooking and laundry apparatus. All of this must be welded into a complete "Domestic Equipment" with the least possible apparatus and piping and with the least waste of space. Each part must bear its proper relation to every other part and be as simple and directly connected thereto as possible. Manifestly, therefore, the best results may be expected when the entire equipment is designed as a whole by one person who fully understands the needs and purposes of each piece of apparatus and all of its relations to the whole scheme.

The greatest expense connected with the operation of any building is its domestic equipment. This item of expense includes labor, fuel, water, oils, packings, waste and repairs; thus too much care cannot be expended upon the design of the plant and the selection of materials therefor. Study and care, based upon, or backed by, an extended experience on the part of the designer, will result in economy in the cost of operation and maintenance throughout the period of the life of the plant and the use of the building.

It is perhaps not strange that the least cost of operation usually accompanies the least cost of installation of a complete plant in which all materials are of the best grade, for both are the result of experience, study and care of the designing expert. This statement excludes a great many cheaply designed and more cheaply installed plants which are always coming into existence without proper supervision.

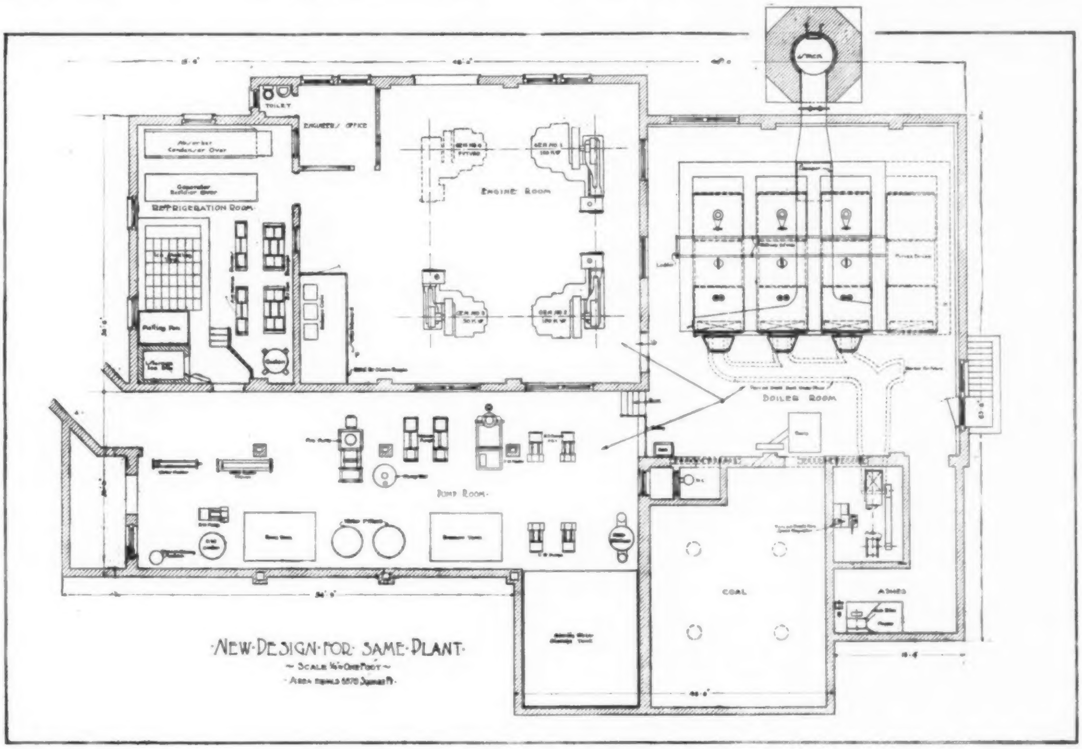
GENERAL ARRANGEMENT:

Reference has been made heretofore to the simplification of the arrangement of the plant for the purpose of minimizing the cost of service. In most plants the item of service is the largest single item entered into, the cost of plant operation being even greater than the item of fuel. Everything possible should therefore be done to reduce the skill, consequently the salary roll, and the number of men required for the operation of the plant. The key to the solution of this problem lies in the general arrangement of the plant and in the selection of the type and size of the units of the different portions of the plant. The least possible complication should be involved and the most direct passage of air, water and steam, as well as the most direct supervision should be secured.

The first essential, therefore, for the general arrangement of a plant is that the least amount of travel is necessary on the part of the operatives, to see or supervise the operation of every portion of the power, heating and ventilating plant. It is a large plant, indeed, which may not be so arranged that from some one working point the chief engineer, or even the fireman, may place his eye on every portion of the plant. If this point be carefully borne in mind a large plant may be so arranged that it may be operated with the assistance of one or two men at a time in the power house.

Illustrating this point, two actual designs for the same power plant are shown herewith.

By referring to the drawing No. 1 it will be observed that the engineer or fireman



·NEW·DESIGN·FOR·SAME·PLANT·

at the front of his boilers can see nothing of any other portion of the plant, nor can he while in the engine room know anything of what is going on in the boiler room. By looking down the stair-well he could see a very limited portion of the pump room. Such an arrangement inevitably involves increased labor on the part of the power plant crew and probably additional men. By reversing the direction in which the boilers face the difficulty would be slightly remedied.

Illustration No. 2 shows another design for the same plant. By referring to this illustration it will be noticed that the fireman, while in his boiler room, may view practically the entire area of the boiler, engine and pump room; thus having under his control every portion of the plant. With such an arrangement the service can be very materially reduced over that required for the arrangement first shown.

A plant of this size would, in either case, require an engineer-in-charge on each shift, but, inasmuch as this institution includes several buildings a large portion of his time would necessarily be spent out among the buildings looking after the ventilating system and other details of the domestic equipment of the institution. With the first arrangement shown there would also be required two men in the power house at all times or assuming three shifts per day, nine men would constitute the engineering crew. With the second arrangement proposed a single man, in addition to the engineer-in-charge, should be sufficient for the operation of the plant, six men thus constituting the engineering crew. While this reduction in the cost of service has been brought about a lessened cost of installation has also resulted.

As an illustration of the value of expert services in the design of such a plant it may be pointed out that the boiler plant capacity required to serve the institution was reduced from 750 horsepower to 486 horsepower, while the generator capacity was reduced from 400 kilowatts to 300 kilowatts.

Sufficient space about and over each piece of apparatus is an important feature in every plant. In the boiler room there should be sufficient space to clean out all portions of the boiler and to clean and replace boiler tubes. About all pumps there should be sufficient space to get at every part and at each end there should be enough space to withdraw pistons and rods.

No apparatus should be placed in a space the height of which about the apparatus is not equal to the height of a man. This is especially important over the boilers where there are many valves and openings to which the operating engineer should have the easiest possible access.

Every unit of the plant should be of the best make and quality for the service required, and its size and design should be studied with a special view to economical operation and durability. Cheap material may reduce the cost of operation but eventually bring about a high cost of maintenance.

Spare units should be provided in the case of boiler and power units and duplicate pumps, motors, etc., should be provided wherever possible.

The characteristics and preference of the operating engineer as to make and kind of apparatus or material should be carefully considered, for it will be found that the things with which he is familiar are, as a rule, the ones which will, under his hands, give the best results, while apparatus installed to which he is strange or opposed is more apt to give difficulty, because of the lack of a certain personal interest on the part of the operating engineer. Similarly local materials and usages should be carefully considered for the cost of installation is often materially effected thereby, and also the familiarity of the operating crew with the devices installed is apt to be in proportion to their previous familiarity with the materials and devices used. Again the matter of fuels, especially where oil and gas are available as fuel, must be considered. These latter fuels require special burners and controlling devices. Bituminous and anthracite coals require entirely different treatment in plant design, and the economy of the plant operation is materially effected by the decision as to the fuel to be burned and then by the treatment of plant design for the most efficient combustion of the fuel determined upon.

BOILER PLANT:

The type and size of a boiler installed in a plant has very great bearing upon the economy and convenience of operation. In a small building, such as a residence, a cast iron sectional boiler will prove very satisfactory. These boilers are available in several different forms, such as the rectangular, sectional, round, front or side fired boiler. For summer use in heating hot water or operating accelerating coils a round boiler is often used. In larger plants the wrought iron or steel boiler is more desirable, and is usually less expensive. These may take the form of water tube boilers, either of the horizontal or vertical pattern, horizontal fire tube boilers, vertical fire tube boilers, locomotive type boilers, or the modification thereof known as the fire box boiler.

Both the water tube boiler and horizontal fire tube boiler require masonry settings, while the vertical fire tube boiler, locomotive type boiler and fire box boiler are usually set without masonry (except foundations) and are covered with an asbestos covering consisting of asbestos blocks and plastic asbestos cement, the blocks being one inch to one and one-half inches thick, and the cement approximately the same thickness. The blocks are first wired on with copper wire, after which a coat of the asbestos cement is applied, then chicken wire mesh and more asbestos cement, the final coat being troweled to a hard smooth finish.

In determining the size of boilers, the total radiation served should first be considered and this should be figured out into actual heat units, allowing 150 heat units per square foot of direct hot water radiation, 250 heat units per square foot of indirect hot water radiation, 200 heat units per square foot of hot water pipe coils, 250 heat units per square foot of direct steam radiation, 300 heat units per square foot of direct steam coil surface, 325 heat units per square foot of direct-indirect steam radiation, 400 to 600 heat units per square foot of gravity indirect steam radiation, and 1,000 to 1,750 heat units per square foot of steam fan coils, the smaller figure in the latter case being used for re-heating fan coils and the larger one for tempering fan coils. The total heat units should be computed and the size of the boiler determined therefrom by dividing the total thereof by 2,220 in small plants, 2,670 in medium sized plants, and 3,330 in larger plants. This will give the square feet of heating surface required in the boiler. This result divided by ten will give the horsepower of boiler required. To the horsepower should be added a proper allowance, where necessary, for heating hot water, cooking, laundry work, sterilizing, drying, etc.

The problem of whether a plant should be operated as a high pressure plant or a low pressure plant can be determined only by a careful consideration of the conditions governing the installation. Where high pressure steam is required for power purposes, cooking or laundry work it becomes necessary to install a high pressure plant operating at forty to one hundred and twenty-five pounds, depending upon the service required and the size of the plant. In such cases pumps are always required to return the water of condensation from the heating system to the boiler. Low pressure plants should be used where only heating work is involved and the installation is small. Plants combining high and low pressure boilers are not desirable, because such an installation usually involves unnecessary complication and consequent expense of installation.

In many cases where medium or large size boilers are installed, for winter use, it becomes necessary to install a smaller boiler, usually of the vertical fire tube type, for summer use, but where possible this arrangement should be avoided by so determining the size of the units of the main boiler plant that one of them can be used for the summer work and thus eliminate the necessity of a complicated and unsymmetrically designed plant.

As already stated the horizontal fire tube and water tube boilers are best suited to large installations, the latter being especially suitable for large plants or plants in which the boiler plant must be installed in a limited floor space, although a greater height of boiler room is required for the water tube boiler. In very large plants large units of water tube boilers may involve less boiler room service, *i. e.*, firemen. Both of these types of boilers require heavy masonry settings which should be erected on concrete foundations not less than two feet deep. The brick should be of the best quality red brick laid in cement lime mortar, the fire box and combustion chamber being lined with best quality fire brick laid with fire clay of the same composition as the brick, the fire brick being dipped in the fire clay and pushed to a close joint so as to leave no space between the brick.

In plants operating on light duty and at a low pressure it may be necessary only to line the fire box on the front and sides and the bridge wall, carrying the side lining approximately twelve inches back of the rear of the bridge wall. The rear wall and rear arch at the rear end of the boiler should also be lined with fire brick. This reduces the number of fire brick and consequently the cost of the masonry setting. In large plants and for high pressure work it is better to use fire brick throughout the length of the inside walls of the boiler setting.

The supporting walls at the sides of the horizontal fire tube boilers should not be less than twenty-four inches thick at the level of the grates, but the inside is usually tapered to a thickness of twenty inches below the supporting lugs. In the case of boilers set in batteries the division wall is usually made of the thickness given for sidewalls.

It is most difficult to construct a masonry setting that will not crack when drying out or under the influence of expansion and contraction, but the extent of these cracks will depend upon the quality of the material used and the care exercised in laying them. As means of preventing these cracks four-inch by four-inch angle irons are sometimes carried about the two sides and rear of the boiler settings on the outside, one side of the angle iron being imbedded in the brick work. With such angle irons carried about the masonry, approximately three feet apart in the height of the setting, and the buck stays and tie-rods properly used there will be no cracking of the masonry work.

In a plant where it is desired to secure an attractive appearance it is possible to use a pressed brick of any desired color or an enamel white brick, but to get the best results the other brick should be first laid and thoroughly dried out and the facing brick applied afterwards.

To lessen as far as possible the cracking of the boiler masonry, it is important that the masonry should be very carefully dried, which should be accomplished by first allowing the masonry to stand a week or more without heat, after which a light fire should be carried on the grates from four to six days with water in the boiler but with valves and manhole openings open so that no steam will be made, after which these openings may be closed and the pressure gradually raised over a period of from four to six days. No more important element than this matter of drying is involved in securing boiler masonry free from cracks.

(To be continued)

THE AMERICAN ARCHITECT
Founded 1876
PUBLISHED EVERY WEDNESDAY BY
THE AMERICAN ARCHITECT (INC.)
No. 50 Union Square, New York
(Fourth Avenue and 17th Street)
G. E. SLY, PRESIDENT
E. J. ROSENCRANS, SECRETARY AND TREASURER

Address all communications to "THE AMERICAN ARCHITECT"

SUBSCRIBERS' RATES:
In the United States and Possessions (Porto Rico, Hawaii, Philippine Islands and Canal Zone), Mexico and Cuba
TEN DOLLARS PER YEAR, POSTAGE PAID
ALL OTHER COUNTRIES . . . $12.00 PER YEAR
SINGLE COPIES (Regular Issues), 25 CENTS

Entered at the Post-office, New York, as Second-class Matter

VOL. CII NOVEMBER 20, 1912 No. 1926

TO LIMIT HEIGHT OF BUILDINGS ON AND NEAR FIFTH AVENUE

THE suggestion of Mr. Arnold W. Brunner that the height of buildings on Fifth Avenue and locations adjacent thereto should be limited to 150 feet, has awakened protest from a class of speculative property owners and builders, who by their strenuous objections practically acknowledge their purpose of accomplishing the very result that Mr. Brunner and other public-spirited men of the Fifth Avenue Association seek to avoid.

It would seem that the conditions existing on Fifth Avenue south of 23d Street, where loft buildings are tenanted by such hordes of garment workers that during the noon hour and for a time in the evening when these employees swarm out of the buildings upon the Avenue it is practically impassable, would justify restrictions of a character calculated to prevent their recurrence further northward.

It has been authoritatively stated that Fifth Avenue north of Madison Square is the most dignified shopping thoroughfare in the world. The location of the better type of department stores and shops on this street has attracted to it the best class of people in the city during business hours. To neglect the adoption at this time of proper restrictive measures to regulate its future development would be to invite conditions similar to those existing on lower Fifth Avenue.

It is to be hoped that Mr. Brunner's suggestion, or other means promising protection against a further extension of a character of buildings and occupancy, which should clearly be avoided in the interests of the city, will receive most careful consideration.

HYGIENIC IMPORTANCE OF PROPER INTERIOR ILLUMINATION

ALTHOUGH foreign countries are credited with being somewhat in advance of America in recognizing the importance of proper lighting of building interiors, especially by artificial means, the fact that adequate illumination of buildings is of equal hygienic importance with certain other features which have already received consideration and are controlled by legislative enactments, is now generally realized in this country. In proof of this, legislative action will undoubtedly be taken in a number of states in the near future to remedy existing conditions in a manner that will insure the adoption of efficient means for the lighting of new structures designed for public occupancy. The French government has already appointed a committee on the hygienic aspects of illumination, composed of prominent physiologists, oculists, engineers, physicists, and others, whose experience and study in connection with factory inspection render their services of especial value. It will be the duty of this committee to study from the standpoint of general health and their effect upon vision the various methods of artificial illumination now in use. The investigations will be directed particularly toward combustible illuminants. The effects of prejudicial gases resulting from combustion will be studied, taking into account the amount of heat generated thereby, and the committee will endeavor to fix a certain minimum amount of artificial illumination favorable to the normal requirements of satisfactory and untaxed vision. Similar inquiries and investigations have been inaugurated by both the English and German governments. In this country the Society of Illuminating Engineers has in a sense taken the initiative and given the various phases of hygienic illumination thoughtful consideration. A committee of the Society in conjunction with the State Factory Commission of New York has been engaged in the preparation of a measure, which it is hoped may be enacted into law, providing for the proper illumination of all buildings under the supervision of this Commission.

The subject is one whose importance is much greater than has perhaps been realized and the results of a satisfactory solution of the lighting problem in any building where work is done or a considerable number of people are required to use eyesight in the performance of any minute operation, will probably be largely in excess of general expectation.

A RECENT LEGAL DECISION

WAIVER OF PROVISION THAT EXTRA WORK MUST BE AGREED UPON IN WRITING

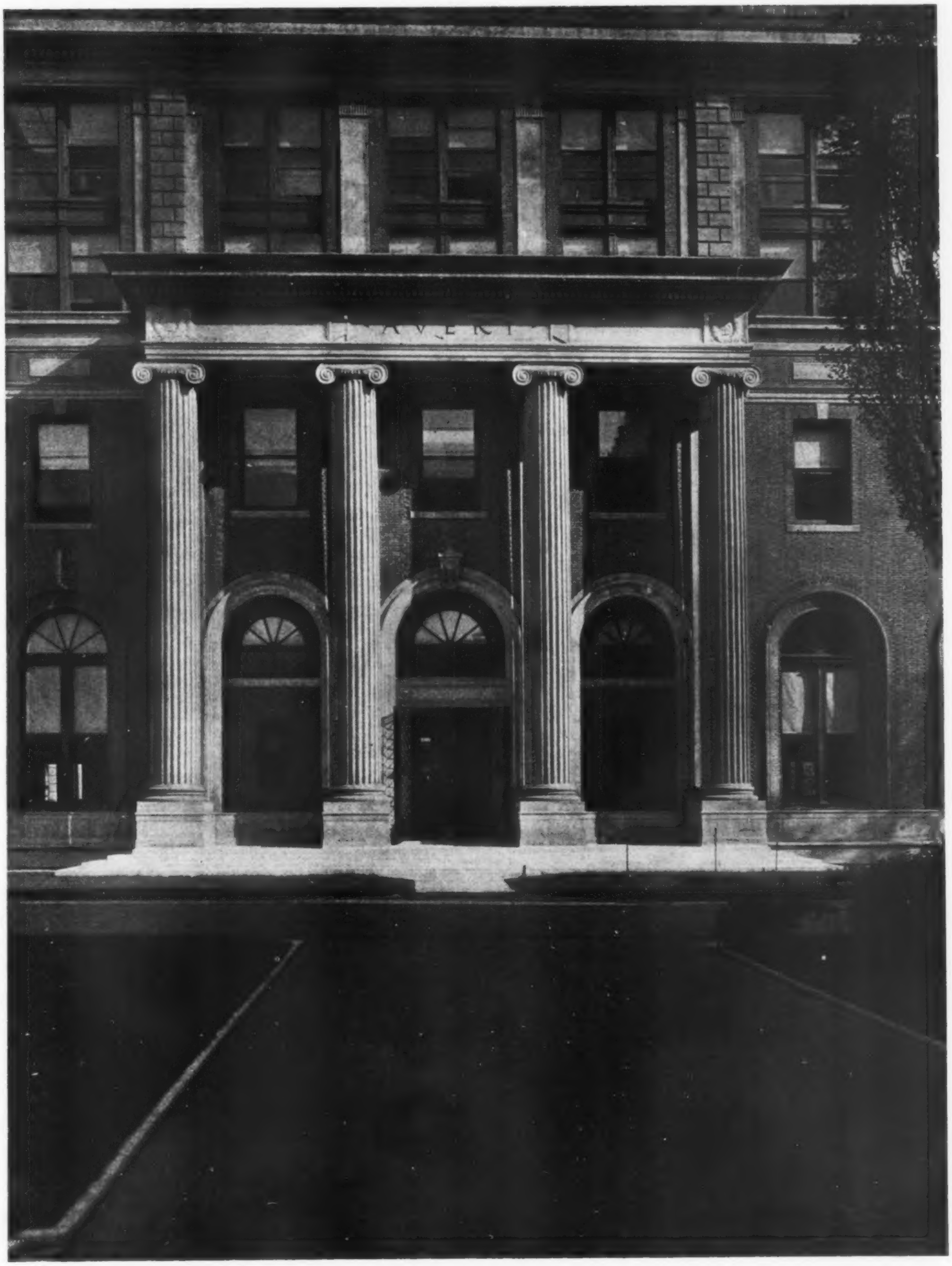
A building contract provided that no additions or alterations made during the progress of the work should be regarded as extra work unless agreed to in writing and signed by the parties before such work is begun. A controversy arose as to a claim by the contractor for extra work. In an action by him for the balance of the contract price there was evidence that by several express agreements between owner and contractor certain changes were made in the details as described in the plans and specifications, and that extra compensation was orally agreed upon therefor, as, for example, detail window frames, instead of stock frames, extra 50 cents each; shingled porch columns, instead of stock turned colums, $3 each; oak finish in two rooms, instead of cypress, agreed on at $59 per house; change in kitchen ranges, $16 each; in door and window heads, $15.60; and in heating apparatus, $86. Other work was done, such as planing floors and varnishing, as to which there was no specific agreement. For many years the effort has been made to limit or prevent the incessant disputes between contractors and owners as to extra work and changes on buildings by putting in the written contract a stipulation that all changes and alterations must be agreed on in writing in order to support a claim for extra work. But a fundamental difficulty is that there is no statute requiring such contracts to be in writing, and parties who have contracted together have a right to cancel their contract, or alter it in any way not prohibited by law, or supplement it by an additional contract, and may do so orally. Consequently such a clause in the contract cannot legally constitute a prohibition against the parties altering the main contract by mutual agreement. No matter how stringently the clause is worded, it is always open for the parties, to agree orally or otherwise, upon proper consideration, that the provision shall be disregarded and another arrangement substituted.

As to what evidence will be sufficient to justify a finding that the restrictive clause was waived they run all the way from holding that the mere doing of extra work and the acceptance thereof in silence will justify a finding that the extra work clause was waived to the position that waiver will not be inferred unless the evidence is clear and convincing. In the present case the New Jersey Supreme Court held that the contractor was not entitled to be paid for the extra work in the absence of a writing signed by the owner and contractor fixing the amount to be paid therefor. The case was taken by writ of error to the Court of Errors and Appeals. That court has reversed the supreme court's judgment. It holds that the mere performance of extra work without such a written agreement will not give rise to an implied waiver of the clause. But where the evidence satisfactorily shows that the parties distinctly agreed, though orally, that the alteration should be deemed extra work, and that the owner definitely agreed to pay extra for it, and especially if a definite price was fixed in that agreement, this would be sufficient to establish an express contract for such extra work outside of the original contract, or a modification of the contract to the extent of such agreed extra work, and would justify a recovery therefor, regardless of the restrictive clause. Such an agreement the evidence in the present case showed; therefore the contractor was entitled to recover for extra work.

Headley *v.* Cavileer, New Jersey Court of E. and A., 82 Atl. 908.

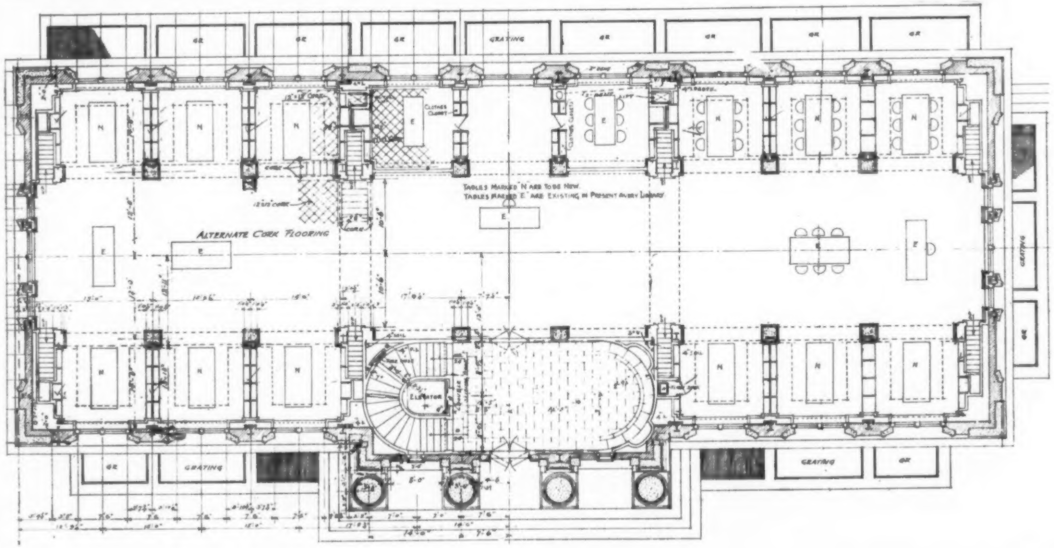
AVERY LIBRARY BUILDING, COLUMBIA UNIVERSITY, NEW YORK

MESSRS. McKIM, MEAD & WHITE, *ARCHITECTS*



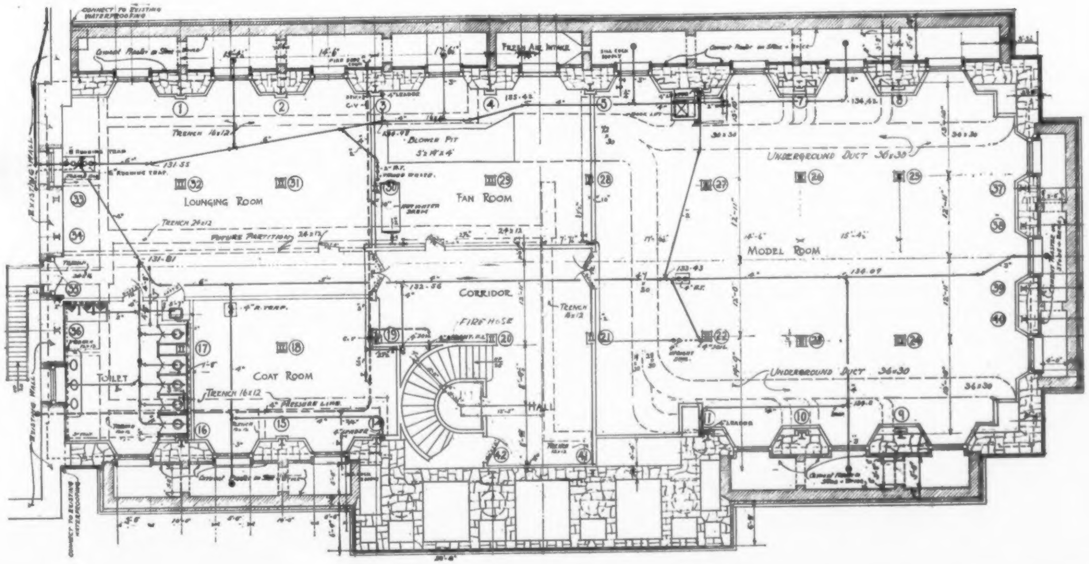
AVERY LIBRARY BUILDING, COLUMBIA UNIVERSITY, NEW YORK

MESSRS. McKIM, MEAD & WHITE, *ARCHITECTS*



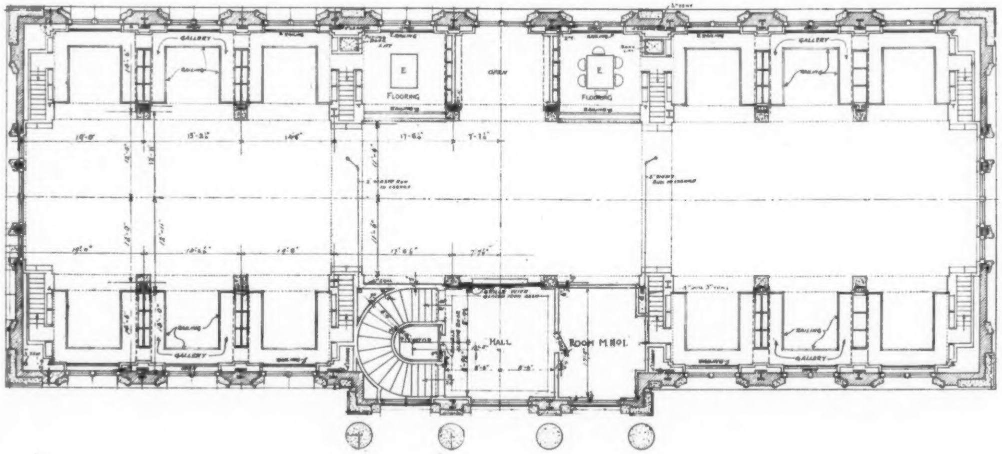
AVERY LIBRARY BUILDING, COLUMBIA UNIVERSITY, NEW YORK

BASEMENT AND FIRST FLOOR PLANS



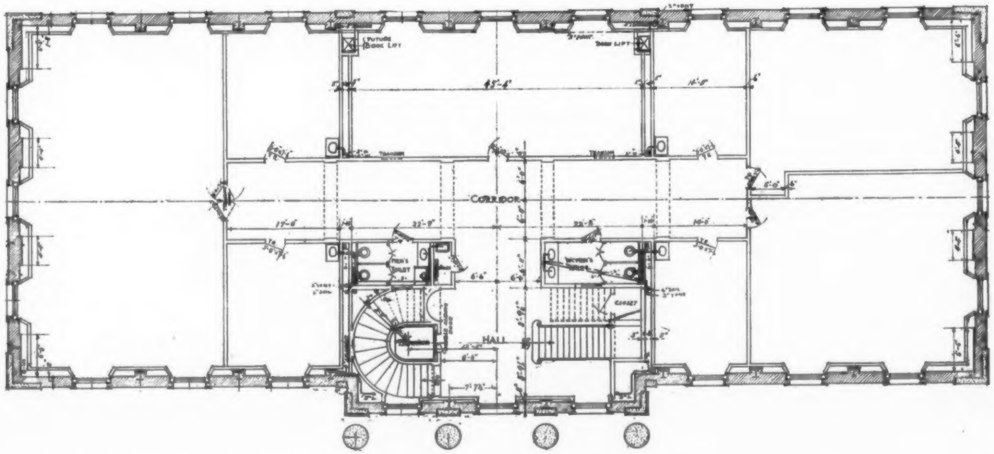
MESSRS. McKIM, MEAD & WHITE,

ARCHITECTS



AVERY LIBRARY BUILDING, COLUMBIA UNIVERSITY, NEW YORK .

MEZZANINE AND SECOND FLOOR PLANS

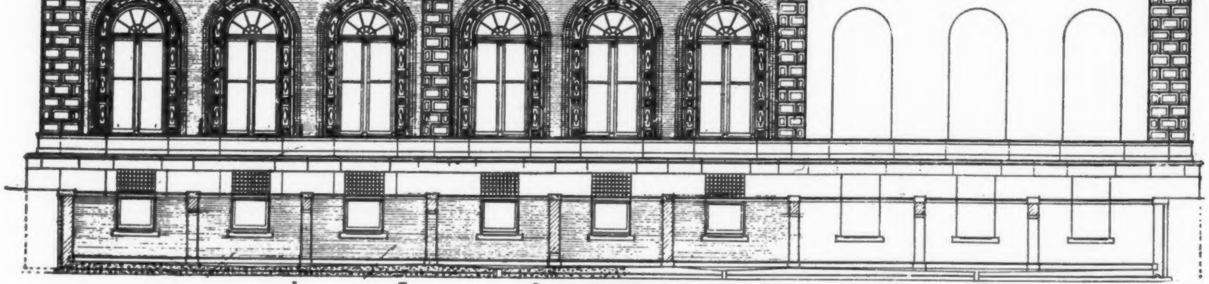


MESSRS. McKIM, MEAD & WHITE,

ARCHITECTS

WEST · ELEVATION


WEST · ELEVATION



EAST · ELEVATION

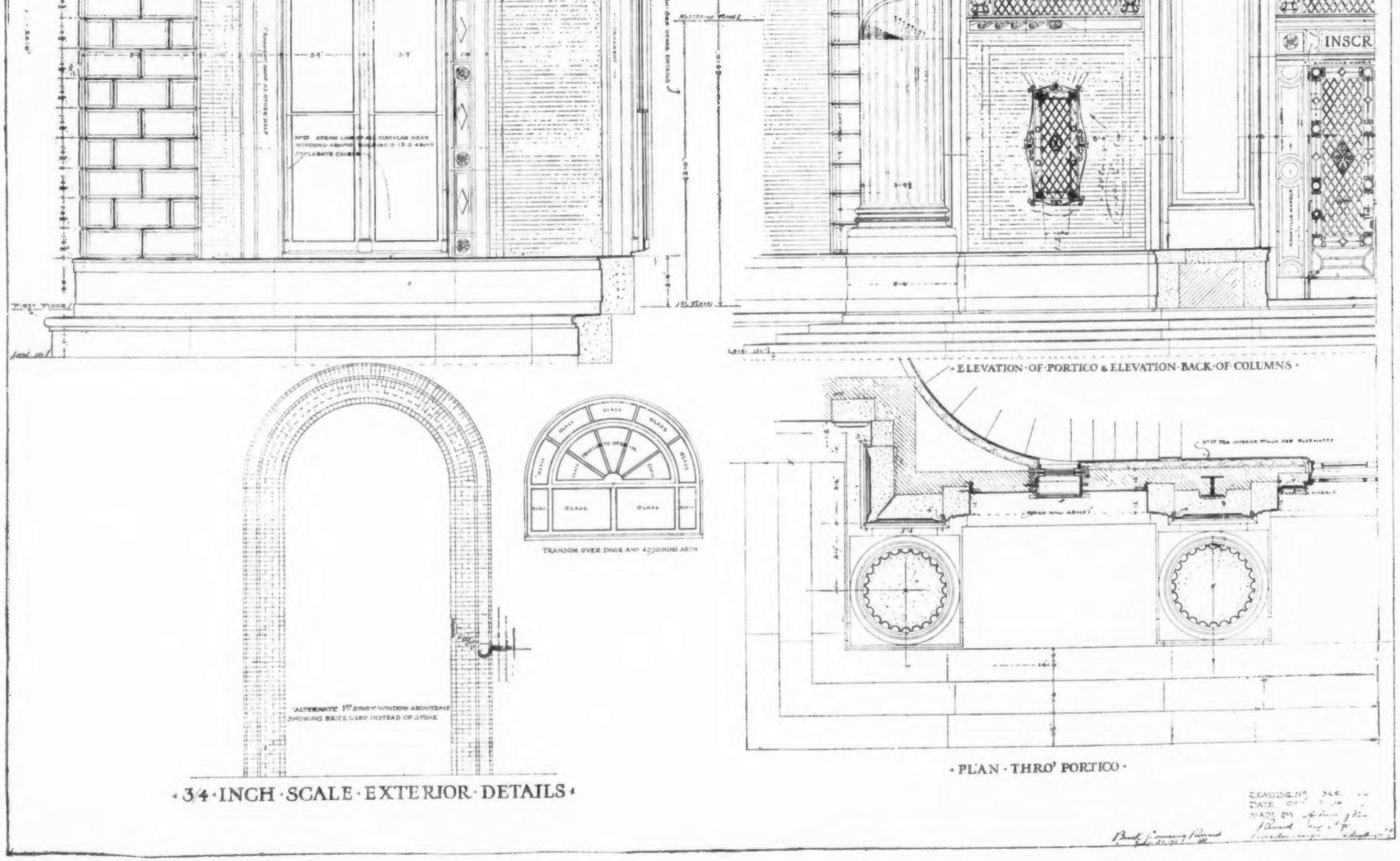
LONGITUDINAL SECTION

AVERY LIBRARY BUILDING, COLUMBIA UNIVERSITY, NEW YORK

MESSRS. McKIM, MEAD & WHITE, *ARCHITECTS*


CONTINUE: CHENEAU
CAST-IRON
GRILLE IN FRONT
ORNAMENT
CAP FLASHING
FLASHING
ISCR


ISCR
INSCR



AVERY LIBRARY BUILDING, COLUMBIA UNIVERSITY, NEW YORK

MESSRS. McKIM, MEAD & WHITE, *ARCHITECTS*

A COURTYARD SARAGOSSA