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SPECIFICATIONS FOR REINFORCED CONCRETE STRUCTURES

By ERNEST McCULLOUGH, M.AM.SOC.C.E.

TO prepare specifications for buildings in which the structural material is wood is not particularly difficult. Tables have been computed by which it is comparatively easy to frame a wooden building with a minimum of scientific knowledge of strains and stresses. The same is practically true for simple structures in steel. The hand books of the steel manufacturers contain tables by means of which beam and column sizes may be quickly checked and a tentative layout made by men not engineers. For a large part of the work of architects the tables referred to are amply sufficient. It is only in the case of large structures that the services of an engineer are necessary.

It is more difficult with reinforced concrete. A man who proposse to use this material in a structure must have a good knowledge of the mechanics of materials or employ a competent experienced engineer. The material is composed of steel and concrete so combined that each takes the stresses it is best fitted to care for. Innumerable combinations are possible and when specifications are incomplete several designers may turn in designs widely differing in strength, yet each complying with the specifications, according to the view of the designer. No standards exist at the present time as in steel and wood, but lately two standards have been proposed and all architects are strongly urged to take cognizance of these attempted standards to the end that reinforced concrete may be looked upon with favor and be no longer feared, because of accidents reported.

After presenting what the writer believes should constitute good specification clauses, he will explain the reasons why reinforced concrete cannot be used without detailed specifications.

The National Association of Cement Users has adopted a standard set of regulations for reinforced concrete buildings and copies may be procured from the Secretary, Harrison Building, Philadelphia, Pa., at a very low cost. These regulations are complete in all particulars, including specifications for quality of steel, cement, sand and aggregates. Architects wishing to refer to these regulations should do so in the following manner:

"The design for this structure follows the regulations for reinforced concrete structures adopted by the National Association of Cement Users, with a maximum steel stress in tension of 16,000 pounds per square inch, and contractors wishing to present alternative competitive designs shall follow the same regulations. After thirty days from the pouring of any floor the architect will require a test load to be applied over the entire surface of two adjacent panels equal to twice the design load, the weight of the construction to be considered as part of the test load. Under this test load the maximum deflection permitted shall not exceed 1-800 the span."

Another clause may be used in lieu of the above, and it is as follows:

"The design for this structure follows the recommendations of the Joint Con-

mittee on Concrete and Reinforced Concrete published in the February, 1913, issue of the Proceedings of the American Society of Civil Engineers. Column loads are reduced as follows: All dead load goes to the columns. All the roof live load goes to the columns. For the top floor the live load is reduced fifteen per cent. and there is a successive reduction of five per cent. for each floor below until the live load on a floor is reduced fifty per cent., after which fifty per cent. of the live load is used on each floor. Slabs and beams shall be designed to carry the full dead and live load but the live load going to girders may be reduced fifteen per cent., except on floors marked."

The above clause goes into some details not mentioned in the previous clause for the reason that the recommendations of the Joint Committee refer only to the reinforced concrete design, whereas the recommendations of the National Association of Cement Users cover structural design also. The writer prefers the second clause to the first, although both will accomplish the desired object. Some details in the Joint Committee report are favored by him as compared with similar provisions in the N. A. C. U. recommendations.

To the second clause above given should be appended the section relating to the test load.

On each blue print should be marked the live load on the floors, for which the building is designed. This feature is beginning to be a prominent one in modern drawings, since so many building ordinances now require floors to be placarded with safe loads.

Competitive designs should never be barred. Inventive faculty should be encouraged and by permitting competitive designs owners frequently obtain designs from competent specialists. There are many honest firms in the business of selling materials, glad to give architects and owners the benefit of their experience in designing structures in reinforced concrete. Many contracting firms also employ competent designers whose services are at the disposal of those who care to receive the benefit. Unfortunately, however, there are also many incompetent designers in the employ of material men and contractors, and there are also many reckless men who give free (?) designs. Such men take advantage of incomplete specifications and this is the reason engineers in private practice who are not pushing any special materials or systems are urging the use of good clauses in specifications to the end that proper protection may be had. Honest manufacturers, patentees and dealers are also now joined in the movement to secure better buildings. The present article is part of the movement and is not written to exalt the engineer, but to protect the material.

It seems necessary to insist, however, that whenever plans are presented in competition or by any interests outside the architect's own office or organization, they should be checked before acceptance, by a competent experienced engineer practicing independently. Otherwise the architect's reputation, as well as his client's interests, will be subjected to grave danger.

The following specifications are incomplete:

"Competitive designs will be received and all floors must carry the following loads with a factor of safety of....." Here follows the floor load schedule.

This clause is incomplete for several reasons. In the first place the factor of safety is not definitely stated. Is it based on the total load or on the live load? Is it based on the ultimate strength of the concrete or on the supposed ultimate combination of the steel and the concrete? Is it based on the ultimate strength or the elastic limit of the steel? Under such a specification no less than five assumptions may be made by designers and the owner is not protected from the man who wishes to skin a design to the limit. Furthermore no bending moment assumptions are made so we do not know if the design may be based on a condition of continuity, of partial continuity or of simply supported beams. Continuity is expressly prohibited in steel design but in reinforced concrete is permitted under certain conditions. Unscrupulous designers will always assume a condition of perfect continuity and yet make insufficient provision for securing continuous action over supports.

The following specification is incomplete:

"Competitive designs will be received and the steel shall not be stressed more than 16,000 pounds per square inch and the concrete shall not be stressed more than

650 pounds per square inch. The floor loads shall be as follows....."

Like the preceding clause the proportion of load going to columns is not given and the bending moment assumptions are neglected. By assuming certain bending moment coefficients the stresses called for may be secured but if the right assumptions are made the resulting stresses will be too high. No stresses are given for the columns. No ratio of deformation between the concrete and steel is given. Several designers may each assume a different ratio and obtain the stresses called for. Each one will point to buildings now standing which were designed according to his assumptions and may influence the owner thereby to take an inferior design.

A complete specification is obtained by reference to the two proposed standards, as already stated, or by giving in detail each item to be taken into account. For a specification writer not fully conversant with reinforced concrete design the recommended clauses will cover the ground and should be used in preference to attempting to give all the items. Some of the items are: the ratio of deformation between concrete and steel in bending; the ratio of stresses in columns; the fiber stress in concrete in bending and also in compression, the latter being about three-fourths the former; the fiber stress in the steel in bending and the fiber stress in the steel in compression; the bending moment coefficients for simple spans, for end spans, for interior spans with two, three or more panels, etc. Enough has been given to show that reinforced concrete design is not so simple a matter as steel and timber design. Each item mentioned plays a very important part.

The question is often asked, "Why do so many things have to be considered in reinforced concrete design that are not considered in steel design?" The answer is that steel is made in a steel mill; it is rolled in standard sections in which numerous items were taken into consideration at the time the sections were adopted; tables of standard loadings are used and the building designer has only the structural design to take into consideration. Reinforced concrete is a structural material manufactured on the building site; it is a combination of the two materials: the stresses depend not only upon the composition of the composite material but also upon the methods used in the structural design, the latter items having no effect whatever upon the standard structural steel shapes which must be used in a way fixed by common practice. Innumerable combinations are possible with the steel and the concrete, which combinations may be further altered by the structural design, or the combination of steel, concrete and the manner of fabrication as reinforced concrete; and the manner of fabrication as a structure. For the reasons given it is necessary to consider in reinforced concrete design many things that in steel work have only to be considered in the factory.

It is known that many men use fairly high stresses in steel and concrete and some building ordinances permit the use of high stresses. There is prevalent an idea that the use of high stresses is conducive to economy. A careful study of economy in concrete design taking into consideration the cost of labor, and cost of materials shows that the maximum economy results when the steel stress is under 16,000 pounds per square inch and the concrete stress is under 650 pounds per square inch. When the cost of carrying the live load is considered the stresses are about the same. The maximum economy is not reached when steel stresses of 18,000 to 20,000 pounds per square inch are used, with concrete stresses of from 700 to 800 pounds per square inch.

Another matter enters into this consideration of economic design that is seldom considered and this is "the changing character of occupancy." Concrete increases in strength with age but this statement does not apply to reinforced concrete, which is a combination of steel and concrete, for the strength of steel is fixed from the moment of manufacture. Varying stresses may be used however with steel and if a design is made in which deformed steel is used with a fiber stress of 16,000 pounds per square inch, the concrete with a fiber stress of 650 pounds per square inch and a ratio of deformation equals fifteen, a fibre stress in the steel of 18,000 pounds per square inch may be used by the time the concrete through age has obtained a strength fifty per cent. in excess of the designing strength.

Assume that a live load of fifty pounds per square foot was used in designing with a floor weighing sixty-five pounds per square foot. The total load equals 115 pounds per square foot. When the strength of the concrete is increased to such an amount that a steel stress of 18,000 pounds may be considered, the total load may be about one and five-tenths multiplied by 115 equals 172.5 pounds. The dead load remains sixty-five pounds so this means an increase in the live load to 122.5 pounds per square foot. The building may have been designed as an office building and after a term of years may be in the center of a light manufacturing district when the floor loads are more than doubled. This point is seldom taken into consideration in designing, but it is most important and a good argument in favor of low initial designing stresses. From the results of experiments made by the writer, and other men, he does not favor the use of plain steel, for some things may occur to lessen the adhesion of concrete to steel and a mechanical bond is good insurance. Deformed steel at the present time competes in price with plain steel and the purchaser has a choice of several kinds and is not limited to patented articles.

When it is considered that by using stresses recommended by safe conservative designers, the owner has a chance to often more than double the live load, and in any event may greatly increase it, the very small saving in material obtained by the use of high initial stresses is really no saving. The use of high stresses was forced by competition of salesmen who cared only for immediate sales. Today with a better knowledge of the material and the use of more complete specifications the use of high stresses should be abandoned. Bond stresses and shearing stresses in concrete are increased with an increase in bending stresses so that every argument is in favor of the use of the stresses recommended by the Joint Committee on Concrete and Reinforced Concrete, the recommendations of that committee being the result of sixty years' experience with reinforced concrete.

EFFECTIVE ARTIFICIAL ILLUMINATION

By EDWARD R. KNOWLES, E.E., C.E.

IN order that any employee may work to the very best advantage his proper housing is a subject of great importance; for upon his surroundings and facilities for work depends his effectiveness of operation.

In this connection the question of illumination plays a most important part.

No matter how well placed he may be as to room space, desk and furniture outfit, heating and ventilation, telephone and stenographic service, filing and card systems and all other appliances and facilities, all of which tend to the best of service, if the lighting arrangements are not properly devised and placed both as to position, quantity and quality of light, he cannot perform his work to the best advantage. He must be properly lighted to do his best work.

This being the case it becomes of the first importance that the lighting conditions should be those which are best adapted to the requirements and needs of the work to be done and are as modern and efficient as possible and at the same time are as economical in operation as the requirements will permit.

Efficiency and economy in artificial lighting by electricity or gas, does not necessarily mean the obtaining of a maximum of light from a minimum of electric current or gas, but it does mean, first, the placing and giving of that quality and amount of light which will enable the operator by its use to do his particular kind of work in the most efficient manner and, second, the obtaining of such lighting at a minimum of expenditure of electric current or gas; Efficiency first and then Economy.

To see easily and comfortably, without danger to the eyesight and health it is necessary to arrange and place the light sources in such position as will best suit the particular conditions which have to be met and select the lamps, fixtures, shades,

globes and other apparatus with this end in view.

Because a light source looks glaring and brilliant it does not follow that it is giving a good light, it may be giving too much light in the wrong place.

A well shaded or enclosed light source may appear to be dim because it is well shaded but may be giving a first class light for working purposes.

There must be sufficient light to see by, but as things are seen chiefly by the light they reflect it is evident that a well shaded source of light which may have very little intrinsic brilliancy when looked at directly, may be so directed on the object to be seen as to give ample light for all required purposes.

Again, unshaded or brilliant lights so placed as to be in the line of vision are fatiguing to the eye and greatly diminish the seeing ability of the user, while a moderate light properly shaded and placed above the range of vision causes no discomfort and enables the user to see easily and comfortably.

Artificial lighting of an enclosed place has two principal requirements to fulfill, general and special illumination; general as applied to the ordinary diffused lighting of a room and special as applied to the local lighting of desks, tables or other special articles or locations, each of which requires special treatment as to the location of the source of light.

It will, therefore, be evident that the placement and positioning of the light sources is of first importance and that in determining this no general rule can be followed. Each case must receive careful and independent consideration.

The quality of the light used is of next importance; by this is meant the character of the light, whether white, yellowish, reddish or bluish white, according to the character of the work to be done.

For instance, in sorting the letters, packages, etc., in the work rooms of the Government post offices it is often quite necessary that the different colors of the envelopes and stamps shall be clearly and distinctly discernible, and this can best be accomplished by a light as nearly white as possible, while in other cases, a yellowish or reddish white light is more grateful to the eyesight and can be used to better advantage than the pure white light

The quantity of light received from a light source on a given subject is of next importance.

What is the light to be used for? General illumination, to read or write by, to bring into view the working parts of a machine, to match colors, to display goods or pictures, or to make a pathway safe and plain? Is the color of the object to be illuminated light or dark or is the object smooth or polished, or rough and unpolished?

All of these and kindred questions must be carefully considered in determining the amount and kind of light required of a given light source.

Each case must be studied by itself and the required effect accomplished by the use of such lamps, fixtures, shades, globes and other apparatus properly disposed as will by means of direct, semi-direct or indirect lighting, insure ample illumination without undue brilliancy or fatigue to the eye and yet in the most economical manner compatible with the result to be accomplished.

Enormous advances have been made in the past few years in the art of artificial illumination until at the present time it has become almost an exact science and forms a separate branch of engineering.

Not alone has the character of the light sources been improved and rendered highly efficient; the character and forms of reflectors, globes and shades, have been changed and made in endless variety and shapes of exact reflecting or diffusing surfaces so that it is possible to select a form of shade or reflector which will meet any given requirement. Also the character and design of fixtures have been made applicable to practically every lighting condition, and the combination of the placement, quality and quantity of light has been reduced to so scientific a basis that it is possible for an expert engineer to accurately design the proper illumination required by any given condition and this at a maximum of efficiency and economy.

From this it will be understood why some lighting systems installed even five or six years ago and at that time considered satisfactory are at the present time regarded as crude, inefficient and uneconomical to

a high degree. Such a condition is evidenced by the enormous amount of changes and re-installations now taking place in every direction in antiquated though comparatively new systems of illumination.

THE NEW YORK COUNTY COURTHOUSE

MR. GUY LOWELL, *ARCHITECT*

A PRELIMINARY presentation of the successful design submitted by Mr. Guy Lowell, Architect, in the competition for the new New York County Courthouse, is made in this issue. Mr. Lowell's departure in submitting a circular building has evoked much comment in the daily press, practically unanimous in approval of a design which is as much a success in its artistic interpretation of the problem as it is an innovation in the conception of buildings of this kind. Mr. Lowell has stated that the plan of the new courthouse is an outgrowth of the idea that the general scheme of the building should be such that all of the work can be carried on in the simplest and most straightforward manner. From whatever direction the building is approached, there is always an entrance that leads directly to the large circular lobby in its center, around which all the elevators are arranged in one continuous ring. Though monumental in its character and of most artistic design, in all its practical details it fulfills every requirement of the business building type.

The rather limited illustration of the design submitted prevents particular references to many details in the planning. This limitation of presentation has been requested by the Commissioners who do not desire at this time to make public any more of the plans than are shown herewith.

The basement floor, through which the subway runs, follows in its circular plan that of the floor above it and the location of a subway station permits those who have business in the building to step from the subway platform directly onto the elevators which will take them to the desired floor.

A feature of the scheme is that there is separate elevator service for the public and for the justices. Once in the building, the judges and the public need never meet, as the passageways connecting the robing rooms, the justices' chambers, the study alcoves and the library are all absolutely separate from the public corridors. In the same way, the juries in the various trial chambers are kept quite apart from the public.

On the ground floor, adjoining the entrance, are important offices of the County Clerk, the waiting rooms for the public and the general consultation rooms for the lawyers and also rooms for the representatives of the press.

On the floors above are arranged the court rooms. There is one complete floor for the city court and four floors for the Supreme Court. Above the court rooms are the library and dining rooms for the justices. Adjoining a broad terrace overlooking the city and harbor are the justices' chambers. Each court has communicating rooms for witnesses and for counsel, has a gallery for the public and is amply lighted both by windows on the outside and by windows in the interior light court. This arrangement is particularly advantageous as it provides in addition to the artificial ventilation ample natural ventilation and also adequate protection against street noises, which have been such a disturbing factor in most of our city courts.

In studying the plans of the various floors, we are impressed with the time-saving features that this circular form makes possible. The adoption of a circular building has produced an exterior of great dignity and one that is simple and impressive in the long unbroken curves—a feature in design not easily obtained in the broken lines of an irregular or rectangular building.

In its general style of architecture, this courthouse is typical of many of the old Roman buildings, for though it is necessarily many stories high, the elements in the design, as in the buildings of the classic period, have been kept few in number. The actual height to the justices' terrace is 200 feet and the building itself covers about 120,000 square feet of ground, leaving ample space for park and terracing around the building and thus providing a dignified setting for a building which will undoubtedly become one of the architectural features of New York City.

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SUCCESSFULLY CONDUCTED COMPETITIONS

PUBLICATION in this issue of the prize-winning designs presented in two important competitions of recent occurrence, both of which were conducted under the rules prescribed by the American Institute of Architects, gives evidence of the growth in popularity of the Institute's plan for the selection of an architect where conditions render a non-competitive choice impracticable.

The plan of program adopted in each of these instances would probably not have been sanctioned a few years ago by the public officials whose approval was necessary before action could be taken. When we contrast the present attitude of public mind toward architectural practice with that which existed even in 1900, we are able to note the remarkable progress that has been made in securing recognition for the architect and acknowledgment of the justice of his demands, particularly those indicated by the provisions which the program of competition approved by the American Institute contains. Of course it is realized that this plan of competition is not yet universally accepted but instances such as those here under consideration will undoubtedly tend to its further adoption by boards and individuals confronted with the necessity of selecting an architect and who through the force of circumstances or a provision of law are unable to make selection outright. It might, however, be well to bear constantly in mind the fact that a continuation of the popularity and favor which the Institute's program of competition now enjoys both in the profession and among laymen, to say nothing of its extension, depends largely upon the manner of its administration. For this reason great responsibility rests upon the professional adviser and the jury of award. In no less degree does it rest upon the individual, committee or board acting for the association, corporation, state or municipality to which the proposed building will eventually belong, but failure to realize it could be understood or even expected in a body of men probably never before called upon to act in a similar capacity and without knowledge of the duties and responsibility involved; so it may be said that the task of explaining this phase of the relation of owner to competitor falls ordinarily and properly upon the professional adviser. Now, if any of these responsibilities are shirked or abused and a few cases of competitions are recorded concerning which a suspicion is aroused that certain requirements or preferences as to plan, design, type of building or materials of construction were known only to a comparatively few of the competitors, if indeed to more than one, confidence in the plan will inevitably be destroyed and the prospects of its ultimate universal adoption rendered extremely remote. Under all the conditions, it would seem to be the unquestionable duty of boards or committees to study the problem sufficiently, under the direction and advice of their professional adviser, to enable them to determine all preferences or predispositions in favor of any particular style or kind of building and to embody any and all information which would enable competitors to meet requirements, or that would have weight in the final selection of a plan, in the program of competition. If there exists a preference for a building with a dome, an interior open court or any other feature sufficiently strong to make it probable or even possible that the ultimate study of designs submitted will be confined or particularly directed to those embodying this

feature, this fact should be stated in the program. Failure to do so, thus leaving the competitors in ignorance, not only renders the labor of a great many of them misdirected and useless with no possibility of reward, but opens the way for a suspicion, however groundless it may be, that perhaps the feeling in regard to the favored features had in some way become known to a favored few. A competitor can, in justice to all concerned, only be left to exercise his own discretion and judgment when the minds of the committee or board, the jury of award and the professional adviser are entirely open and without prejudice or leaning of any kind.

It is to be hoped that the quality of service required in order to meet the measure of responsibility, as well as danger to the institution of architectural competitions which attaches to the respective offices, will be fully appreciated by all members of the profession whose knowledge and attainments are sufficient to qualify them to act in the capacity of either advisers or jurymen.

ACCEPTED DESIGN FOR THE ALBANY COUNTY COURTHOUSE, MESSRS. HOPPIN & KOEN, ARCHITECTS

AS will be noted by reference to the illustrations of the prize winning competitive drawings of the Albany County Courthouse presented in this issue, the design selected is typical of the Greek revival period of American architecture and was employed, it is stated by the architects, by reason of the appropriateness of its simple and dignified lines and for the further reason that it harmonizes with the existing City Hall, which is immediately adjoining the site for the proposed County Courthouse.

The material that it is proposed to employ is a light granite facing to the first spring course and above that white marble facing, inclusive of the cheneau.

The structural columns and floor beams are to be of steel and the building will have brick masonry walls with standard type of fireproof partitions. All of the other finishes, such as plastering, trim, etc., will be of a character suitable for a structure of this kind and will be determined later.

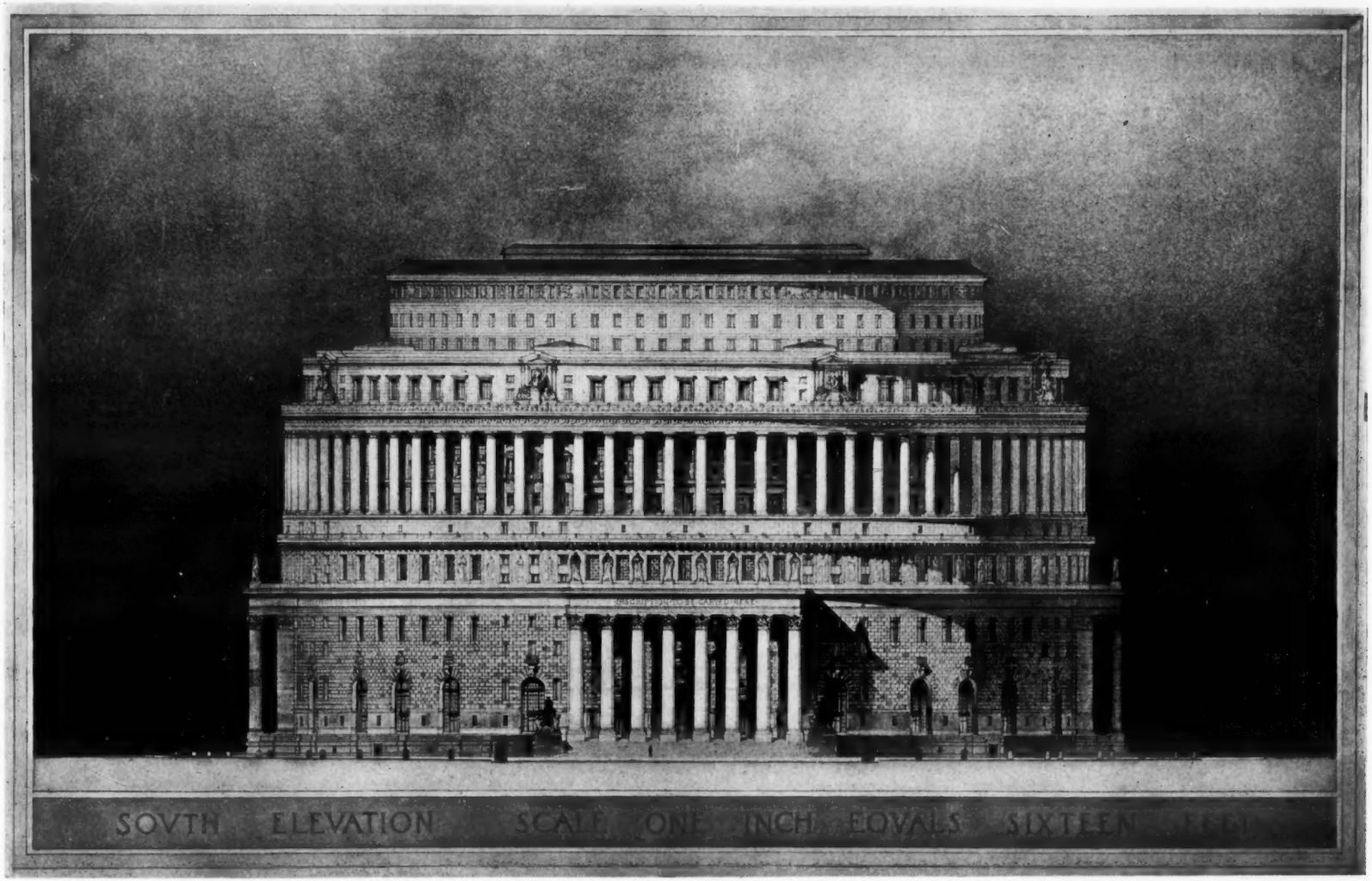
The roof will be of copper.

The cubage of the plans aggregate 2,086,526 feet and the estimated cost of the building approximately $668,000.

A feature of the plans is that they admit of flexibility in the space allotments without interfering with the main structural lines. This allows for the expansion or contraction of the different departments as their needs dictate.

The method that it is proposed to employ in heating is by indirect steam to the main rooms, direct steam elsewhere with mechanical ventilation.

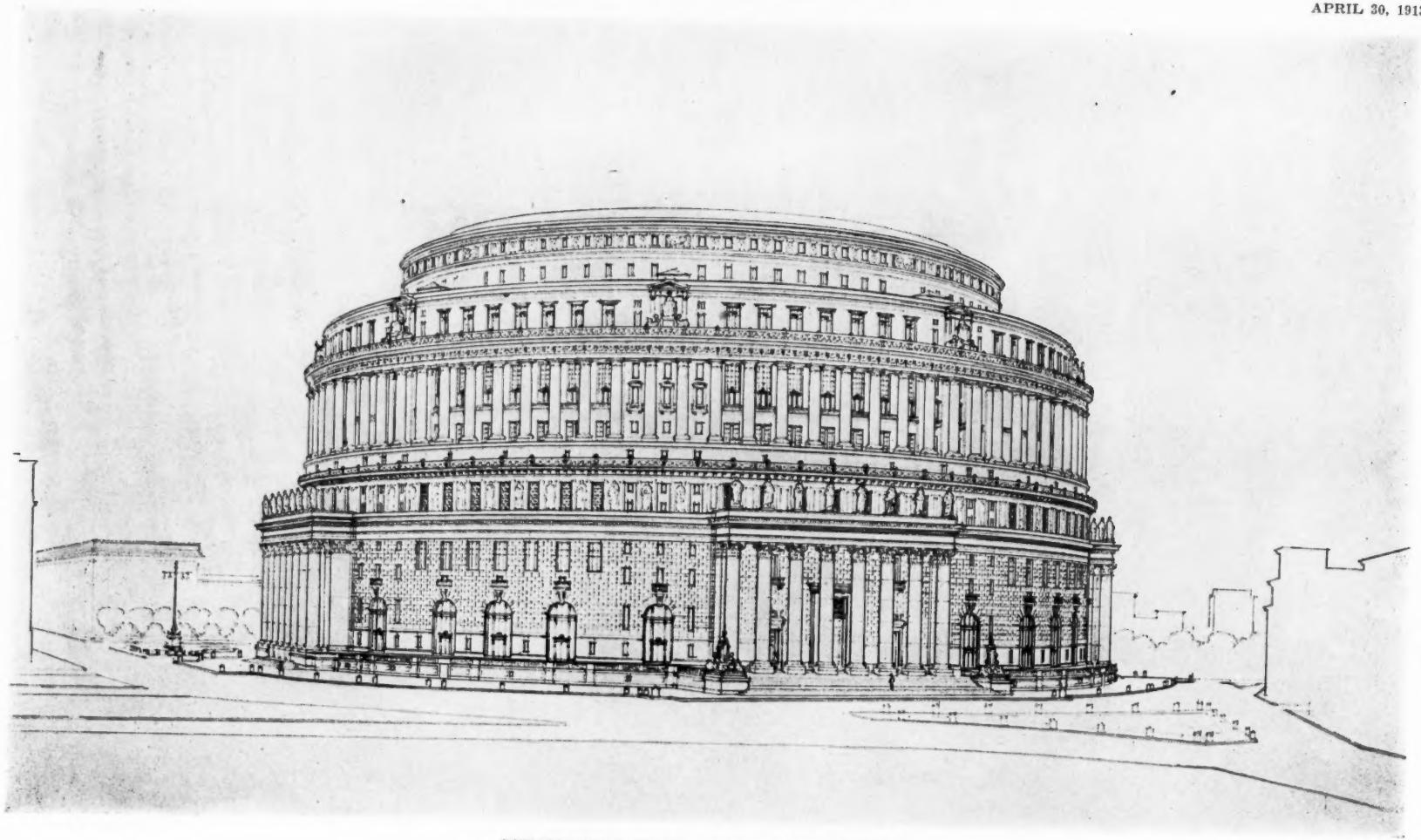
Space is provided for four electric elevators.



FIRST PRIZE DESIGN

COMPETITION FOR NEW YORK COUNTY COURTHOUSE

MR. GUY LOWELL, *ARCHITECT*

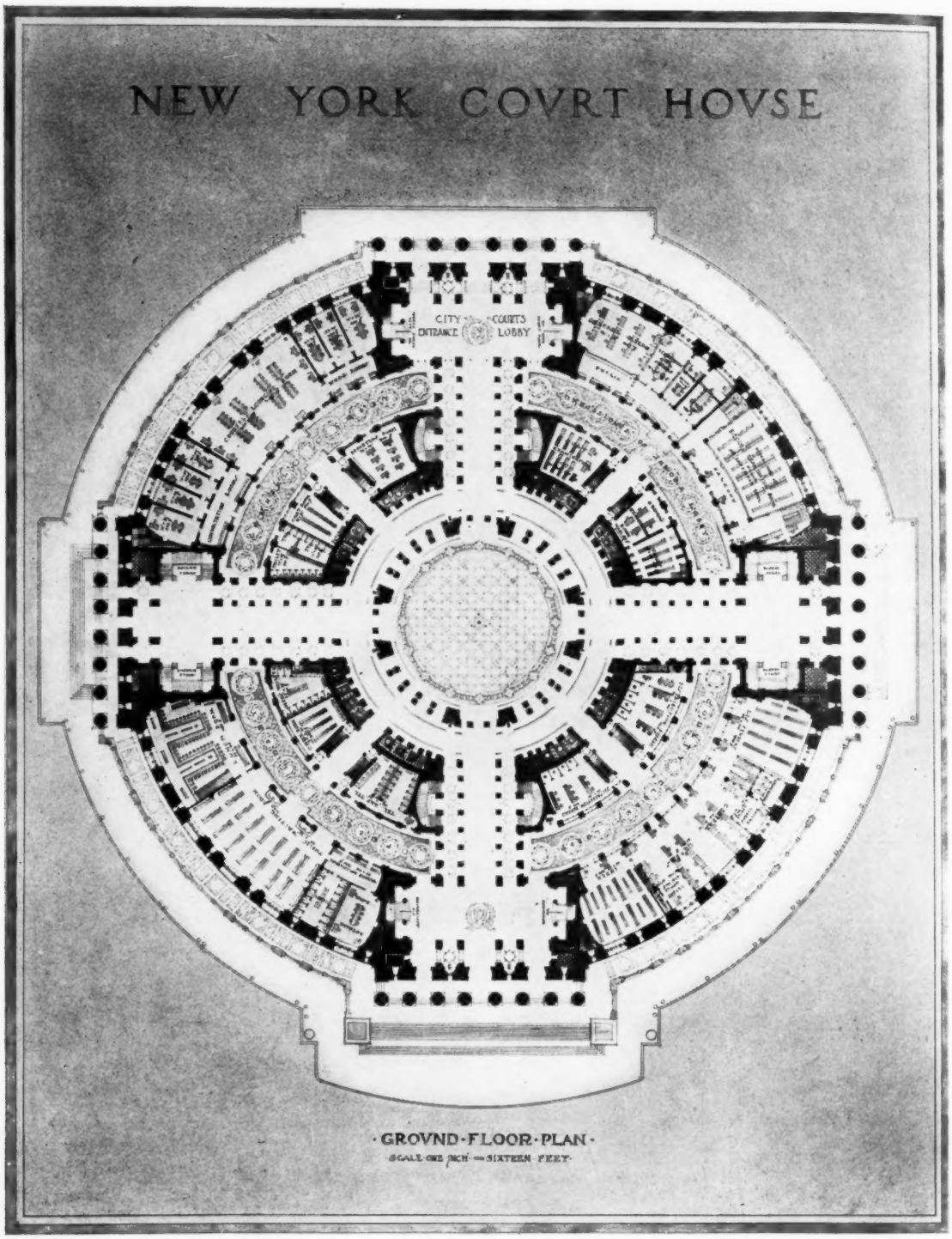


PERSPECTIVE VIEW — FIRST PRIZE DESIGN

COMPETITION FOR NEW YORK COUNTY COURTHOUSE

MR. GUY LOWELL, *ARCHITECT*

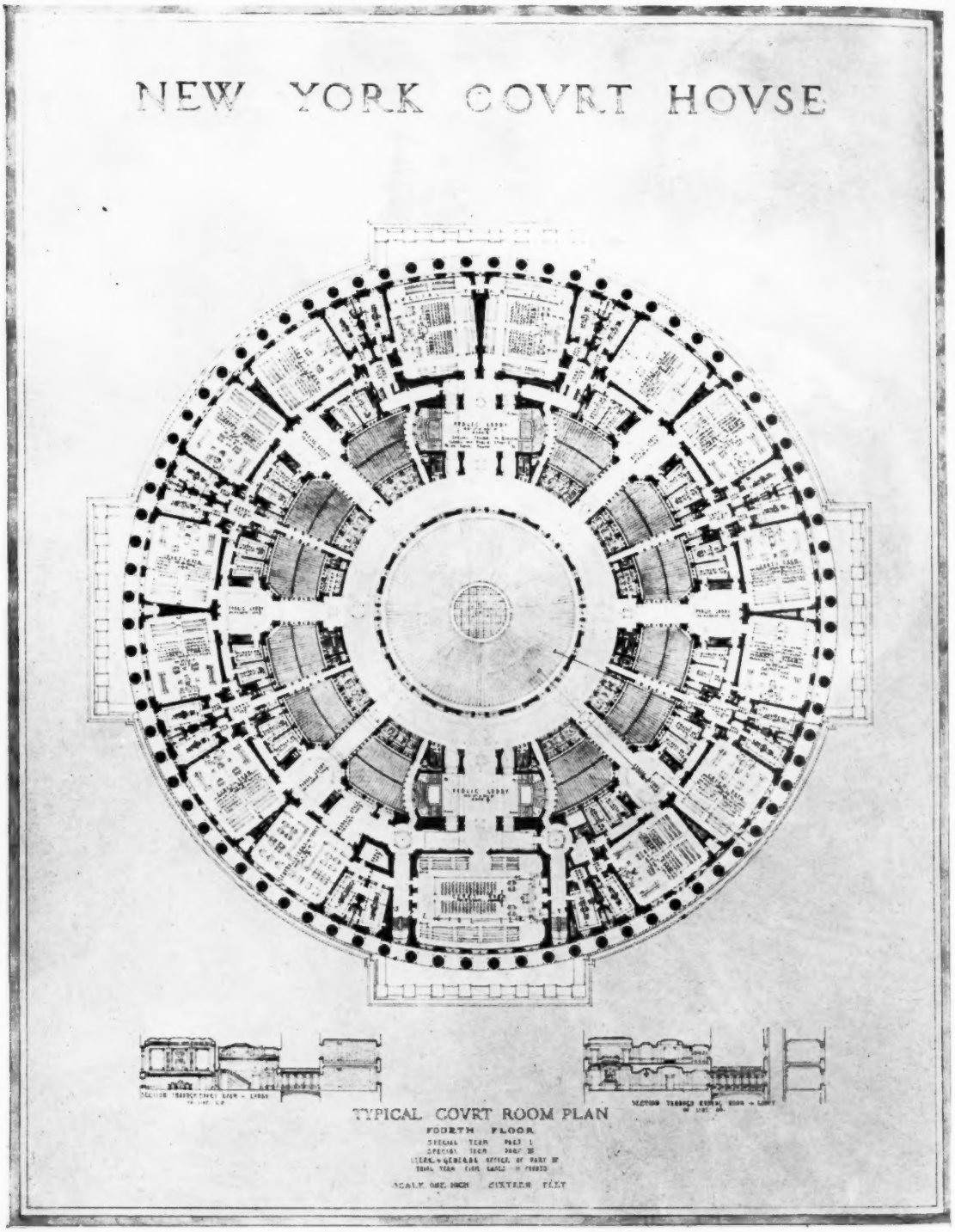
NOTE—While the problem was being studied by the architect, a succession of models were made. This perspective was drawn from a photograph of the last model.



FIRST PRIZE DESIGN

COMPETITION FOR NEW YORK COUNTY COURTHOUSE

MR. GUY LOWELL, *ARCHITECT*



FIRST PRIZE DESIGN

COMPETITION FOR NEW YORK COUNTY COURTHOUSE

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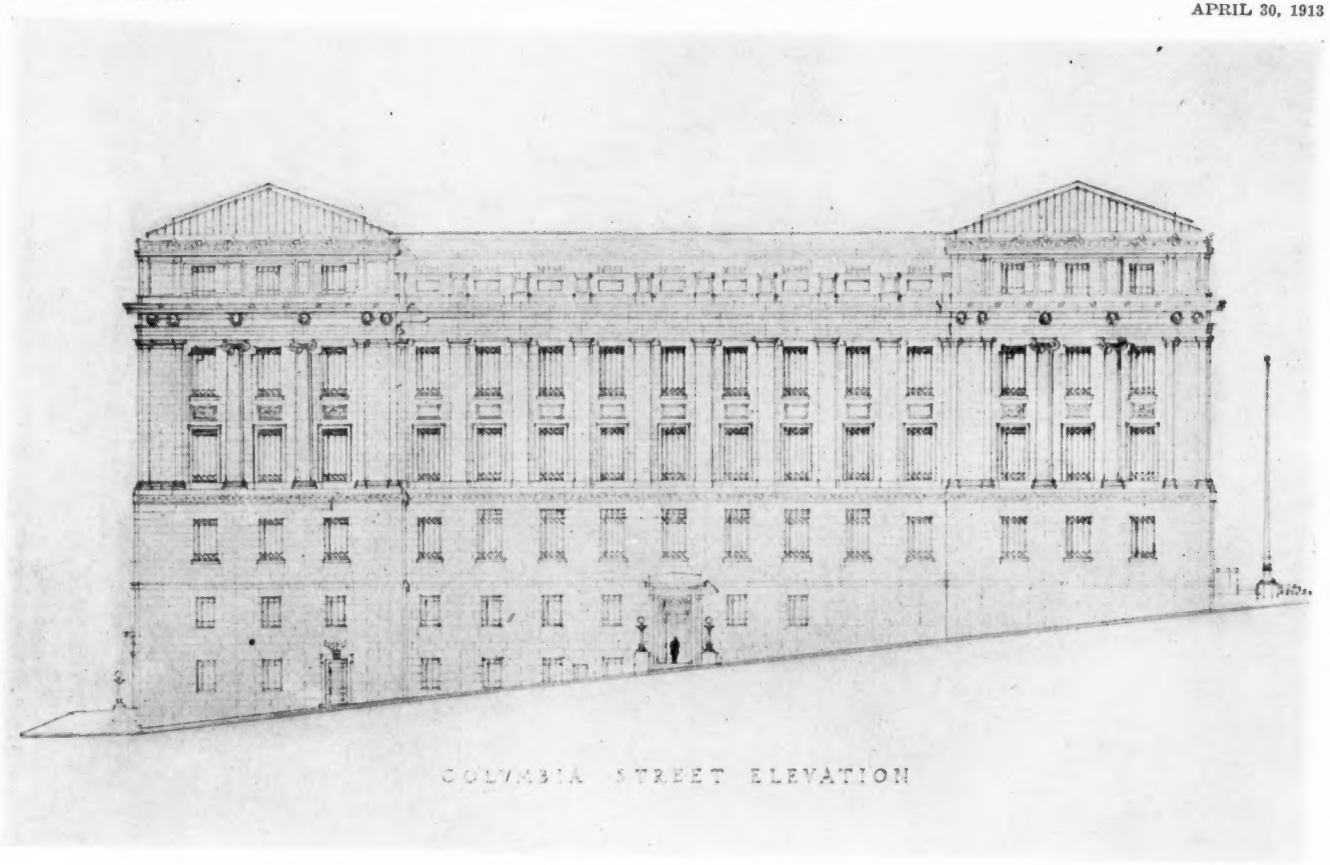
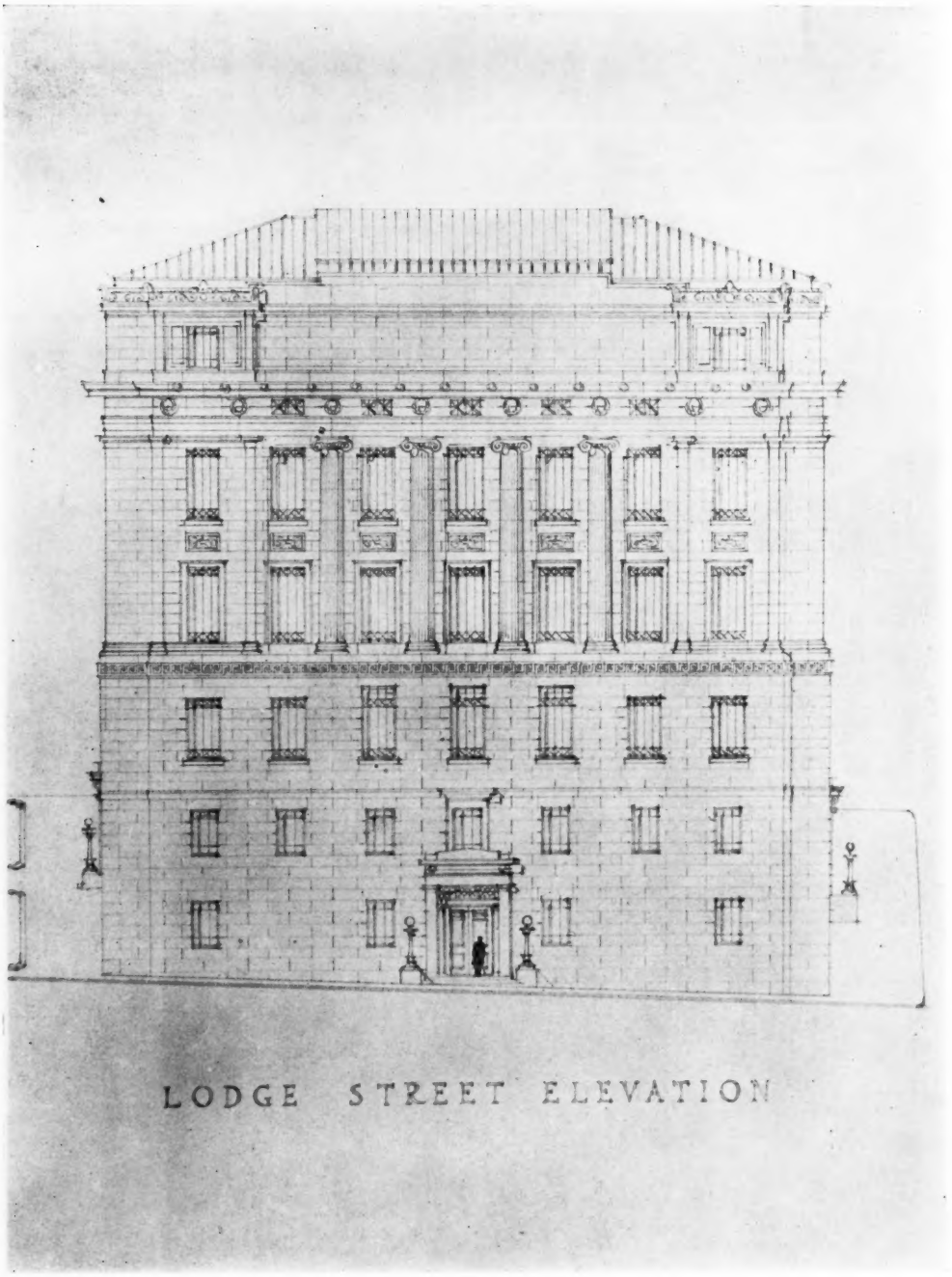


FIRST PRIZE DESIGN

ALBANY COUNTY, N. Y., COURTHOUSE COMPETITION

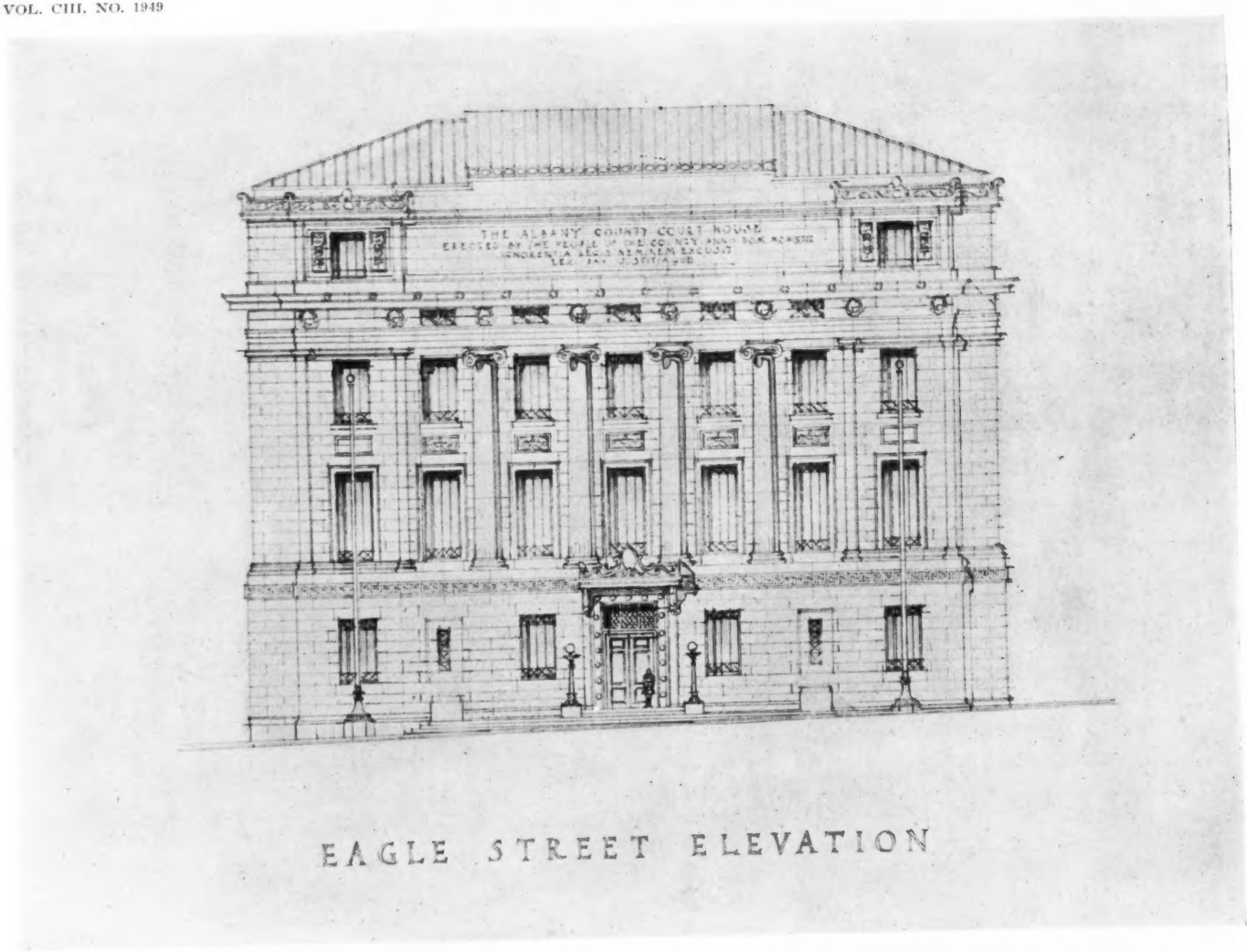
MESSRS. HOPPIN & KOEN, *ARCHITECTS*



FIRST PRIZE DESIGN

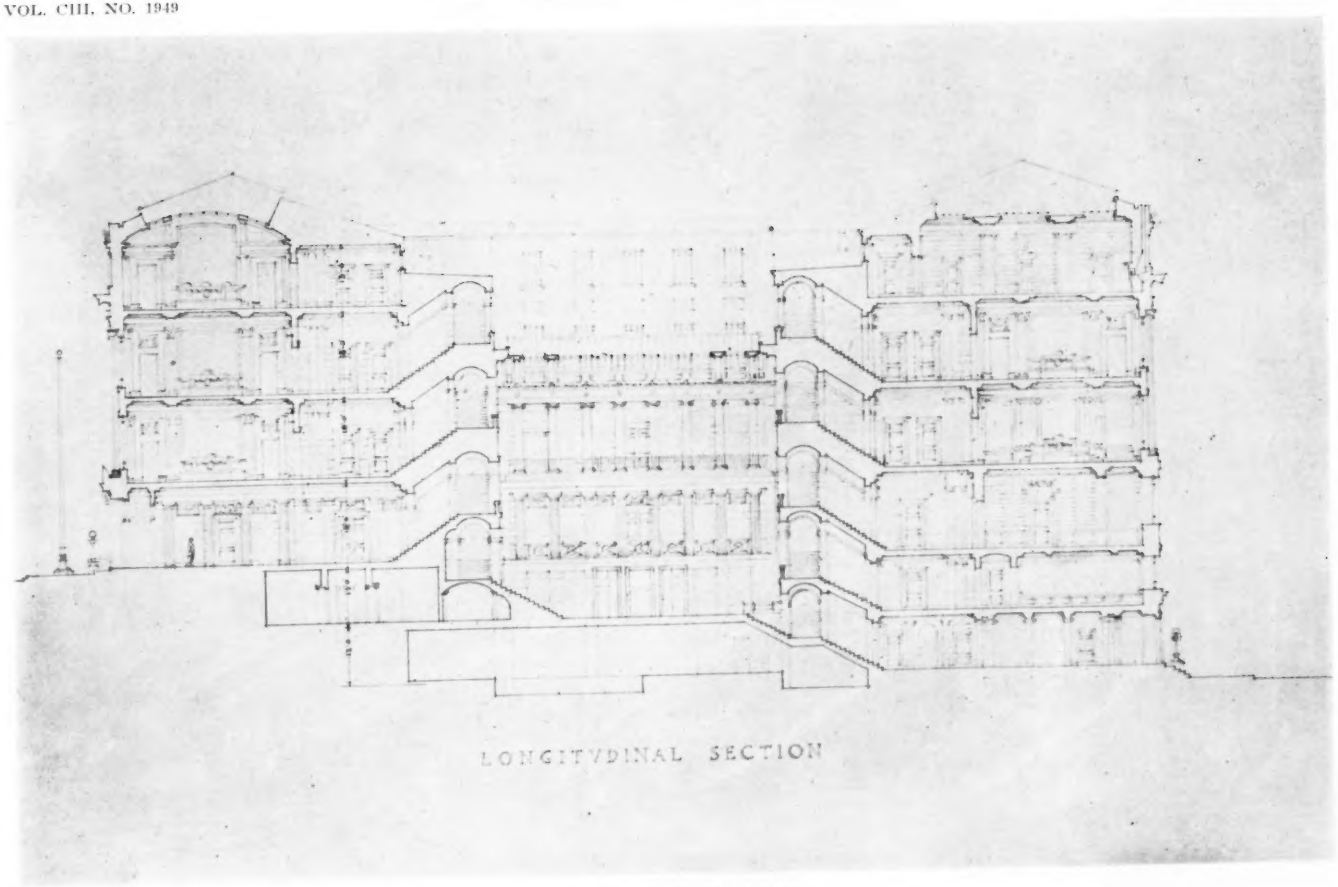
ALBANY COUNTY, N. Y., COURTHOUSE COMPETITION

MESSRS. HOPPIN & KOEN, *ARCHITECTS*



FIRST PRIZE DESIGN, ALBANY COUNTY, N. Y., COURTHOUSE COMPETITION

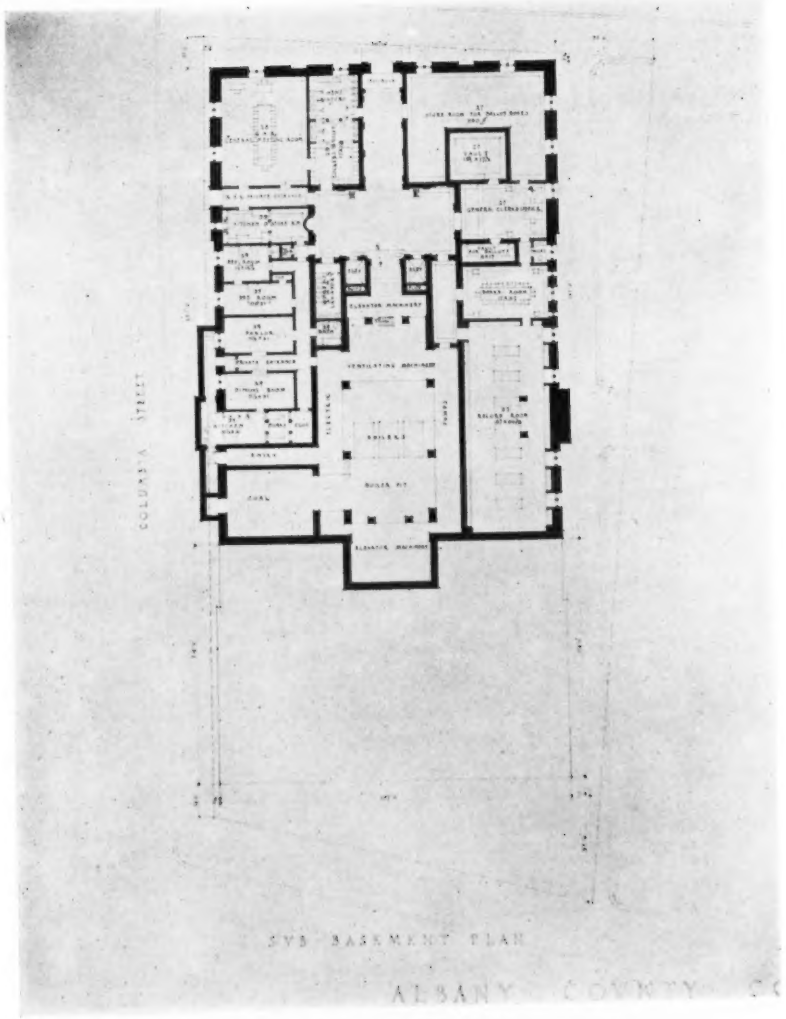
MESSRS. HOPPIN & KOEN, *ARCHITECTS*



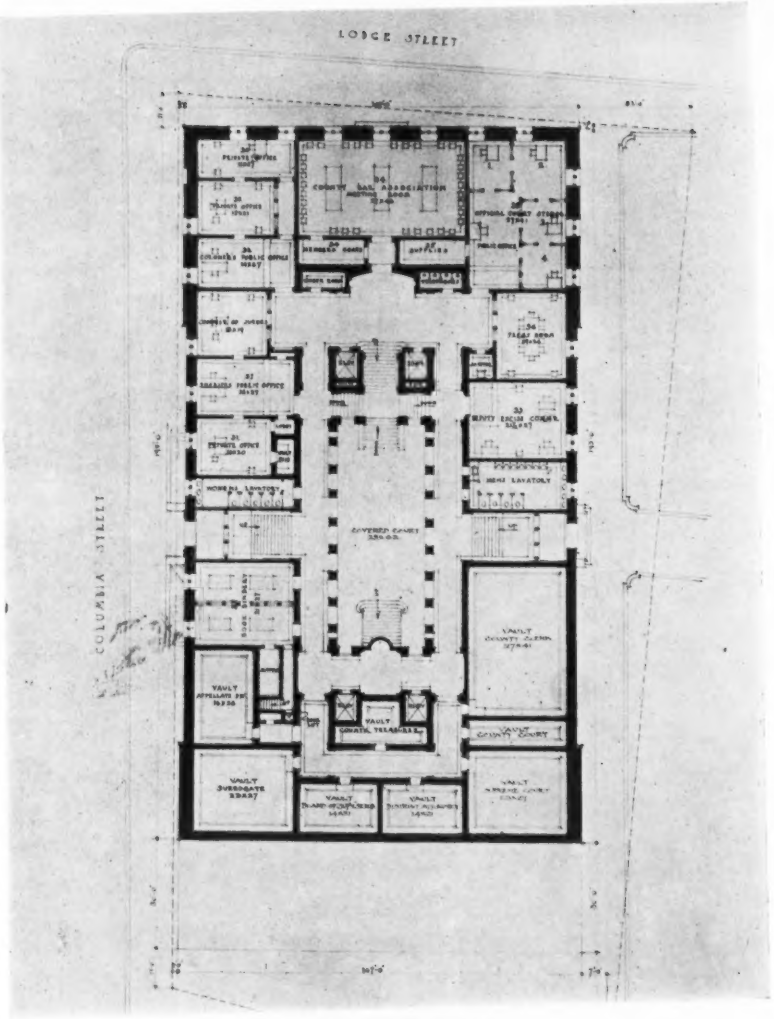
FIRST PRIZE DESIGN

ALBANY COUNTY, N. Y., COURTHOUSE COMPETITION

MESSRS. HOPPIN & KOEN, *ARCHITECTS*



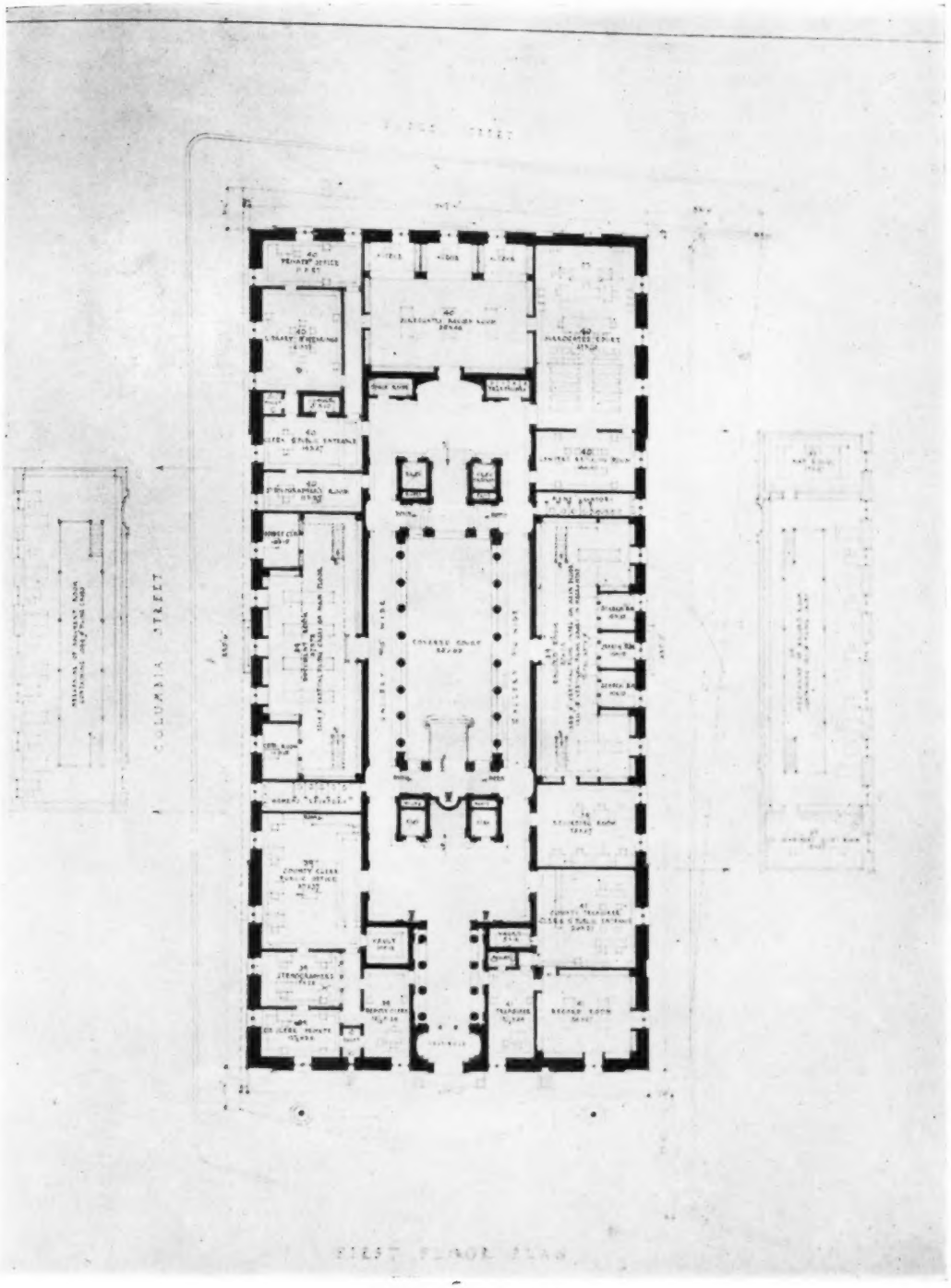
SUB-BASEMENT PLAN



BASEMENT PLAN

FIRST PRIZE DESIGN, ALBANY COUNTY, N. Y., COURTHOUSE COMPETITION

MESSRS. HOPPIN & KOEN, *ARCHITECTS*

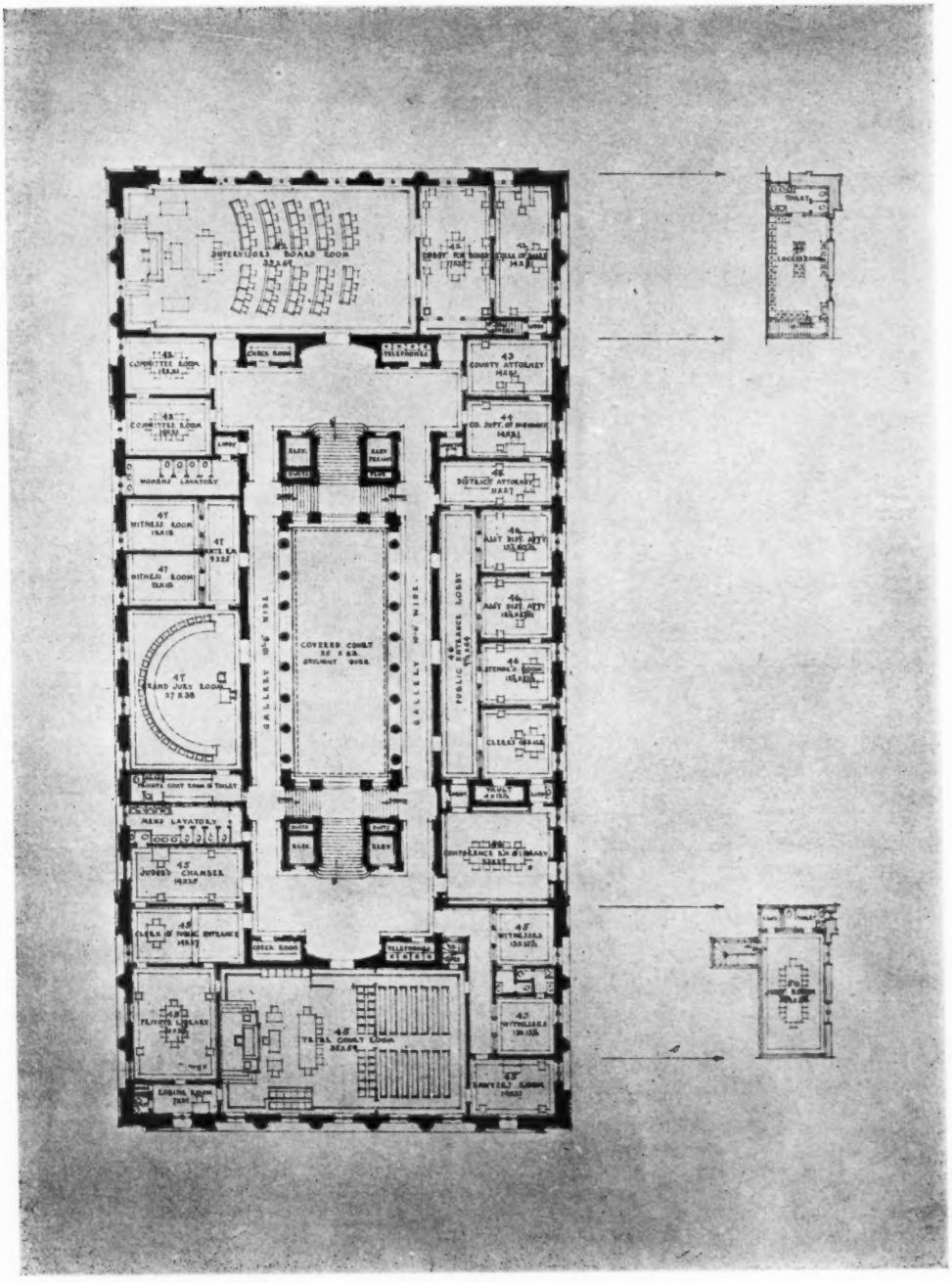


FIRST FLOOR PLAN

FIRST PRIZE DESIGN

ALBANY COUNTY, N. Y., COURTHOUSE COMPETITION

MESSRS. HOPPIN & KOEN, *ARCHITECTS*

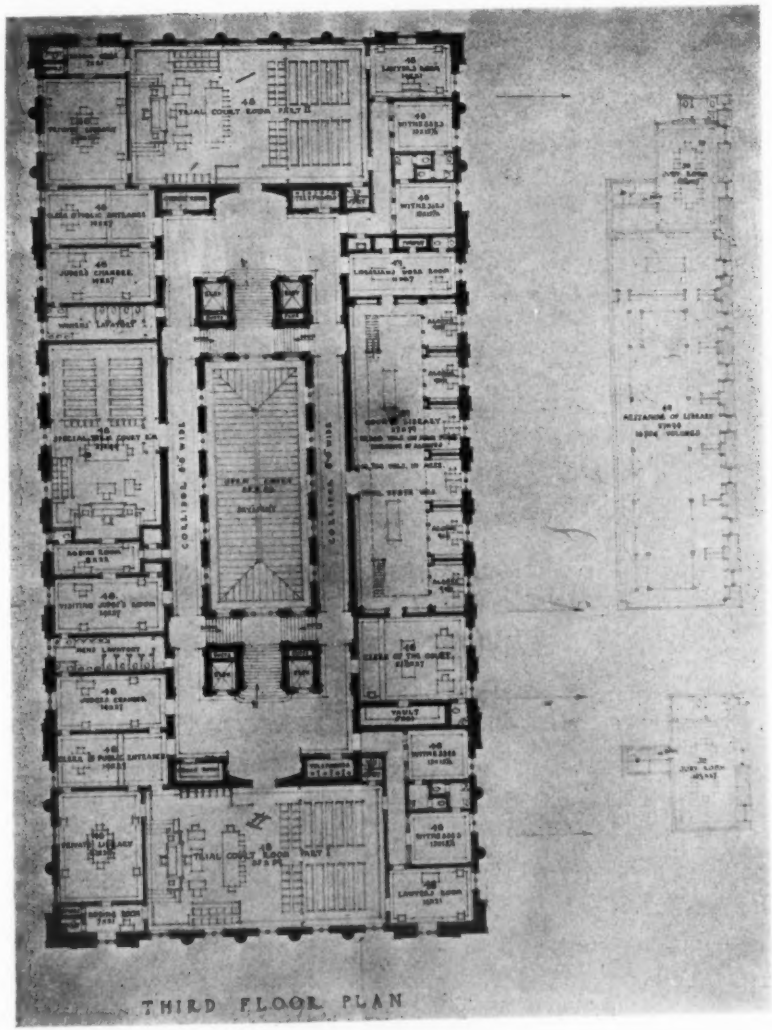


SECOND FLOOR PLAN

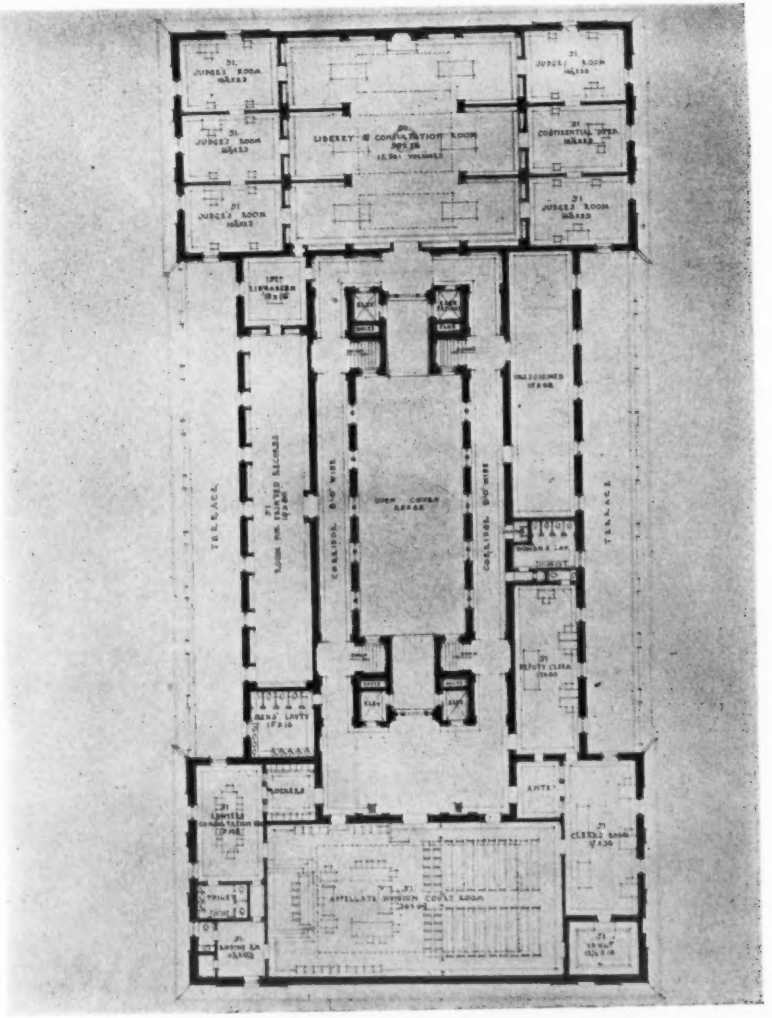
FIRST PRIZE DESIGN

ALBANY COUNTY, N. Y., COURTHOUSE COMPETITION

MESSRS. HOPPIN & KOEN, *ARCHITECTS*



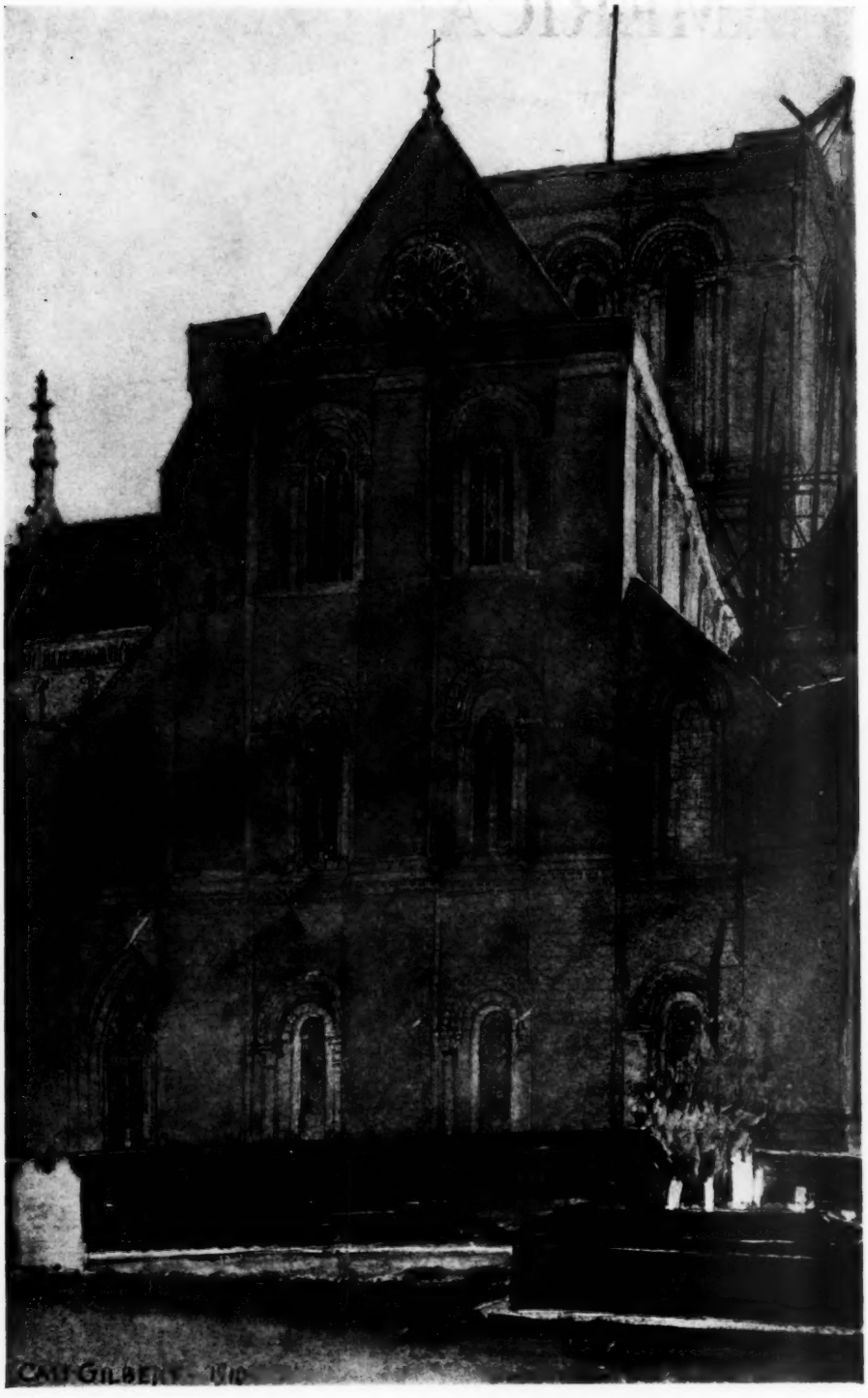
THIRD FLOOR PLAN



FOURTH FLOOR PLAN

FIRST PRIZE DESIGN, ALBANY COUNTY, N. Y., COURTHOUSE COMPETITION

MESSRS. HOPPIN & KOEN. *ARCHITECTS*



NORTH TRANSEPT, WINCHESTER CATHEDRAL

(From the original water color by Cass Gilbert, F.A.I.A.)