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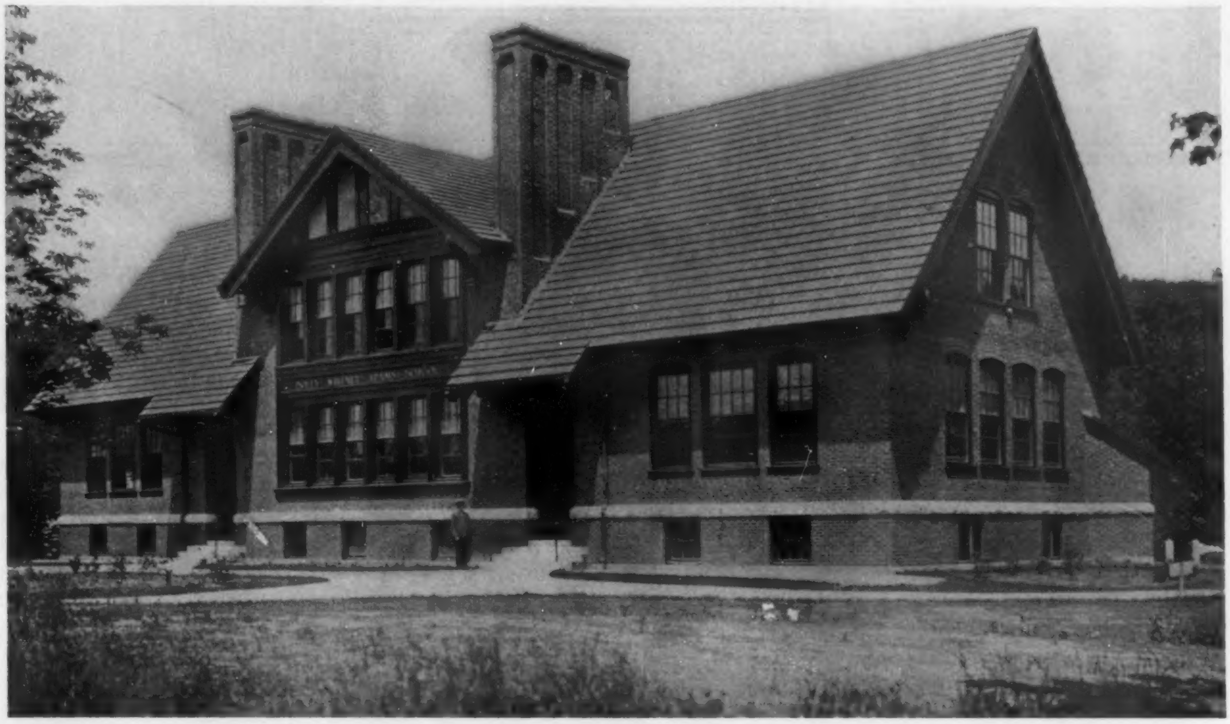


FIG. 5, DOLLY WHITNEY ADAMS MEMORIAL SCHOOL, ASHBURNHAM, MASS. MESSRS. COOPER & BAILEY, ARCHITECTS

THE PLANNING OF SCHOOL HOUSES

BY FRANK IRVING COOPER

EVERY architect entrusted with the planning of a school building is confronted with the problem of satisfying the citizens in regard to the appearance of the building, of satisfying them that it shall meet the needs of the educators, and that it shall be so permanently and sanely constructed that its maintenance will not be a burden to the taxpayer.

These results are difficult to secure, far more difficult, too, when the architect is selected by competition. The architect should be chosen even before the site is decided upon, as frequently the site chosen makes a satisfactory building almost impossible.

The determining factors in the size and style of the school building are the site, the appropriation, and the number and grade of the pupils to be accommodated. Knowing these, the architect is prepared to lay out plans for any particular building.

The direction from which the pupils come, the number of pupils to be accommodated, and the position of the playground determine the entrances of the building.

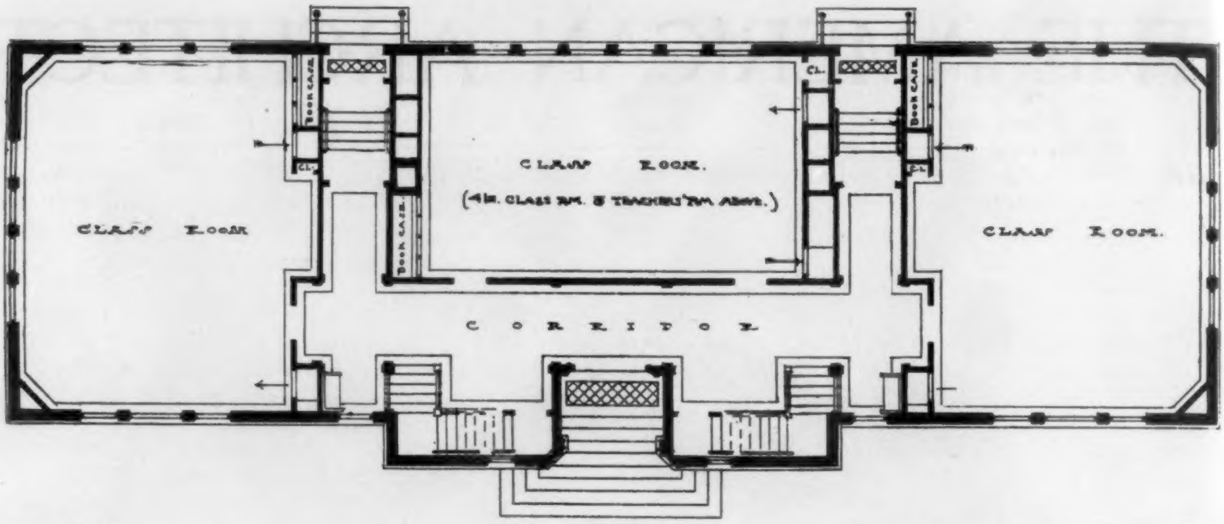
The size of the building and the entrances having been determined, the character and layout of the building further depend upon whether it is to be extended or compact.

A compact building is one in which the building and its parts occupies the minimum amount of space. (See illustration No. 2.) When the grounds and the available funds allow more ample proportions the plan of the building may be extended. (See illustration No. 4.)

The skeleton of each building consists of its main halls and corridors. There are three types of corridors.

The straight line corridor is the simplest type. Illustration No. 2, Woodbridge School, Newbury, Mass., and illustration No. 4, the Ames School, South Easton, Mass., show schools based on this type of corridor.

The ell (L) corridor is the next type. Fig. 6, the Dolly Whitney Adams School, Ashburnham, Mass., represents school houses having this type of corridor.



FLOOR PLAN FIG. 6 DOLLY WHITNEY ADAMS MEMORIAL SCHOOL

The T corridor is shown in illustration No. 8, the Colt Memorial High School, at Bristol, R. I.

All schemes for corridors may be resolved into one of these three types.

Whenever possible it is best to use the simplest form, even a modification of this form is better than a more complex form.

Illustration No. 10, the Malden High School, Malden, Mass., shows an extended building in which a modified form of the T corridor has been used.

When the skeleton has been decided upon, the arrangement of the rooms is settled to a certain extent, the positions of the stairways are determined with consideration for safety in case of fire, convenience in going from floor to floor, and comparative value of floor space.

If there are to be large or especially important rooms such as assembly hall, gymnasium, large study room, laboratories, lecture rooms, drawing rooms, manual training rooms, boiler room or sanitaries, they should receive the architect's next attention, and any special condition in regard to any of them must be considered.

Then follows the distribution of the general rooms, class and recitation rooms, wardrobes, library and store rooms.

WOODBRIDGE SCHOOL, NEWBURY, MASS. FIG. 1 MESSRS. COOPER & BAILEY, ARCHITECTS

All rooms to be used for school purposes must be supplied with adequate natural light; no pupil should be seated more than twenty feet from the source of light. There are two good methods for introducing natural light, a long, narrow room may have sufficient window surface on a long side, or a broader room may have window surface on two sides. Light should come over the left shoulder of each pupil.

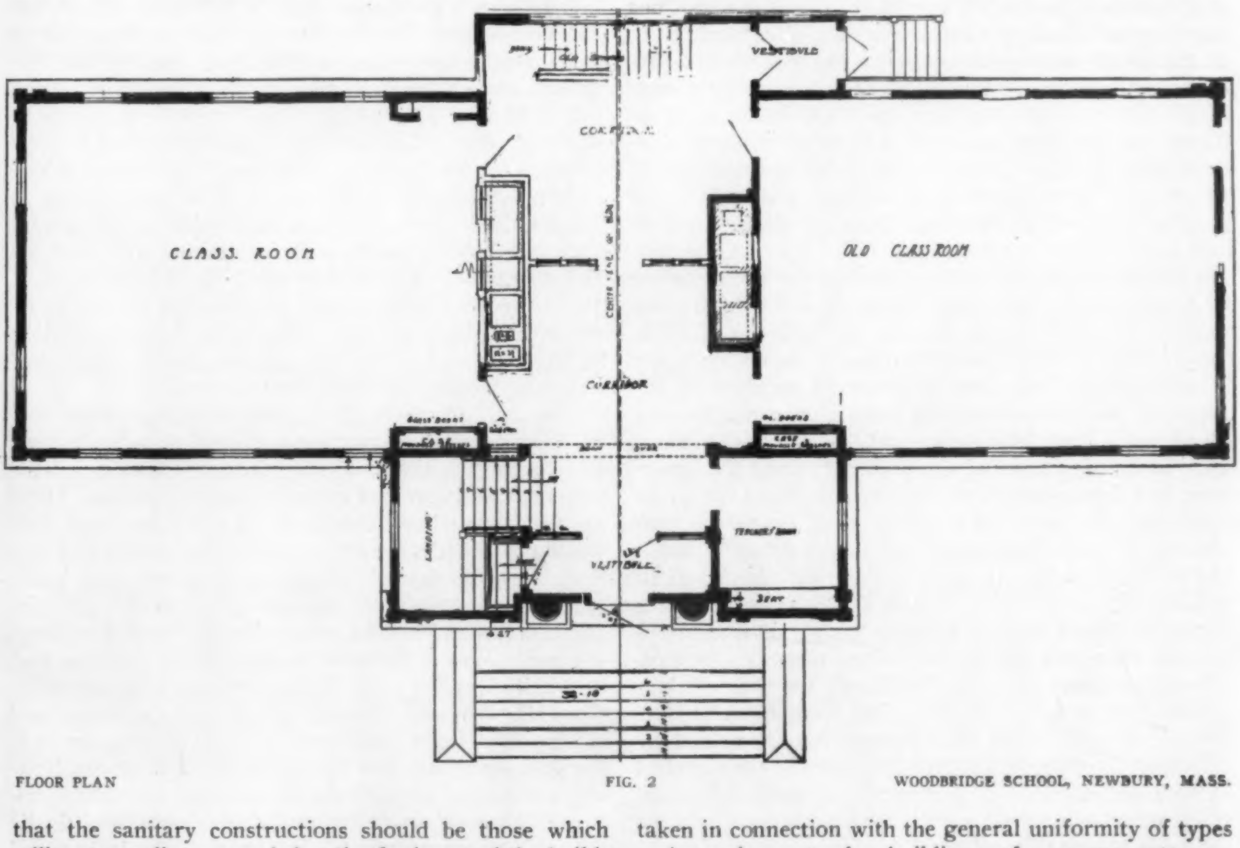
The system by which the building is to be heated and ventilated is practically settled by the appropriation, and the size and arrangement of the building.

The laws of some States lay out the system and determine the results to be obtained. In all cases a modern system which will secure proper results should be employed. The simple systems are entirely adequate when the buildings are small and compact.

Abundant quantities of warmed fresh air should be introduced through ducts to each schoolroom, and care must be taken that the ducts are of sufficient area and directness for passing the required amount. Ducts should also be provided for removing the vitiated air.

All modern school buildings should have a system of telephones, electric clocks and signals as aids to administration.

An architect who intends that his school buildings shall be successful must constantly keep in mind the requirements of the teachers and pupils who are to use the building; he must remember that it must be so constructed as to safeguard their lives against fire or panic; that the sanitary constructions should be those which will prevent disease; and that the final cost of the building should never exceed the amount placed at the architect's disposal.



FLOOR PLAN FIG. 2 WOODBRIDGE SCHOOL, NEWBURY, MASS.

CONSIDERATION IN SCHOOL HOUSE DESIGN. BY A. D. F. HAMLIN, PROFESSOR OF ARCHITECTURE, COLUMBIA UNIVERSITY.

The data for the designing of public school buildings have been more completely standardized than for any other type of structure, except the American public library. The public school concerns more intimately and directly a larger number of persons than any other class of public edifices, and since its design may affect for better or for worse not only the educational work and administration of the school but the health and happiness and even the morals of the pupils, the principles which should control its design have been made the subject of special study for many years past by the health authorities, as well as by the educational boards of all the more highly civilized countries and communities. In most states and cities the conclusions of the experts in sanitation and in school administration have been embodied in legislative acts and municipal building codes; and while these vary widely in the minuteness of their specifications and the severity of their restrictions, they are generally in substantial agreement as to certain fundamentals which have become commonplaces of principle among school experts of all classes, while the more detailed and minute of these codes represent the most advanced teachings alike of the sanitarians and the educators.

This careful formulation of the data of school design taken in connection with the general uniformity of types and requirements for buildings of any one category, makes the problem of school design comparatively easy for the architect, so far as general plan and form are

AMES SCHOOL, SOUTH EASTON, MASS. FIG. 3 MESSRS. COOPER & BAILEY, ARCHITECTS

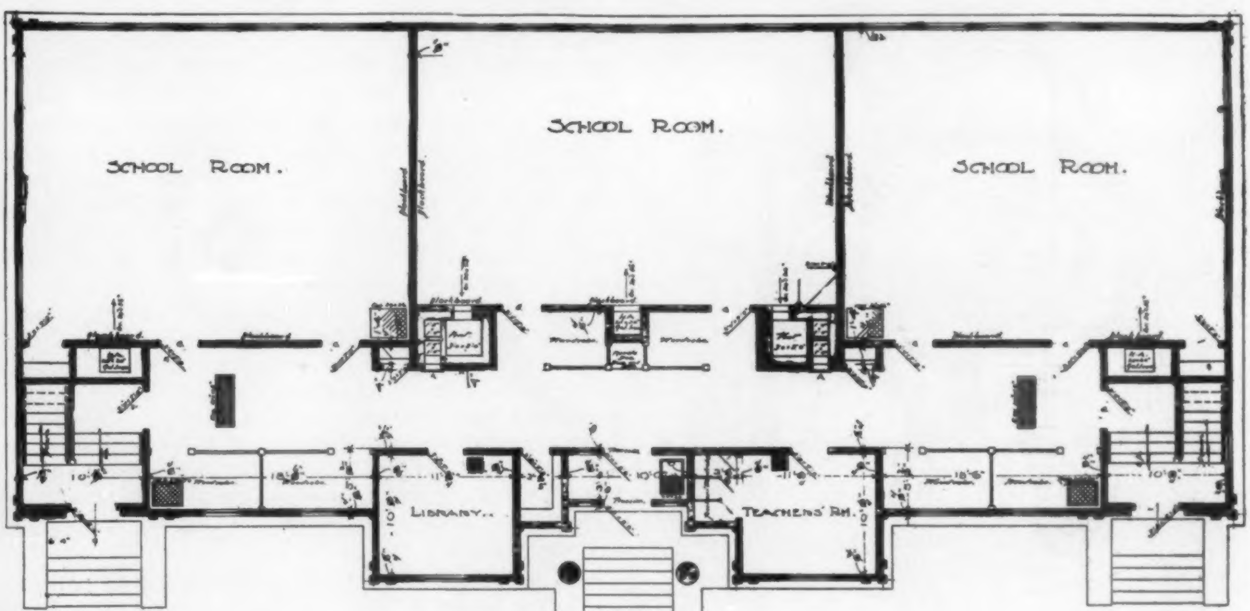
concerned. By so much the more, however, does this give him the opportunity, and thereby impose upon him the duty, of devoting abundant time and careful study to the details and execution of the design, which is all the more imperative when one reflects how large a span of the life of a community is spent within the walls of its schools, and how important it is to surround its children with the most perfect environment for their hours of study. The schoolhouses of any community are gauges of its enlightenment. They should be the best and most carefully constructed buildings it possesses: not the most splendid and ornate, but the most perfect in design and complete and thorough in execution and equipment. This is, as anyone may see for himself, very far from being generally the case, and wherever a school building falls short of this high standard of excellence, some one—or the whole community—has blundered. Such falling short may be due to the ignorance or incompetence of the architect, or to the ignorance and incompetence of the School Board, or to an inefficient city or county government, or to the parsimony and shortsightedness of the community itself; but all these causes are phases of blundering, private or public. It is rare indeed that the inferiority of the school architecture of a town or county is due to deliberate fault and corruption. Even where corrupt officials have made the school buildings the prey of their political or financial cupidity, they have done so only because the public and the educators have been careless or stupid, in other words have blundered in their control of their own affairs. As a general rule the people mean to be generous to their schools, and it requires only the diffusion among them of correct information on the subject to secure from them all that is necessary for the erection of suitable and creditable school edifices. In this work of education the architects can and should rightly take a prominent part, and if they will always and everywhere stand for the highest excellence in all that pertains to school architecture, the national reproach of our backwardness in this branch of design will before long be wholly wiped out. It ought to be said that the last fifteen years have witnessed a great advance in the average quality of American school buildings, and that in the larger cities, and notably in Boston, New York, Chicago and Saint Louis, a very high standard of design and construction has been set and maintained by such men as E. M. Wheelwright, C. B. J. Snyder, Dwight Heald Perkins and W. B. Ittner, respectively, and in many other cities by conscientious architects less widely known only because they have had less conspicuous and extensive opportunities.

The chief elements of the schoolhouse problem may be divided into those relating to planning, to equipment, and to construction. The controlling elements of the plan are the classrooms and the communications. These are fundamental and universal; all else is in a way subsidiary to them. Assembly halls, laboratories and studios, cloakrooms and toilets, gymnasiums and baths, teachers' rooms, offices and reception rooms, libraries and cabinets and lunch-rooms, subserve in various ways the work done in the class-rooms. Many of these may be wholly wanting; only the larger high schools contain them all. The communications comprise entrances, corridors, halls, stairs and elevators. The chief elements in the equipment are, first the apparatus or plant for heating, ventilating and lighting the building, then the furniture of the various rooms and departments, and finally the sanitary arrangements—lavatories, baths, lockers and plumbing. On the side of construction the chief elements of the problem relate to materials, especially to the question of the exclusive or partial use of fireproof or noncombustible materials.

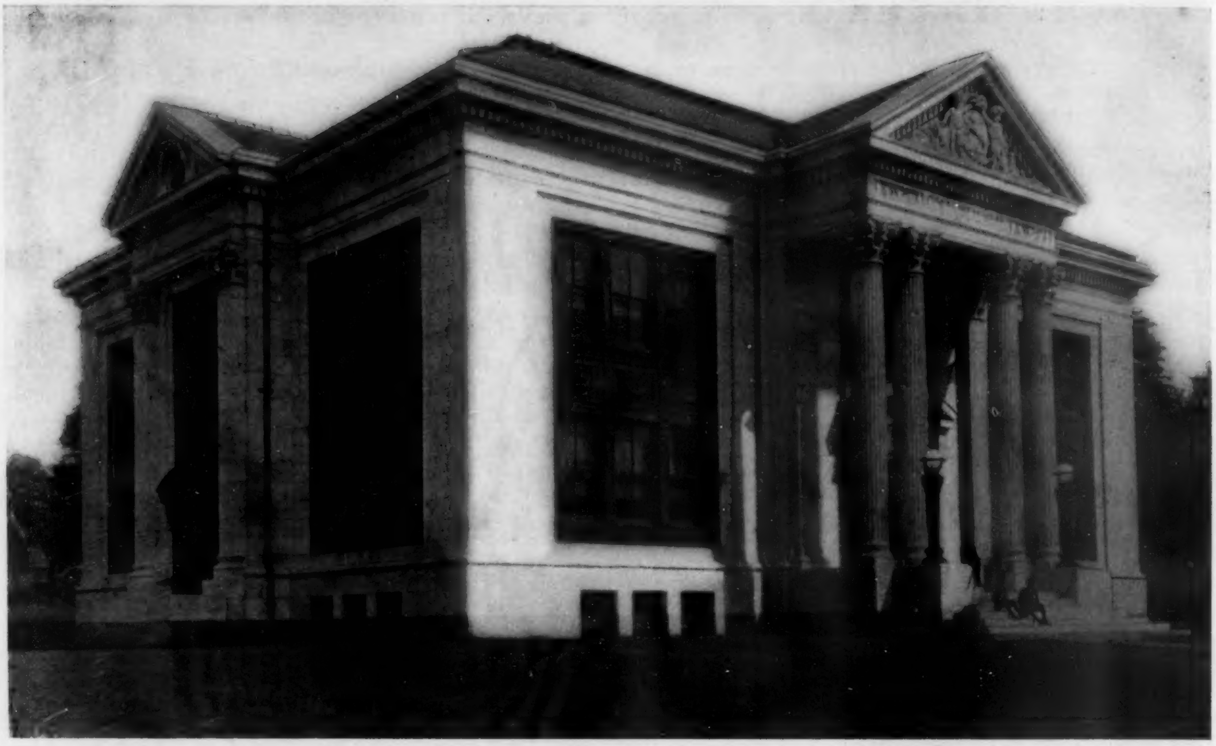
On all these elements of the problem more or less positive opinions have been pronounced by competent technical authorities, both in Europe and America. In reaching these conclusions there has been general co-operation between the educators and the medical men, and on all the fundamental questions involved there is substantial unanimity. As to details there is wide divergence, and practice varies widely, not only as between European and American schools, but in Europe itself, and still more widely in America. The differences are, however, greater in seeming than in reality, and are chiefly due to different educational systems and methods. The variation is greatest in the United States because we have no central or imperial authority stamping its informal seal upon all our schools. While our own democratic principle of local self-government lends itself sometimes to local inefficiency, it stimulates initiative, and gives larger scope for the working out of new or special problems. The very first thing, therefore, which the young architect needs to do in handling a schoolhouse problem, is to familiarize himself with the schools themselves; with the educational system and organization of the place, its methods and its aims, and with the details of the work of the schools, particularly of the grades for which the new building is required. Thus the question of cloak-rooms must depend upon the regulations in force for the arrival and departure of the pupils; and an assembly room, which is used but once a week or once a month, may be tolerated on an upper floor, to which it would be unkind and disturbing to require the pupils to climb twice a day. In some schools the pupils remain in their class-rooms while the teachers rotate from one to another room and division; in others the pupils pass from room to room at each recitation period. Some schools provide gymnasiums, lockers and baths, under constant supervision from basement attendants, others have none. A boys' high school must be differently planned from a mixed high school, and so on.

I propose to sum up very briefly some of the leading points on which the best modern American practice has reached fair uniformity; and then to note some of the problems which still await final solution. No doubt much of what follows will be absolutely commonplace to many of the readers of the ARCHITECT, but it may be helpful at least to some of the younger practitioners, as well as to educators and laymen who have to do with school buildings.

CLASS-ROOMS. The class-room is the fundamental unit of the schoolhouse design. In American practice it is distinguished on the one hand from the recitation room, which has only chairs or settees for the pupils and is used, as its name implies, only for recitations (or sometimes also for lectures and dictation exercises); and on the other from the general study room, which is found more frequently in Europe than with us, and in which a number of classes, aggregating a hundred or two of pupils, spend the assigned hours of study between recitations. The normal American class-room accommodates from 30 to 50 (or rarely up to 60) pupils at fixed desks. In some special or private schools the number in a class-room is as low as 25; but economy of administration makes it desirable that the number should not fall below 30 to 35, while efficiency demands that it should not greatly or often exceed 40. Each pupil has a desk, and the total floor area should not be less than 18 square feet per pupil, with at least 216 cubic feet as the minimum cubic volume per pupil. Twenty square feet and 260 feet, respectively, are better figures for all except the lower grades attended by small children. A slightly oblong room, with the teacher's desk at one end, is the best shape. Thus for a 40-desk class-room in an upper-grade grammar school or high school, a room 32 by 25 feet, 13 or 14 feet high in the clear, would represent excellent practice. One ample door, 40 to 44



FLOOR PLAN FIG. 4 AMES SCHOOL, SOUTH EASTON, MASS.



COLT MEMORIAL HIGH SCHOOL, BRISTOL, R. I. FIG. 7 MESSRS. COOPER & BAILEY, ARCHITECTS

inches wide, should be provided near the teacher's end of the room, alike for entrance and exit. Such a door is wide enough to allow two files to pass in or out at once, and is under the teacher's eye and full control. A wide aisle, 3½ to 5 feet wide, should skirt the room next the corridor-wall, and a narrower aisle next the window-wall and the rear end of the room. Six rows of seven desks each from front to rear can be conveniently placed in a room of the above dimensions. More than seven or eight desks in a row place the rearmost pupils too far from the teacher and the blackboard, so that the length is best not much over 32 to 36 feet; and it is undesirable, as we shall see later, to make the class-room more than 25 feet wide. Widths of from 27 to 30 feet are common in the United States, but do not represent the ideal practice.

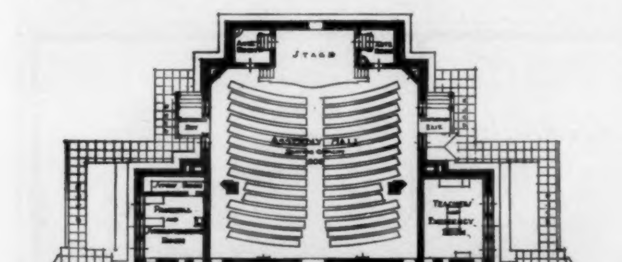


FIG. 9. PLAN COLT MEMORIAL SCHOOL, BRISTOL, R. I.

COMMUNICATIONS. It is customary in our larger school buildings and in all buildings for mixed schools, to provide at least three entrances. One for the public, and one each for the two sexes. The location and designing of these do not always receive the study they demand, with reference to the convenience and comfort of those who are to use them, as well as to their easy supervision. Outside and unsheltered steps should be avoided as far as possible, as being dangerous and troublesome in icy and inclement weather. Whether the pupils should enter the basement and then go up, or enter the main floor and thence go down, or enter by a "split level" door, going either up or down a half-story as may be required, depends partly on topographical conditions and partly on the custom and administration of the school. A very common mistake is the failure to provide at each entrance a suitable lobby, with inner doors, so as to interpose two sets of doors between the interior of the building and the outer air. When this blunder occurs, the hideous excrescence of storm doors becomes a necessary corrective during the Winter months.

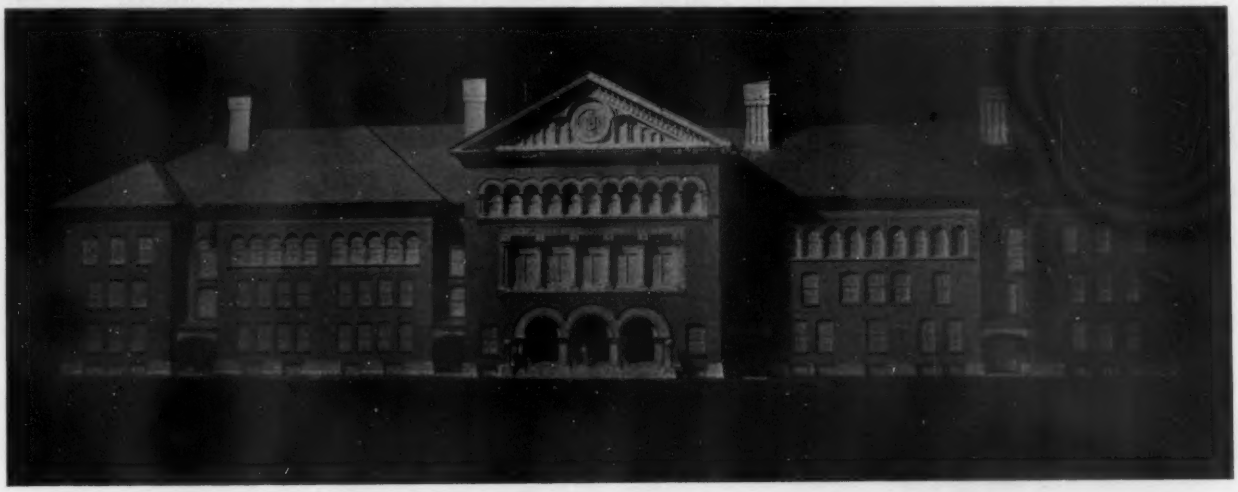
Main corridors should be never less than 8 feet wide, and in the larger buildings 10 feet should be the minimum width. It is, however, wasteful to make them more than 12 to 14 feet wide, except at points near the heads or feet of stairways, or at entrances or exits, and other points of probable congestion, where the width should be suitably expanded. Minor corridors may be 6 or 8 feet wide. It goes without saying that corridors should be as straight and well-lighted as possible.

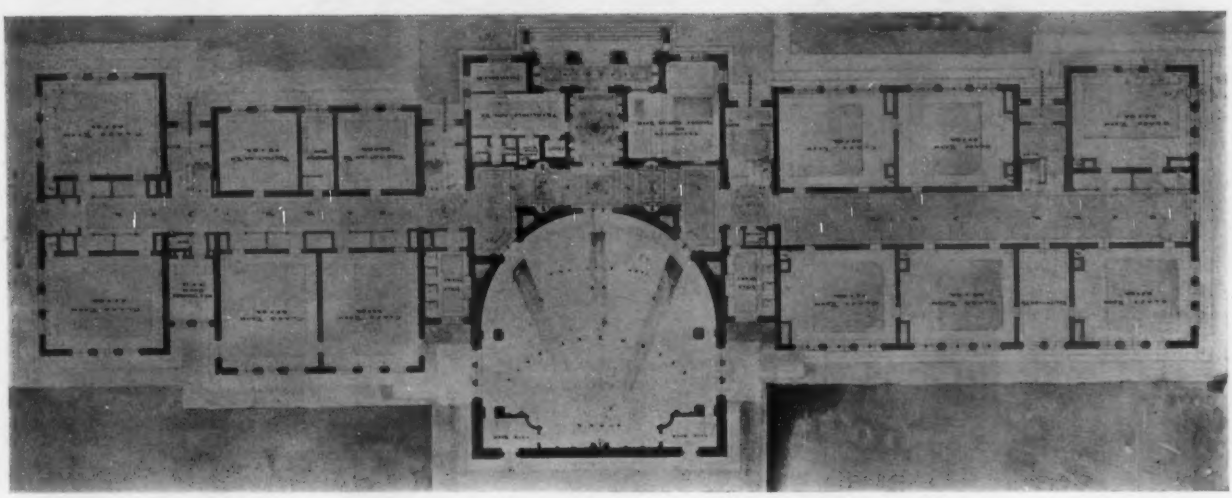
The stairways should be never less than two in number, complete from top to bottom of the building, and should always be sufficient to empty the school in three minutes. They should be so placed as to be within the shortest possible reach of the largest number of class-rooms; for example, so that no class-room door shall be more than (say) 40 feet distant from a flight. They should moreover be located at conspicuous points in the plan, where there position is clearly announced by the architectural features of the interior. Their width should be such as to allow two files of pupils to ascend or descend, with sufficient intervening space to permit of the passage of one or more persons between them. A width of 4½ feet per run, which is found in many schoolhouses, is insufficient for this; 5 feet is the minimum, and 5½ feet is better. Six feet is the maximum width allowable; any greater width than this is wasteful. There should always be two runs and a single wide landing between each floor and the next; never three runs with two landings, if it can possibly be avoided; and never a single straight run from one story to the next. The two runs should be in reverse directions. There should, therefore, be no open well between the runs. It is sometimes recommended to divide the staircases from the corridors by wire-glass partitions and safety-doors, but this is, in my judgment, a precaution of doubtful utility, if not actually a source of possible danger. The stairs should, of course, be well lighted by windows.

(To be continued)

Mr. Anthony Ittner, of St. Louis, Chairman of the Committee on Industrial Education, at a recent meeting of the National Association of Manufacturers held in New York, in discussing the subject of Industrial Education stated as follows:

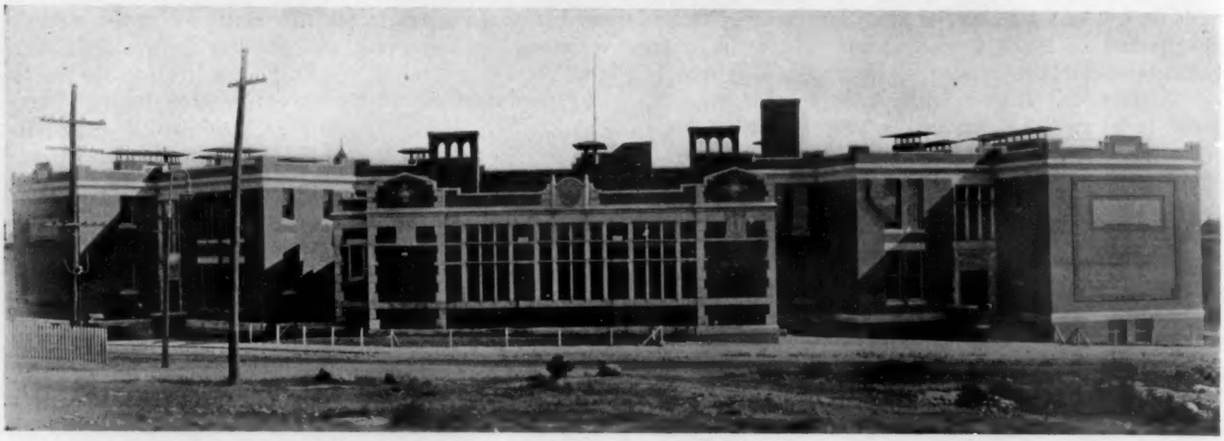
"Industrial education has taken a firm and lasting hold upon the people of this country, and we are pleased to come before you with the encouraging news that its progress and growth during the past year have been greater than during the year previous."





FIGS. 9 AND 10

ELEVATION AND PLAN, MALDEN HIGH SCHOOL, MALDEN — MESSRS. COOPER & BAILEY, ARCHITECTS



BISHOP CHEVERUS SCHOOL, EAST BOSTON, MASS. MESSRS. BRAINERD & LEEDS, ARCHITECTS

TWO EXAMPLES OF ECONOMICAL FIRE-PROOFING IN SCHOOLHOUSES

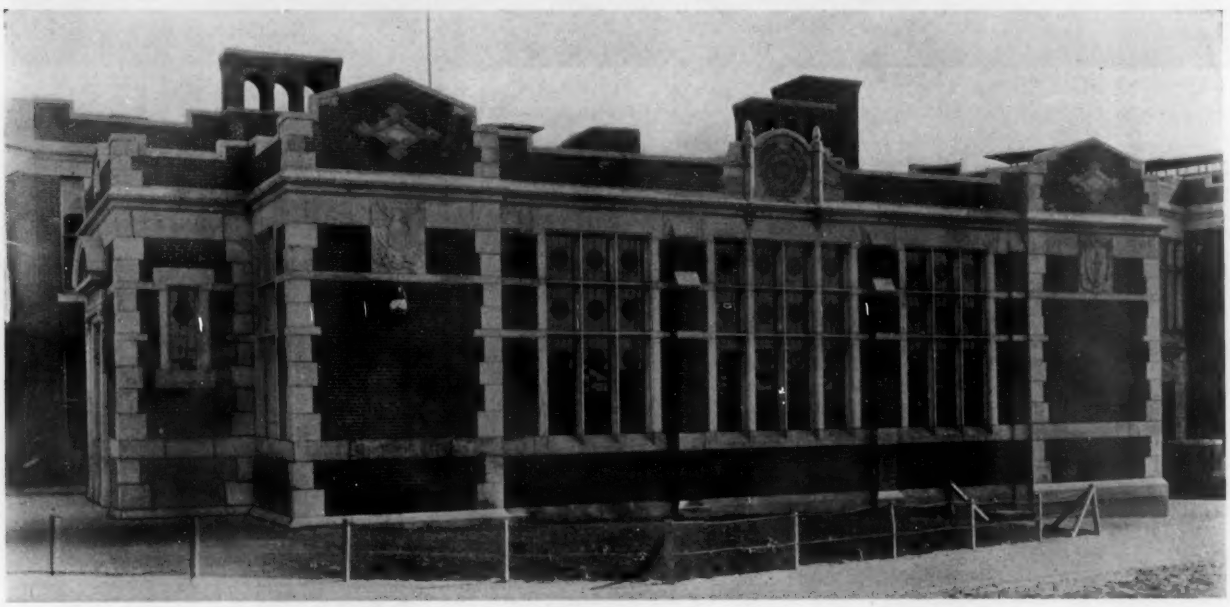
BY WILLIAM H. BRAINERD.

The first was the *Daniels* Grammar School for the city of Malden. This contains 14 classrooms and assembly hall with the usual accessories. The buildings previously erected by this city had their floors and interior walls of wood, and financial conditions were such that they were unwilling to materially increase the expense of the construction.

The only space available for the hall, within our means, seemed to be in the roof.

This gathering of the entire school at the top of the building demanded absolute safety of exit. This put before me the problem of how to gain this without large increase in cost. The first move was to use brick walls for all main partitions. It was found that where these were incorporated with the heat and vent flues, so that they replaced galvanized ducts and the furrings about them as well as a stud bearing partition, the cost was actually reduced; furthermore, the brickwork could be carried up to form the top of the vent flues in place of the metal frequently used. Such tops have two advantages over metal, greater permanence and less cost. The change from wood to brick in walls without flues did somewhat increase cost, but did away with all necessity of buttresses for exterior walls or of interior bracing to stiffen the building. The remaining stud partitions were few and were set on strips of metal on top of the floors or were filled with brick where they passed through the floors. This divided the building into six brick boxes and eliminated all vertical concealed spaces where fire might spread. Plastering wherever possible was applied directly to the brickwork. Exterior walls were lined with hollow brick and coated with asphaltic paint before plastering.

To remove the most frequent source of fire originating from within the building, or being communicated to it, the boilers were placed in a room entirely outside the



BISHOP CHEVERUS SCHOOL, EAST BOSTON, MASS. MESSRS. BRAINERD & LEEDS, ARCHITECTS walls of the building and covered with a roof of reinforced concrete, and the single connecting opening protected with a tinned fire door. This, too, added a little to the cost, but increased the playroom space of basement and kept the building free from all dust arising from fuel or ashes. These features greatly reduced the chances of origin and spread of fire, but the floors of corridors and exits were still in danger from any fires which might start in closets or similar places beneath them. To obviate this, we decided to make all corridor floors of reinforced concrete spanning from brick wall to brick wall with a finished surface of magnesium cement carried up the walls six inches to form a sanitary base.

All stairs were of iron. All exits were now enclosed with incombustible floors and walls, and the woodwork in them reduced to the doors with their frames and wardrobe posts and rails, so that we bebelieved them to absolutely safe. The additional cost of the concrete construction and cement floors for corridors over hard pine joist with maple upper floors, was about $1,500. To partially compensate for the extra expenses, we omitted the high hipped roofs over the end wings where space was not needed for rooms. This saved many cubic feet of construction and permitted the use of a roof covering—more economical both in first cost and in maintenance. Besides reducing cost, this did away with an open attic where trash might accumulate increasing the fire risk. It also gave an opportunity to express the assembly hall architecturally. The great gable windows, buttressed by the grouped vent shafts, have proved to be the feature of the building.

The lighting of the hall by the large windows high up on the sides, is one of the most desirable forms of illumination, similar in effect to a clearstory in a church, or a monitor in a mill.

The exterior of the building is of selected red sand struck brick laid with gray joints and trimmed with Indiana limestone and gray brick. The building in general is planned to fill the requirements of the Boston Schoolhouse Department in window area, finish and fittings. The interior finish is of chestnut. Floors of rooms are maple. Each classroom has exposure to sun during some portion of the day, is 26 x 32, and is supplied with slate blackboards on three sides—contains a bookcase and a teacher's closet. A wardrobe for each sex is provided with every classroom.

Heating and Ventilation.—The system for steam is low pressure with gravity return. The system for air is gravity. The ventilation is stimulated by aspirating coils placed in the vent flues. A small heater is provided to heat these and to provide hot water for baths and bowls when the main boilers are not in operation. There are two horizontal return tubular boilers, either of which will handle the building in ordinary winter weather.

Each classroom is warmed by direct radiation and has an air supply of 30 cubic feet a minute per occupant brought through brick heating chambers with pin radiators in basement.

The temperature is controlled by hand mixing dampers operated by the teachers.

The first story corridors have foot warmers. Teachers' and Master's rooms are heated by direct radiation.

Toilet Ventilation.—All closets have seat vents of extra size, these, with the space behind urinal, are connected to separate heated flues which extend to the top of main stacks. Each basement toilet and bathroom has its separate vent flue heated with an aspirating coil.

Electric Construction.—The building has an interior telephone system of 16 stations, a system of program bells under control of a master clock; wiring for a system of electric clocks, and wiring for electric lights throughout.

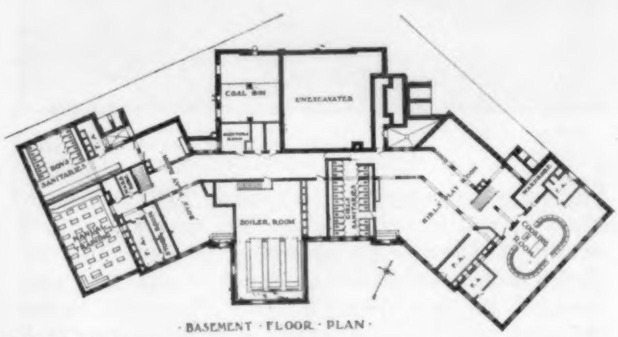
Gas Piping is installed for emergency lighting in corridors and assembly hall.

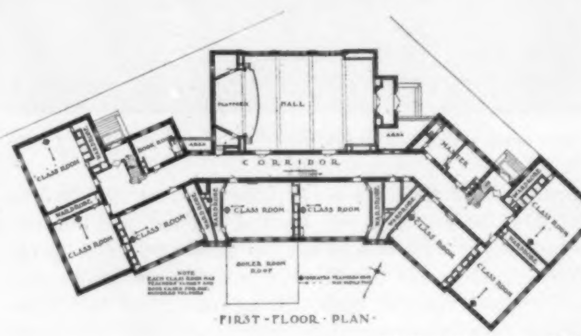
The 14 classrooms each seat 56 pupils, or a total of 784. The cost per pupil was $100.18. The cost per cubic foot was 12.9 cents. This covers building, heating, plumbing and electric construction and includes the six shower baths for each sex. The total cubic contents of the building is 608,114 feet.

The second example is the *Bishop Cheverus* Schoolhouse, East Boston.

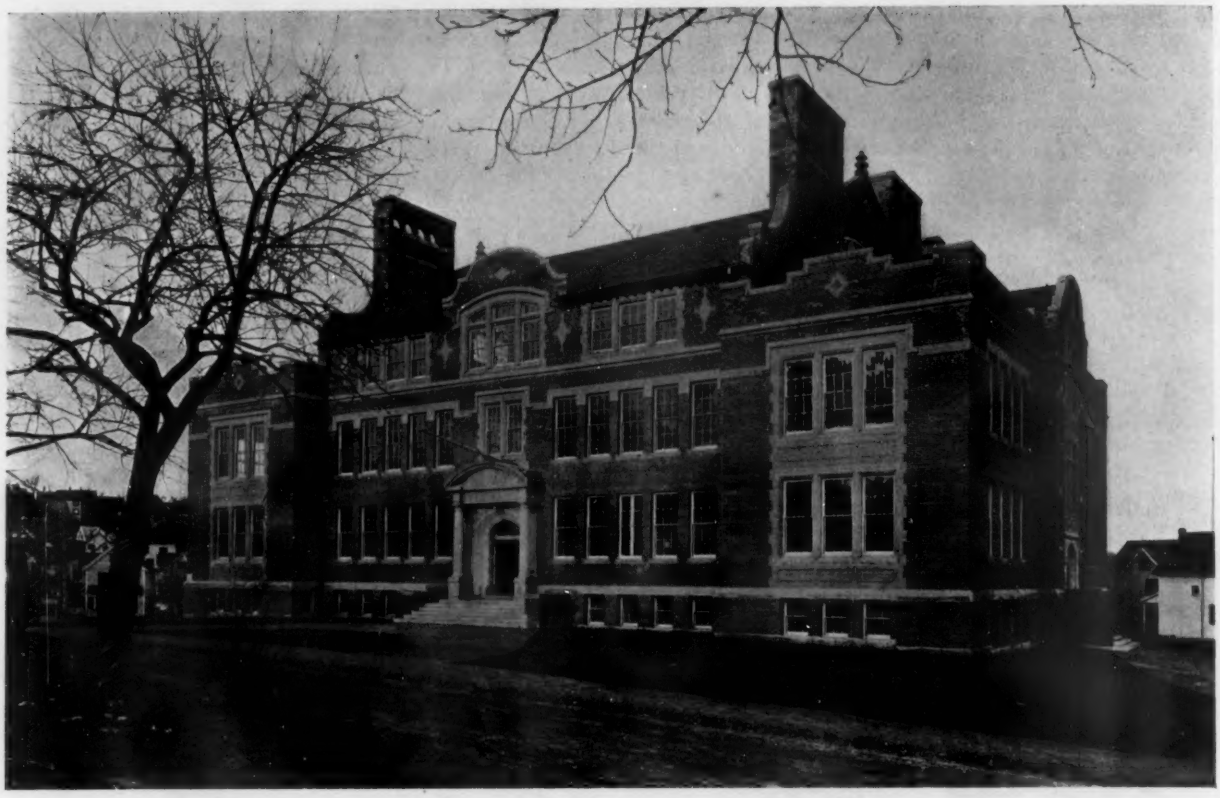
The following description is compiled from the Annual Report of The Schoolhouse Department of the City of Boston for 1908-09.

The Bishop Cheverus elementary school, upper (grammar) grades. This building is located on land surrounded by four streets in East Boston, and owing to the fact that it was a large lot, the Board felt justified in trying the experiment of an extended plan, with all the classrooms on the first or second floor, and with the assembly hall on the first floor immediately





FLOOR PLANS BISHOP CHEVERUS SCHOOL

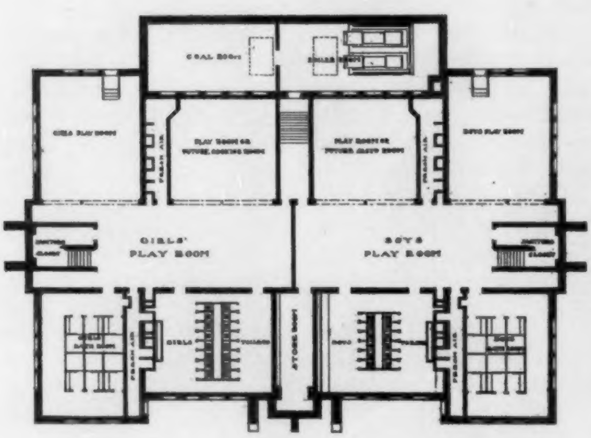


DANIELS SCHOOL, MALDEN, MASS. MESSRS. BRAINERD & LEEDS, ARCHITECTS

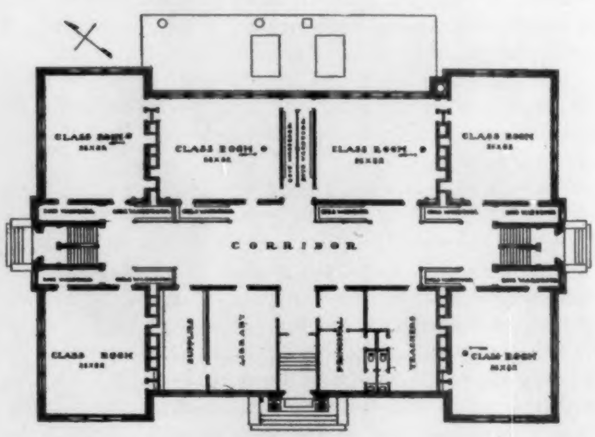
accessible from the outside without entering the building. The boilers also are located outside the line of the building. The rooms are so arranged as to give sunny exposure for all the classrooms, and, notwithstanding the extended plan, the figures prove that this building is as economical as any of its size and type that has been erected by the Board.

The basement contains the playrooms, toilet rooms, manual training room and cooking room. There are eight classrooms and an assembly hall on the first floor and eight classrooms on the second floor, all of the standard 23 x 29 dimensions, to seat 44 pupils.

Heating and Ventilation.—System: The system for steam in this building will be low pressure, gravity return. The system for air will be gravity. The ventilation will be stimulated by means of aspirating coils placed in the vent flues. Boilers: There will be two horizontal return tubular boilers of 78 horsepower each, 60 inches in diameter and 18 feet 4 inches long, containing 72 3-inch tubes 17 feet. long. Radiation: There will be a total of 12,241 square feet of radiating surface. Classrooms will be warmed by indirect pin radiators generally placed in brick heating chambers in the basement. Foot warmers encased in galvanized



BASEMENT FLOOR PLAN



FIRST FLOOR PLAN

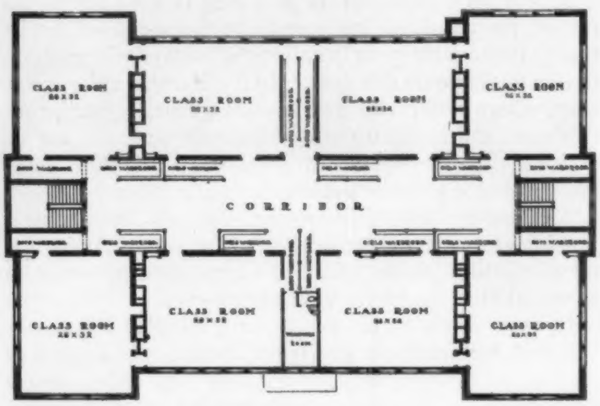
DANIELS SCHOOL MALDEN, MASS.

iron and suspended from the basement ceiling are provided for the first floor corridor. Direct radiation will be placed in the wardrobes, masters' and teachers' rooms and also in the basement playrooms and sanitaries. Temperature control: The temperature of the air entering the classrooms will be controlled by means of hand mixing dampers operated by the teachers. Fresh air will be supplied to the manual training and cooking rooms in the basement by two 24-inch propeller fans belted to electric motors.

Toilet Ventilation.—All water closets in the basement sanitaries will be provided with outlets for seat ventilation which will be connected together by means of galvanized iron ducts and run in two separate flues to the top of the main ventilators. Connection will also be made to the space back of the urinals. Ventilation will be assisted by aspirating coils placed in the main flues. The individual closets have similar seat vents.

Warm Air and Vent Flues.—These will be built of brick instead of galvanized iron as has been the former practice.

Electric System.—The building will be equipped with



DANIELS SCHOOL SECOND FLOOR PLAN MALDEN, MASS.

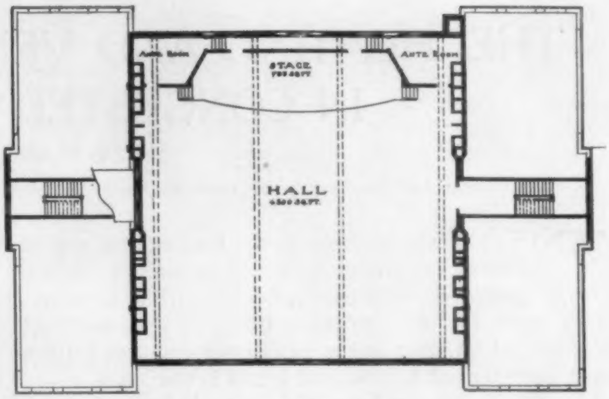
electric lights, a telephone system for interior communication, a system of electric clocks controlled by one master clock, a system of program bells also under control of the master clock, a combined local and auxiliary fire alarm system, and a projection lantern with reflectoscope attachment for the assembly hall.

The contracts are as follows:

General contract	$81,392
Heating contract	17,795
Plumbing contract	4,875
Electric contract	4,844
	$102,906

This building on the basis of a 16 room, upper elementary, with an assembly hall, was rated at 18 rooms, 30,000 cubic feet per room and 22 cents per cubic foot or $118,800. It has been let considerably below this amount and the cost per pupil will be in the neighborhood of $160.84. This was figured at a favorable market, and it is not likely that these prices will be readily duplicated.

The cost per pupil was fixed (See Report for 1906-07) at $174 to $192 for upper elementary (grammar grades).



DANIELS SCHOOL THIRD FLOOR PLAN MALDEN, MASS.

Here the cost per pupil in the upper elementary is $162, which is below the low limit for large buildings. The total cubic contents of the building is 544,000 feet. Cost per cubic foot, 19 cents.

NOTE.—The cost per pupil is reckoned on 40 pupils per classroom, the average use—not on 44 pupils per room the full seating capacity.

It is interesting to compare the results in this case with the averages of the Commissions work to date:

Total number of new buildings erected by Commission 1904-09	29
Total number of children accommodated, lower elementary	9,530
Total number of children accommodated, upper elementary	10,650
Average cost per pupil, lower elementary (primary)	$162.83
Average cost per pupil, upper elementary (grammar)	197.13

The results were attained in much the same manner as in the *Daniels* School.

The exterior is of selected sand struck brick with trim of Indiana limestone.

All ducts and bearing walls were made of brick. The exterior walls were lined with hollow brick and coated with asphaltic paint before plastering. The floor construction is of reinforced concrete. Floor beams are adapted to the spacing of ceiling lights and are left exposed. Corridors are spanned with plain slabs. The stairs are concrete with iron strings and balustrades. Classrooms and offices have a single matched maple floor nailed to screeds 16 inch o. c. The screeds were nailed to the stone concrete slabs and then filled flush with cinder concrete.

The structural slabs in the corridors and wardrobes are finished with a granolithic surface.

The floor of the assembly hall is battleship linoleum glued to the concrete. Flat roofs with parapets are used throughout. An interesting feature of the assembly hall is the medallions of the leaded glass window which give in proper colors the seals of the 46 States of the Union. The carved decorations of the façade of the hall are the Seal of the City of Boston at the center and on the end pavilions the Coats of Arms of the United States and the Commonwealth of Massachusetts.

THE HEATING AND VENTILATION OF SCHOOLS IN CONGESTED CITY DISTRICTS

By FRANK G. McCANN,

Member Am. Soc. Heating and Ventilating Engrs., Chief of Heating and Ventilating Division, Board of Education, New York

THE problems involved in the heating and ventilation of the school houses to be built in the congested districts of a great city, while in general very much the same as those found in the same style and size of building in the more open country, yet present some special features not found in the latter.

One of the principal special features is the exceedingly compact arrangement of plant made necessary by the massing of a large number of rooms on a small ground area.

The street floor in such a building is almost entirely given up to playrooms or auditorium (see Fig. 1), making it impracticable to use vertical heat flues from cellar to supply each individual room with fresh air. To obviate this difficulty we have adopted the system shown in Fig. 2, whereby all the fresh air for one story or a section of one story is brought up to ceiling of said story and there is distributed in furred space under ceiling of corridor with two inlets to each room. Each inlet in every room has a wire screen, and back of same in neck of room runout we place an adjustable diffuser (see Fig. 3), of which each blade can be separately set to give a uniform flow of air through all portions of the inlet at a velocity of about 200 feet per minute. This is too slow to cause drafts.

The cellar arrangement for above work is shown by Fig. 4.

The foul or vitiated air in our schools is removed from the classroom proper through wire screens in the several doors of the pupils' wardrobe, and therefrom through a wire mesh screen in end or top of wardrobe. The screen in end is made full height of wardrobe—7 feet—and no coat hooks are placed over same, so that clothes cannot prevent free discharge of vitiated air into the vent flues. This scheme obviates the need of steam coils in wardrobes, as the vitiated air is sufficient to thoroughly dry the clothing even in wet weather, and overheating of classrooms by coils in wardrobes is thus also prevented.

In this system the vent flues are usually run straight up through roof and are capped on top with special vent hoods having an aspirating effect. In some cases, where attic is used for lunch rooms or gymnasiums, to avoid interference of such vertical flues with the free floor space or to avoid the rather unsightly appearance in case of steep-pitched roofs, we gather the vent flues together under ceiling of top story in furred spaces and use exhaust fans to overcome the friction incidental to such long horizontal offsets.

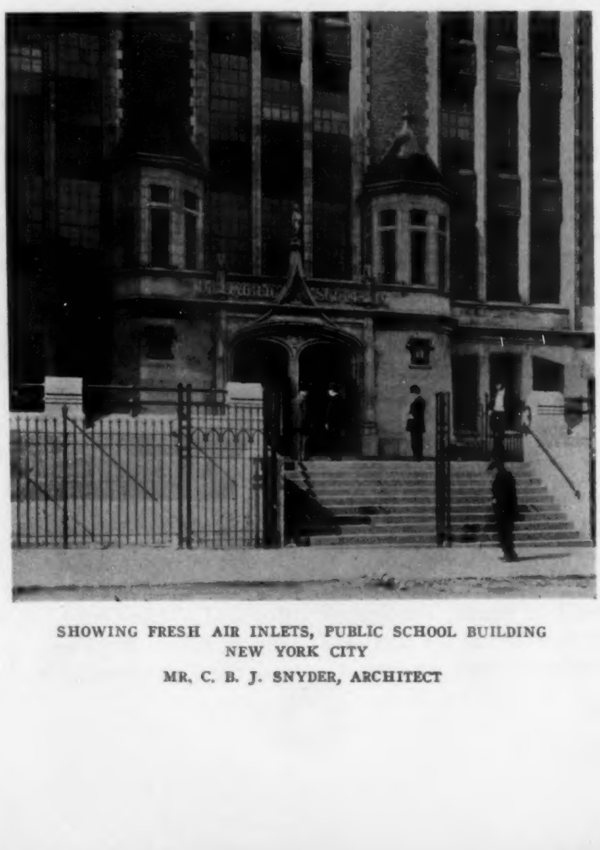
Another difficulty encountered in the design of the school in congested districts, and one of which the importance cannot be overestimated is the difficulty in obtaining pure air for ventilation.

In Western cities, where soft coal is used for steam plants, the all-pervading soot from the soft coal smoke makes it compulsory to install some form of air-washing device to eliminate this soot. In the Eastern cities, however, where anthracite coal is most generally used, soot is absent, and in clean surroundings air washers may be omitted without serious detriment to the plant if funds are not ample to include same.

The writer believes, however, that air washers and humidifiers will soon be demanded by good practice for all ventilating plants and urges their general adoption as essential to the health of the occupants.

In cases where no air washers are installed it is essential that the fresh air supply be taken from a point at least 25 feet above ground level in order to avoid the indrawing of street sweepings and other filth which the winds will often raise several feet into the air. It is also absolutely essential that the air supply be taken from a point where it will always be free from contamination by noxious gases emanating from toilet vents, smoke flues, etc.

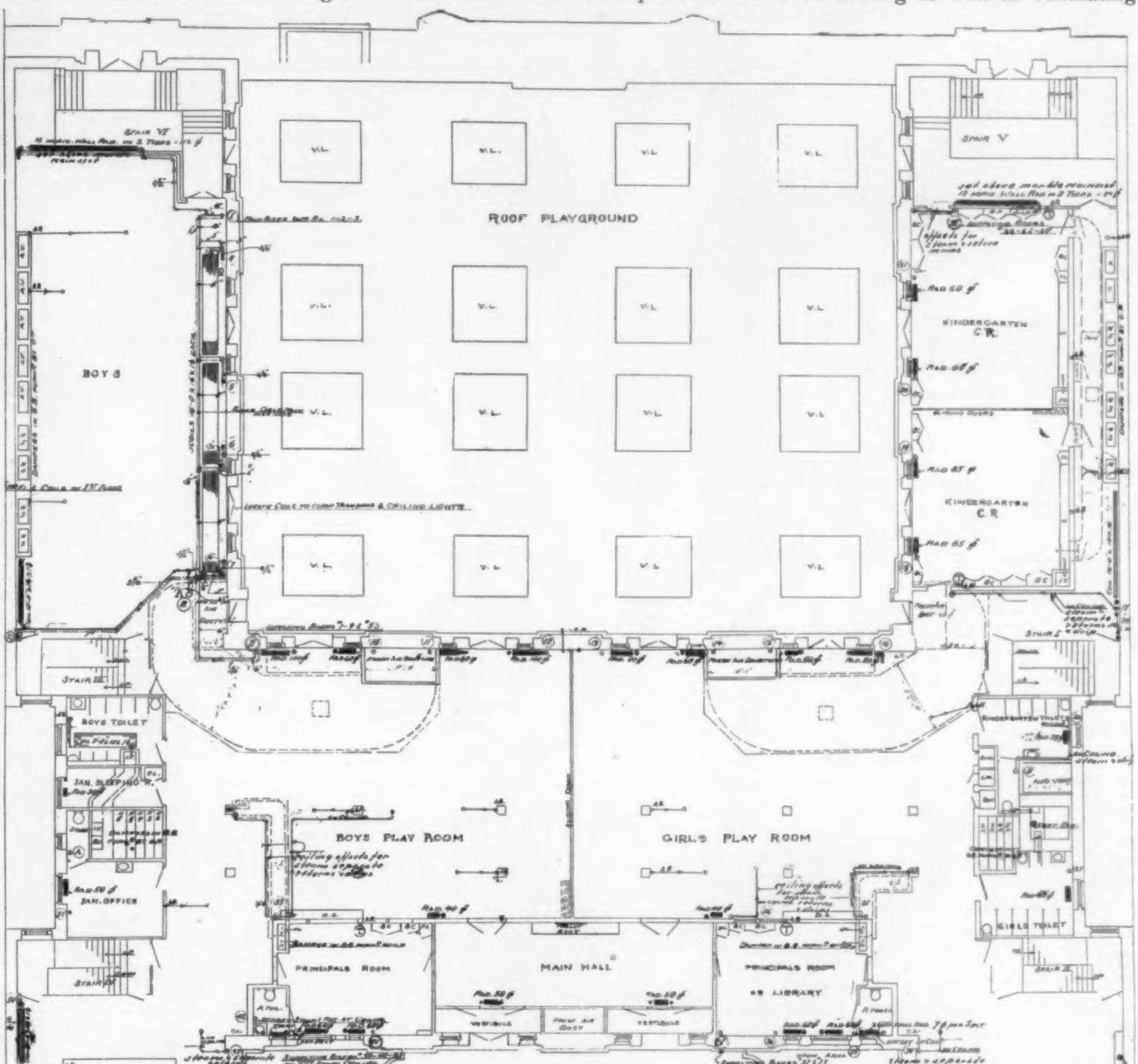
It is our practice, even where air washers are used, to draw our air from about mid height of the building, thus getting the air as pure and as free from contamination as possible. This can be done without detriment to the architectural ef-



SHOWING FRESH AIR INLETS, PUBLIC SCHOOL BUILDING
NEW YORK CITY
MR. C. B. J. SNYDER, ARCHITECT

fect, as is shown by Fig. 6. A typical arrangement of fresh air inlets, heating chambers, etc., for a large building is shown in Fig. 5.

In buildings of this character it is customary to use the auditoriums for holding assemblies, for study halls and for classes in music during school hours and for lectures, entertainments, mothers' meetings, etc., outside of school hours. This varied use of auditoriums makes necessary a separate blower, engine and heating chamber for heating and ventilating the auditorium independently from the rest of the building. For quick and effective heating as well as ventilating



FIRST FLOOR PLAN, PUBLIC SCHOOL 100, BOROUGH OF MANHATTAN, NEW YORK CITY MR. C. B. J. SNYDER, ARCHITECT

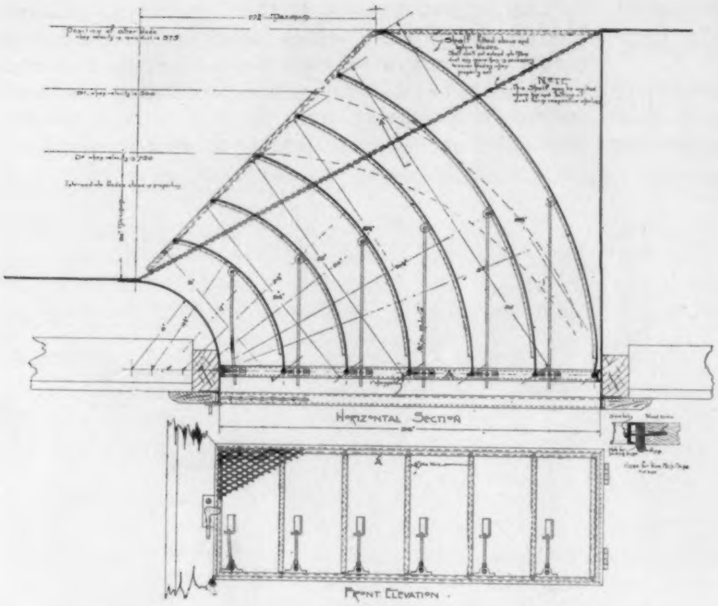


FIG. 2

of such a room there seems to be nothing superior to the hot-blast system with uptakes in front of windows (see Fig. 7) or under ceiling and under gallery (see Fig. 8) as best suits the case, with indirect surface forming reheaters at the base of each uptake and controlled by thermostats of which there must be enough, properly placed, to give a uniform temperature throughout the room (of course, the double-duct system may equally well be used if better suited to building conditions.)

The vents in such case should be through grilles in front of stage and through cast-iron registers in floor placed in several rows in aisles, so that all parts of room will be equally supplied with fresh air. Upward ventilation is not well adapted to such auditoriums, as they are usually less than 25 feet high, mostly being one story high, and the dirt brought in on shoes also militates against this system, even in high rooms, if floor registers are used. In very high auditoriums where permanently set opera chairs having special hollow legs can be used to admit a supply of fresh air at each seat, upward ventilation with a modification of the double-duct system is advisable and requires less air for satisfactory operation than would be needed for downward ventilation.

An item worthy of passing mention is the need for care in designing floor registers in order that the openings shall not be large enough to permit the entrance of the heels of ladies' and children's shoes, as a panic may be started by even so trivial an incident as that.

The temperature of all rooms, etc., and of the air supply, must, of course, be automatically controlled by the use of some system of temperature regulation, in order that the busy teachers may not need to divert their attention from their official duties to adjust heating appliances, which they naturally will not do until the conditions are intolerable. We also control the temperature at which the thermostats on our fresh-air ducts function, by means of a special thermostat placed out of doors, thus causing the temperature at which fresh air is supplied for ventilation to change to suit the outdoor conditions, and overheating is thereby obviated. The theory of this outdoor control is shown by Fig. 9.

It is generally considered the best practice to use blowers for supply of air at 65° to 75° Fahr. for ventilating purposes only, and to use direct radiators or coils placed under windows in classrooms for heating independently of the blowers. This system is valuable in that the heating surfaces are placed where they will most quickly and effectively counteract the draftiness and chilling effects of cold windows and walls and also that heat may be supplied without the use of the blowers after school hours in cold

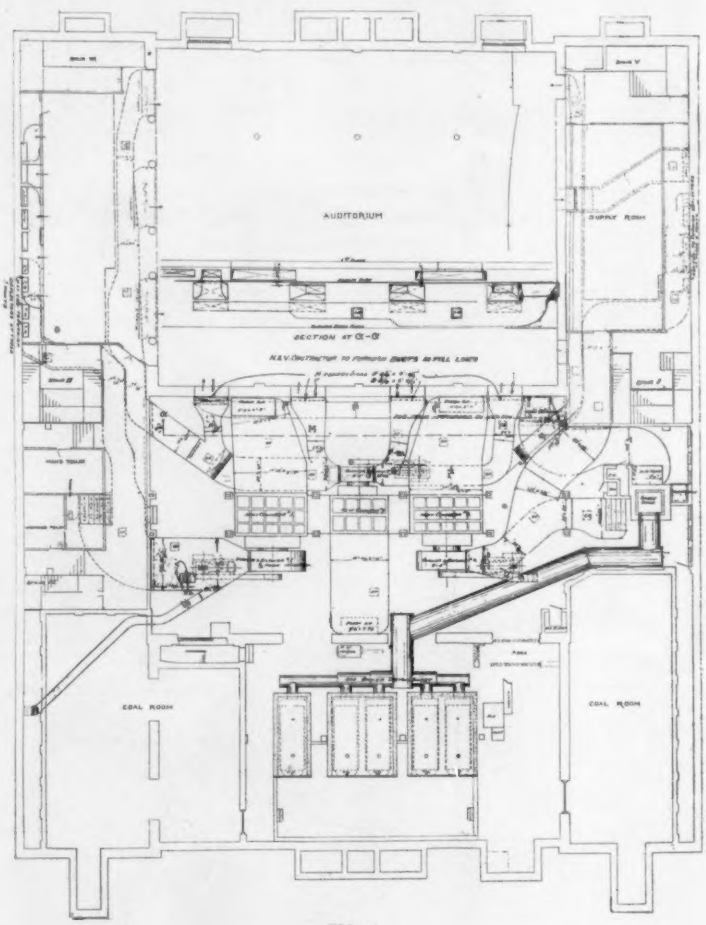
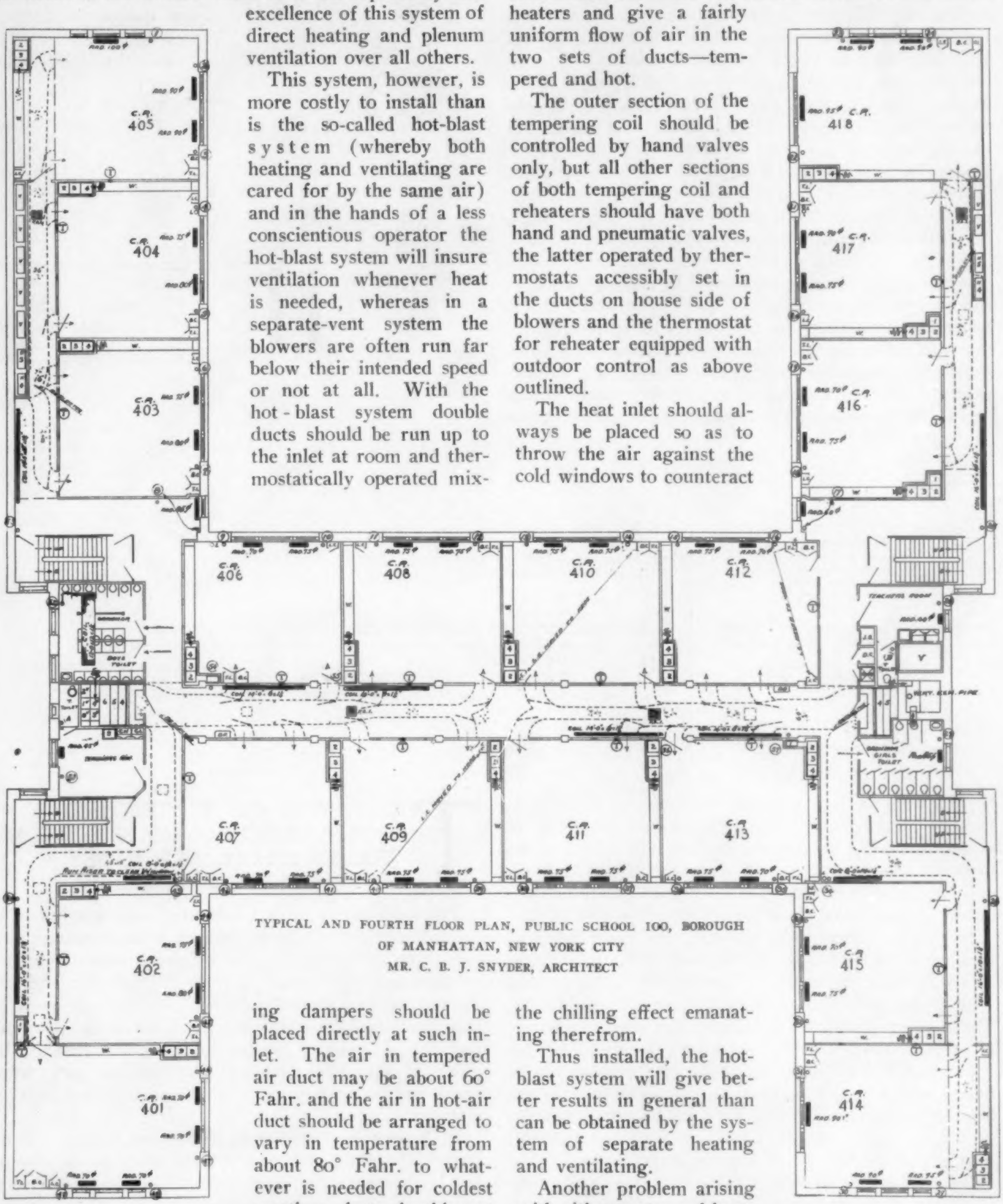


FIG. 4

weather as well as during school hours in mild weather, when teachers refuse to close windows.

If carefully operated by conscientious help, there is no doubt in the writer's mind as to the superiority and excellence of this system of direct heating and plenum ventilation over all others.

This system, however, is more costly to install than is the so-called hot-blast system (whereby both heating and ventilating are cared for by the same air) and in the hands of a less conscientious operator the hot-blast system will insure ventilation whenever heat is needed, whereas in a separate-vent system the blowers are often run far below their intended speed or not at all. With the hot-blast system double ducts should be run up to the inlet at room and thermostatically operated mixing dampers should be placed directly at such inlet. The air in tempered air duct may be about 60° Fahr. and the air in hot-air duct should be arranged to vary in temperature from about 80° Fahr. to whatever is needed for coldest weather, but should not exceed 120° Fahr. The quantity of air supplied to each room and the total heat losses for exposed wall and glass in addition to heat required to warm the ventilating air in each case in coldest recorded weather will, of course, determine this necessary maximum temperature.



TYPICAL AND FOURTH FLOOR PLAN, PUBLIC SCHOOL 100, BOROUGH OF MANHATTAN, NEW YORK CITY
MR. C. B. J. SNYDER, ARCHITECT

The temperature at which the "hot-air" or "reheater" thermostat functions should be controlled by a special outdoor thermostat of type shown in Fig. 9, hereinbefore mentioned. This will economize on steam in the reheaters and give a fairly uniform flow of air in the two sets of ducts—tempered and hot.

The outer section of the tempering coil should be controlled by hand valves only, but all other sections of both tempering coil and reheaters should have both hand and pneumatic valves, the latter operated by thermostats accessibly set in the ducts on house side of blowers and the thermostat for reheater equipped with outdoor control as above outlined.

The heat inlet should always be placed so as to throw the air against the cold windows to counteract the chilling effect emanating therefrom.

Thus installed, the hot-blast system will give better results in general than can be obtained by the system of separate heating and ventilating.

Another problem arising with either system of heating is to heat principal's and similar offices to 70° Fahr. after school hours and on holidays while the rest of the building only needs to be kept above freezing. It would seem that gas radiators would be more economical than steam for this purpose were the gas radiators only used when no other heat is available and then only when room is actually in use. If gas is not available for this purpose, the steam from one boiler only may be used for heating such rooms by means of separate steam and return lines direct from boiler to these rooms at the same time permitting a safe temperature to be kept on the rest of the building by vapor from other boilers.

In case this is done, by-passes must be arranged so that during school sessions these special lines may be connected into the regular heating mains, and valves (including a safety valve set at 10 lbs. on house side of stop valve in steam line from boiler and a swing check in return to boiler) must be very carefully located for easy and sure operation by janitor, to prevent high-pressure steam reaching such special radiation.

All the boilers in such a building, unless an electric generating plant is installed, should be run high pressure say 60 to 80 lbs. during school hours to furnish steam to drive the ventilating fans or blowers by steam engines, the exhaust steam from such engines being used in the heating system after being passed through a suitable grease extractor. Live steam at reduced pressure should be supplied to make up the required additional steam for heating with the back pressure valve set at 2 to 5 lbs. as may be demanded by outdoor conditions. Outside of school hours the boilers may be run under little or no pressure, as a mere vapor of steam, such as banked fires will provide, will be enough to keep a well-built building above freezing over night except in zero weather.

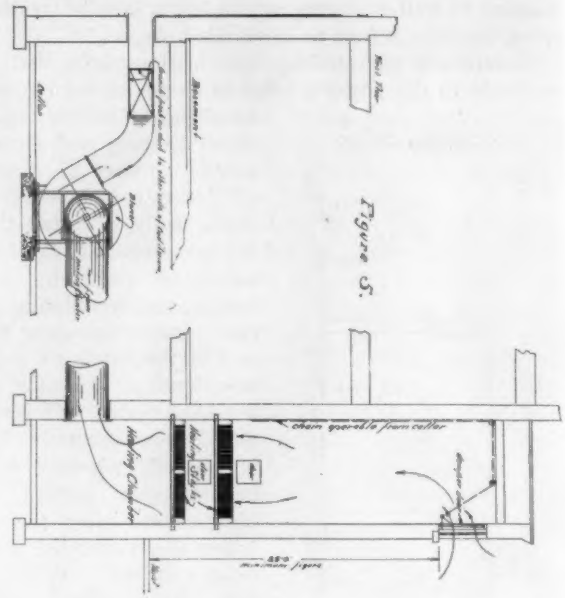
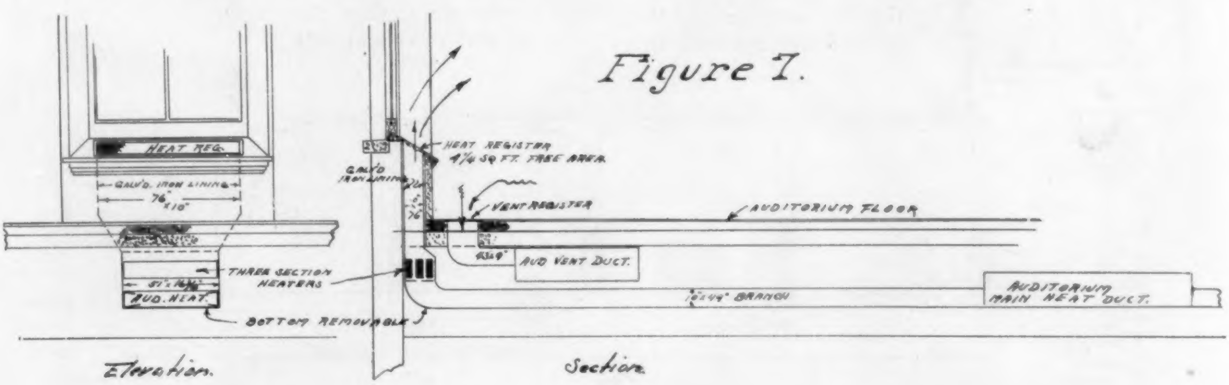


FIG. 5



In this connection may be noted the great value of weather strips or double sash as well as the importance of seeing that the building construction work around door jambs and window casings is closed up air-tight. These items are often overlooked and result in failure of properly designed heating plants to give satisfaction.

In general the special problems of the large school house in congested districts, so far as relates to the heating engineer, may best be solved by mechanically providing plenty of air taken from purest available source and further purified by passage through combined air washers and humidifiers, delivering such pure, fresh air to the rooms at suitable temperatures (controlled thermostatically) and at low velocity, through ducts and flues so arranged as to give a uniform distribution throughout each room and at the same time permitting unobstructed use of floors for large rooms where needed.

THE HEATING AND VENTILATING OF INEXPENSIVE SCHOOL HOUSES—THE METUCHEN SCHOOL, NEW JERSEY

BY CHARLES MORRIS, ARCHITECT

The architect is often confronted with conditions in a small school building where cost is an important factor. The committee usually require a certain number of class and other rooms, and the appropriation may be limited. Often other conditions are imposed, such as the character of the exterior, the brick to be used, and possible additions of terra-cotta or stone courses. The question then arises, and it is a serious one, as to what portion of the appropriation can be set aside for heating and ventilation.

In large school buildings where low cost is not an object, the more elaborate systems may be employed; but in the case of a small school these expensive systems must be eliminated, especially if the other requirements are to be carried out.

Still, even in the small school there are certain conditions which must be met in order to insure to each pupil the requisite amount of fresh air. In the States of New York and New Jersey, for instance, warmed fresh air

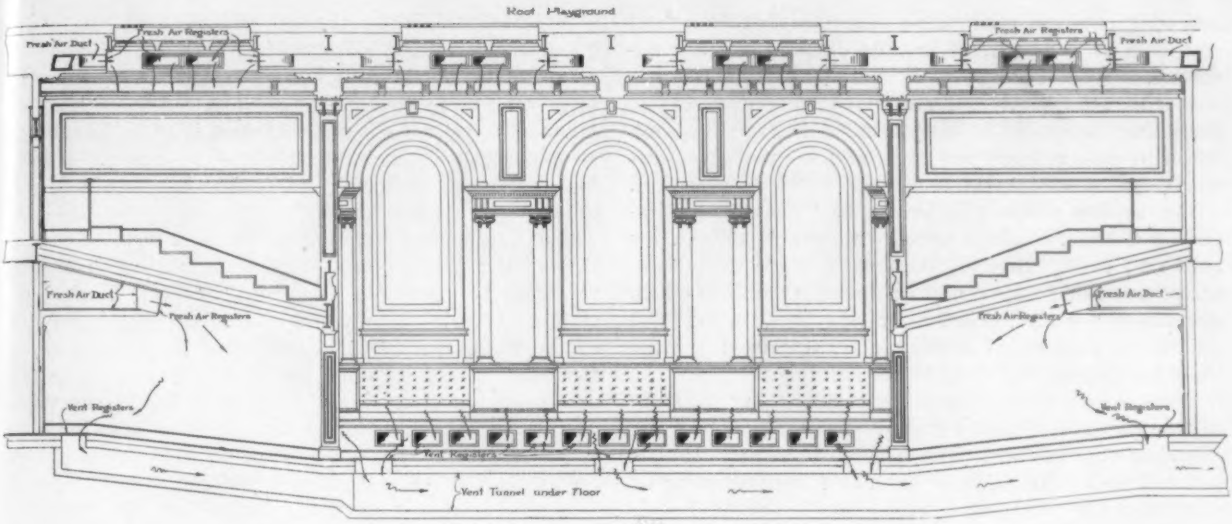


FIG. 8

must be introduced at the rate of 30 cubic feet per minute per pupil.

In the case of the Metuchen School, illustrated in this issue, where the appropriation was only $45,000, eleven class rooms, seating forty pupils each, and an auditorium seating 300 being required, the more elaborate systems could not be considered. The problem then arose to fulfill the requirements of the law and not exceed the appropriation.

This was accomplished by using a system of forced hot air, carried to the various rooms from the fresh

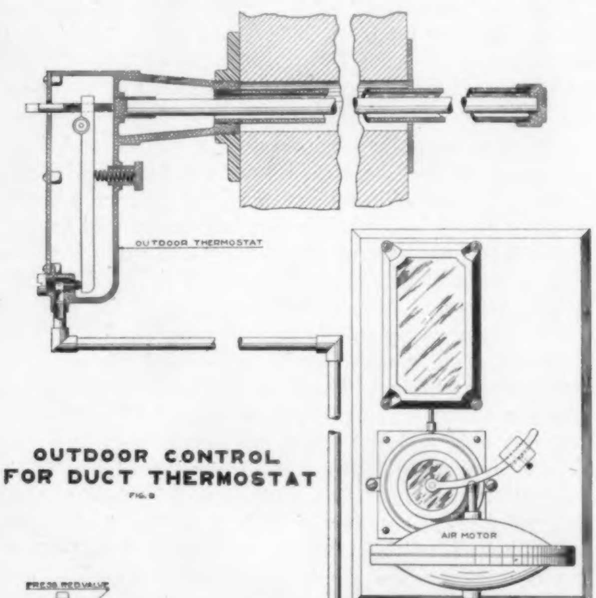


FIG. 9

air room in the basement in which was placed the fan and motor. The heat was supplied by four large hot-air furnaces. Air was furnished to the fresh-air room by a large galvanized iron duct hung from the ceiling. Hinged windows in the outside wall were connected to this for regulating the amount of air to meet the varying weather conditions.

At the warm air registers in the class rooms, placed 8 feet above the floor, there is a pulley attachment for operating damper chains; the pulley is provided with clutch for holding chain operating damper at foot of riser at any desired position. By this arrangement the temperature of the room may be lowered without effecting the amount of fresh air admitted to the rooms. This chain also operates a temperature indicator in the furnace room, informnig the engineer of the condition of all rooms without the necessity of visiting them, thus making it possible for him to regulate the supply of coal for the furnaces.

Vent registers are placed at the floor.

The ceilings over the four groups of cloak rooms on the second floor are furred down and the vent risers empty into these spaces, which in turn are connected to two large chambers on the third floor, and thence to the ventilators above the roof. This part of the system is very simple and works admirably, the principle being that the warm air forces the foul air to the vent flues and also that there is a certain amount of suction by the ventilators, which are open on four sides.

The principal's and teachers' rooms, while being provided with the same system as the above, are supplemented by hot-water radiators connected to a coil in the furnaces, so that these rooms may be heated independently of the hot-air system if desired.

The cost of the above system was $3,750, which is considerably less than a system of direct radiators using either steam or hot water, and supplying tempered fresh air to the rooms.

The cost of coal consumed the first year (which is usually in excess of the normal amount) was $423.80. Considering the fact that the cubical contents are 288,060, it is equivalent to $1.47 per thousand. Two dollars and over per thousand cubical contents is not uncommon in the other systems.

System of Ventilating Cremating Closets.

This I think may be of interest to many architects erecting schools in districts where there are no sewers and where the soil is of such a character that the use of cesspools or a system of sewage disposal are not advisable.

In this school the soil conditions were unfavorable for either cesspools or a system of sewage disposal. The soil was a thick red clay, and, to make matters worse, water was found at about a depth of four feet.

The system adopted is known as "Ventilating Cremating Closets." There are two ranges of closets, for boys and girls. Beneath these ranges are ducts connected to a flue forming part of the main stack, in which was placed a heater, called a "stack heater," which also serves the purpose of heating all water used for the wash basins and slop sinks in the building.

The fire in this stack heater is kept burning throughout the day and creates a current of air from the toilet rooms to the outer air. The height of chimney stack is five feet above the ridge of roof. At the beginning of each duct are pits called "firing pits," provided with small grates. The ducts are divided by a cast-iron dome-shaped plate, called a "drying plate," and the under portion of each closet is of iron, also the underside of closet seats. About once a month, kerosene is sprinkled on the drying place in the ducts under the closet ranges and a small fire is kindled in the grate. This dries the deposit and it passes up the stack as a fine dust.

The urinals are also connected to the underground duct by a large earthenware pipe.

These toilet rooms are absolutely free from any odor and have given entire satisfaction.

The cost of installation for 15 closets, 10 urinals and stack heater was $600. Estimates received for a sewage disposal plant amounted to four times this amount, owing to the large quantity of tile required for the irrigation fields.

THE PLAYGROUND

THE NECESSITY FOR LARGER SPACE THAN IS AFFORDED BY THE USUAL SCHOOL YARD, FULLY REALIZED—ITS BENEFICIAL INFLUENCE ON THE HEALTH AND MINDS OF SCHOOL CHILDREN

It is largely in the playgrounds of our schools and colleges that the attributes that make the necessary qualifications for good citizenship are fostered. The teachers in charge of the school playgrounds and those spaces provided in large cities for the recreation of children on holidays and after school hours, are unanimous in the verdict that they are powerful factors in the mental and moral development of school children.

The American people, as a rule, take life too seriously. As children, we have never been taught how to play.

It is a healthy sign that those in charge of educational matters in this country are awakening to a true sense of the importance of recreation in the school life, and are making provisions for this in the planning of our schools.

The Playground Association of America has been organized to provide adequate playgrounds in districts where, owing to congestion of population, there would ordinarily be no space for this purpose.

Dr. Luther Halsey Gulick, president of the Playground Association of America, recently stated: "A fundamental condition for the permanent development of a free people is, that they shall in childhood learn to govern themselves—self-government is to be learned as an experience rather than taught as a theory. Hence, in a permanent democracy adequate playgrounds for all the children are a necessity."

The Craftsman, referring to the well directed activities of the Playground Association, and with special reference to conditions as existing in New York City, states: "Aside from the encouraging showing made of the rapid and effective spread of the movement as a whole, one of its most interesting features was the demonstration given of the good which has been accomplished within a very short time by one branch of its many activities. About a year ago the association succeeded in making the national and folk dances of different countries a distinct feature of the physical training of children in the public schools of New York, particularly those which are situated in the congested districts of the East Side, where the majority of the children are either foreign-born or the American-born children of foreign parents. The teachers have found that one great difficulty in the way of the training of these children for future citizenship is the racial antagonism that so often manifests itself among them. This is fostered, rather than discouraged, at home and in the streets and is often beyond control even in the schoolrooms, but it soon vanishes when all share in the dances and games at the playground. Another element of discord is the inevitable result of the newly acquired American "smartness" which makes them ashamed of the old-fashioned foreign speech and ways of their parents, and anxious to forget, as soon as possible, the customs of the old country. As the denial of loyalty to the traditions of their native land is hardly the best foundation upon which to build a sound and loyal citizenship in this country, it was considered advisable to try to keep alive in the hearts of the children a kindly memory of the land of their forefathers, as well as genuine interest and respect for the customs and speech of their parents and grandparents, by reviving the traditional games and dances that are a part of the national life of almost every people but our own."

The obsolete notion that the elemental education of the younger children should be confined simply to the "three r's" has given place to a scheme of instruction that not only includes the fundamental requisites, but aims to impart patriotism and good citizenship. While inculcating the veneration and respect in foreign-born children for the country of their adoption, it does not do so by teaching them disrespect for that of their birth. It takes them when the hours of study are past and places them in surroundings where within reasonable limits they may find recreation and exercise to help the body sustain the mental work that it is called on to endure. In fact education in this country has become so broad in its scope that it may be said to be parental in its character and today among our poorer classes of foreign population in the congested districts in our larger cities throughout the country the boy may be truly said to be the father to the man.

THE HEATING AND VENTILATING OF SCHOOL-HOUSES IN EXPOSED LOCALITIES

By CHARLES F. EVELETH, Heating and Ventilating Engineer, Schoolhouse Department, City of Boston, Boston, Mass.

IN the early days of schoolhouse design it was customary to assign certain spaces, rather indistinctly defined, to contain the heating and ventilating apparatus. The basement was often divided off into commodious toilet rooms, playrooms, corridors and store rooms; the rest of the space being reserved for the boilers, radiating surface, fuel, ashes, etc. This was often so small that the heating contractor was compelled to cut down the size of his apparatus to fit the contracted quarters, with the result that the building was insufficiently warmed, poorly ventilated, could contain but a limited supply of fuel and many parts of the apparatus were almost inaccessible for cleaning or making repairs. In extreme weather it was only by starting up the fires very early in the morning and forcing the apparatus to the utmost that the janitor was able to have the building habitable in time for the opening exercises.

The importance of installing a suitable heating and ventilating apparatus in the modern schoolhouse is now very generally recognized, on account of its relation not only to the comfort and health of the occupants, but also through their ability to accomplish better results when provided with a plentiful supply of fresh warm air. The success of any system depends in a large degree upon the proper location of the various parts of the apparatus, and it is therefore necessary, even in preparing the preliminary sketches, to make suitable provision to receive them. The room taken up by the boilers, radiating surface, fan engine, pumps, heat and vent ducts and the like, should first be approximately plotted out, after which the enclosing walls may be drawn in.

The limited extent of this article will not permit the writer to go deeply into the details, but an attempt will be made to call attention to certain fundamental points which must be kept in mind by the architect in planning the building. If these are taken into consideration at the outset much valuable time will be saved later. After a brief description of a number of systems, mention will be made of the more important features to be taken into consideration, and these will then be illustrated by an account of the heating and ventilating apparatus recently installed in two new schools located in the outlying districts of Boston.

Before allotting the space which the apparatus will require, a choice must be made of the system best adapted to the building. The low pressure gravity indirect and the plenum systems have been successfully employed. Each has its advantages and limitations, and in each the field of usefulness is quite clearly defined. In the former a stack of indirect pin radiators enclosed in galvanized iron is placed in the basement near the ceiling and at the foot of the air flue to each classroom. The stack is arranged in such a manner that the air from outside will pass between the sections and after having been heated will enter the room through the warm air flue. An opening at the base of the flue will permit the cool air to enter without being warmed. By means of a mixing damper operated by a chain under the control of the teacher the volume of cool or heated air may be varied so that the temperature of the air at the inlet to the classroom may be varied through a wide range. The fresh air flues may be so grouped that the stacks for any tier of rooms can be located in a single chamber, the cold air being admitted through hinged windows or doors. If the proper amount of radiation is installed, a sufficient quantity of air may be furnished both to warm the room and provide the requisite ventilation. The foul air is removed through vent flues carried well above the ridge of the building and provided with aspirating coils, placed just above the room outlets to raise the temperature of the outgoing air, and thus increase its velocity. The wardrobes, corridors and smaller rooms as well as the basement sanitaries and play rooms are heated either by direct radiators or coils. A steam pressure of from two to five pounds is carried in the boilers and the water of condensation is returned by gravity. The advantages of this system are the low cost of installation, minimum cost of repairs and ease of operation, requiring no skilled help. It is, of course, not as positive

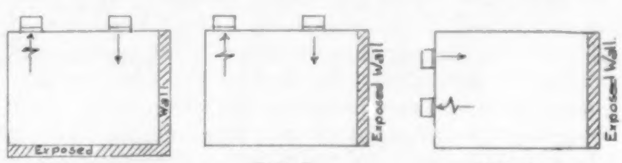


FIG. 1. FIG. 2. FIG. 3.

as the plenum system under all conditions of temperature and weather, inasmuch as the flow of air is produced by the difference in temperature between that in the flue and that outside. Care must therefore be taken to have all ducts built as nearly vertical as possible and the flues and openings made of ample size.

In the plenum system, air is forced into the room by a fan or blower driven either by a steam engine or an electric motor.

The air is first warmed to a temperature of about 68 degrees F by means of a primary heater located close to the fan. The heater may be made either of pipe coils, divided up into sections, or of cast iron indirect radiators arranged in groups. Where pipe coils are used certain sections are controlled by hand valves and the remainder are provided with diaphragm valves operated by a thermostat located in the main duct beyond the fan discharge. A most satisfactory arrangement is obtained by employing pin radiators, with mixing dampers placed above and below the sections and under the control of a thermostat placed as described above. In mild weather some of the stacks may be shut off. If the heater is so arranged that the air is drawn

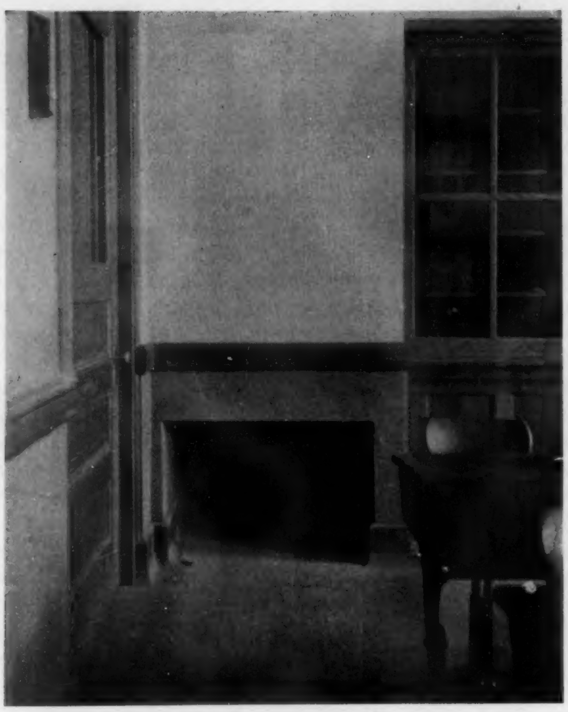


FIG. 4

through the churning action of the fan blades will thoroughly mix together the hot and cold air. A supplementary heater of cast iron pin radiators is placed at the base of the hot air riser to each classroom and is provided with diaphragm valves controlled by a thermostat placed in the classroom. The temperature of the entering air may then be varied by the opening and closing of the valves. In place of the supplementary stacks the rooms may be kept at the proper temperature by groups of wall radiators or by pipe coils placed along the outside walls under the windows and controlled by thermostats.

When the fan is driven by an engine it should have a cylinder of large diameter so that the boiler pressure need not exceed twenty-five pounds. By means of a reducing valve the steam pressure on the system can be reduced to from three to five pounds and the water of condensation automatically returned to the boiler by a steam pump and receiver. By installing a back pressure valve and a suitable oil separator, the exhaust steam can be turned into the heating system, thereby making a very material saving in fuel. In case it is not desired to have the condensation mingle with that from the rest of the system on account of the presence of oil, the steam may be turned into certain sections of the primary heater, which in this case should be piped up separately and arranged to waste into the sewer.

Aspirating coils are placed in the vent flues from the classrooms in the same manner as the previous system.

In the plenum system the air supply is practically constant under nearly all conditions of outside temperature and wind action. It is, however, considerably more expensive than the gravity indirect system. The additional apparatus required, such as automatic feed pumps, fan, engine, temperature control, etc., is not only more complex but also much easier to get out of adjustment and requires a more experienced janitor to operate it.

For a building containing not more than ten or twelve classrooms, the basement being given up to sanitaries and playrooms, thus permitting the heating chambers to be conveniently located directly under the warm air flues, the gravity indirect system can be installed and yield satisfactory results. If, however, it is desired to use part of the basement for such purposes as cooking, manual training and the like, which require the same air supply and temperature regulation as regular classrooms, the plenum system is preferable for two reasons: First, the space required for the gravity chambers will badly interfere with the satisfactory planning of the rest of the basement; and, second, there is no way of providing a suitable arrangement of mixing dampers and air supply to these basement rooms, except by installing small fans or blowers.

The location of the schoolhouse should have considerable influence in the selection of the system to be installed. No difficulty will be experienced in obtaining skilled help to operate the apparatus, or making quick repairs in case of a sudden breakdown, in a city school; but if located in a thinly settled community where repair parts can not be readily obtained and a competent janitor is an uncertain proposition, the failure of some of the automatic apparatus in severe weather would entail considerable annoyance and a possible closing of the school.

The next step in the design is the location of all of the heat and vent ducts, and it is very important to have

FIG. 5

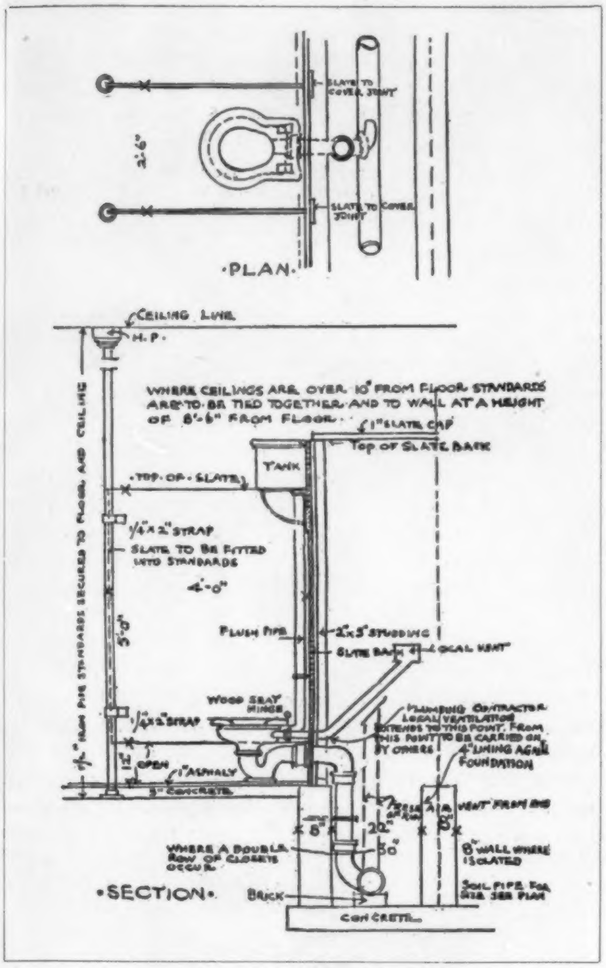


FIG. 6—SHORT HOPPER CLOSET

those for the classroom properly placed so as to obtain a thorough and complete circulation of the air and heat throughout the room. Figs. 1, 2 and 3 show satisfactory arrangements.

In each case the bottom of the heat inlet is about 8½ feet above the floor, allowing the room to be 12 feet high, and the vent outlet is at the floor.

In some instances the ducts for two sets of rooms can be grouped together. By referring to the floor plans of the Nathan Hale and Edward Everett School, the advantage of this arrangement is at once apparent. In the case of the first mentioned school it brings two sets of indirect stacks together in a single chamber. In the other school it decreases the number of branch ducts. Special care should be observed in placing the indirect stacks in the right position at the base of the air ducts. They should be located so that the warm air will pass up on the front or room side of the duct and the cold air used for mixing will pass up on the rear side. If placed in the opposite direction so that the warm air rises on the rear side of the duct, cold draughts will be felt when the mixing dampers are in certain positions.

Additional ducts should be provided for removing the foul air from the wardrobes, corridors, master's, teachers' and nurses' rooms. It is not necessary ordinarily to incur the extra expense of providing separate air supply for rooms of this character. In the accompanying drawings the door of each wardrobe which is situated farthest from the vent duct is sawed off about two inches at the bottom, thus providing an opening through which air from the classroom may pass to replace the foul air drawn out. The vent flues from the sanitaries should be carried up separately to the tops of the main ventilators. They should be so located that the horizontal runs, particularly from the fixtures in the basement, are as short as possible. One frequently finds the chimney made of heavy boiler iron and set in a rectangular brick flue, the space around the chimney being used as a toilet vent stack. Several cases have recently come under the writer's observation where the iron has been almost entirely rusted through, due probably to the action of the damp air. This method is not recommended. An aspirating coil of sufficient size placed at the base of the flue, just above the inlet, or a series of rising pipes is more satisfactory.

Vertical flues may be built either of brick, terra cotta blocks or galvanized iron. When built of masonry care must be taken to have the joints on the inside laid as smooth as possible to prevent loss by friction. Galvanized iron ducts are usually furred in with metal lath and then plastered.

The smaller vent ducts from the wardrobes, teachers' and master's rooms and the like, should be preferably of galvanized iron and may be offset in the attic space to enter the main vent outlets.

The horizontal ducts radiating from the fan, in connection with the plenum system, are usually built of galvanized iron if carried on the basement ceiling. A better method is to run them beneath the basement floor, making them of brick or concrete, and thereby permitting the height of the general basement to be reduced. Where a gravity system is to be installed the location of the heating chambers should be the first step in planning the basement. The most satisfactory arrange-

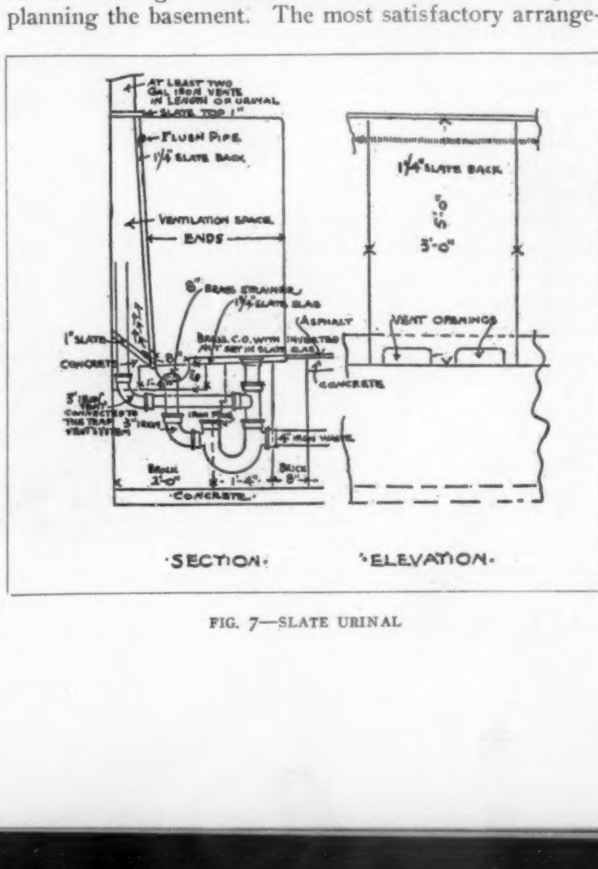


FIG. 7—SLATE URINAL

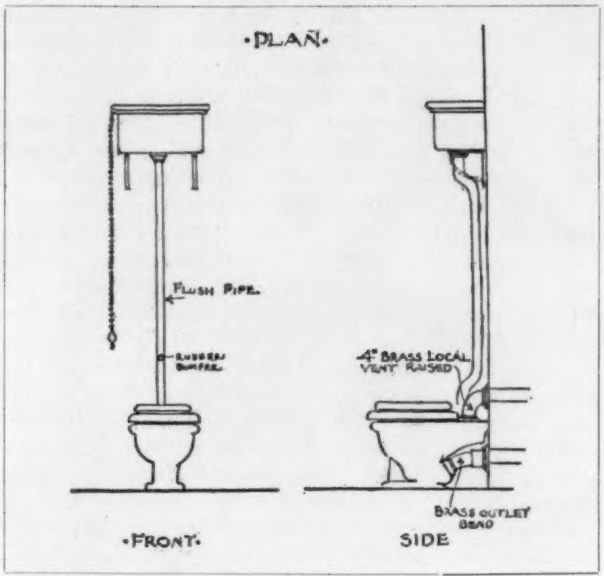


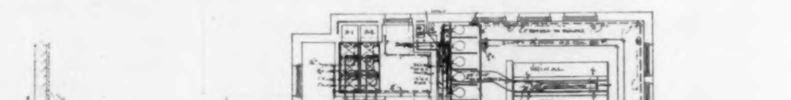
FIG. 8—TEACHERS' CLOSET

ment is to build them of brick with 8-inch-thick walls, which will also serve to support the radiators. A reference to the basement plan and detail sheet of the Nathan Hale School will give one an idea of the size and arrangement and also details of construction. The boiler room ought to be centrally located, but at the same time there must be easy access to the street for removing the ashes. A coal room adjoining the boiler room and large enough to contain a year's supply, with a driveway to permit teams to reach the chute and thus do away with the necessity of handling it with baskets, will simplify the fuel question. An allowance of ten tons of coal per classroom and 43 cu. ft. per ton will give the required contents of the room, bearing in mind that the coal cannot be piled up to the ceiling. If horizontal return tubular boilers are installed, a space in front equal to the length of the tubes is necessary in order to permit their withdrawal in case of repairs. It is well to allow a distance of four feet at the rear for piping up the return connections. A solid foundation is absolutely necessary to sustain the boilers, and an examination should always be made of the character of the soil to determine whether piling is necessary. If the ground is wet, waterproofing may be required. The height of the boiler room will depend upon the size of the boilers and may range from fourteen to seventeen feet in the clear. The determining factor is the distance between the water line of the boiler and the bottom of the lowest stack of radiators, which, in a gravity system, should be at least three feet, and preferably more.

Avoid placing the boilers or any of the other apparatus in a poorly lighted place. Provide plenty of windows to give air and light, and encourage the janitor to keep the premises clean. The most satisfactory floor for both the boiler and coal room is made of paving brick laid on edge and grouted. A floor drain will enable the fireman to keep things tidy with the least amount of effort.

By exercising some ingenuity the fan and engine room may be located close to the boiler rooms. Plenty of space should be allowed in front of the engine cylinders so that the head may be taken off and the piston withdrawn. If the engine is belted to the fan, keep the belt centers at least ten feet apart.

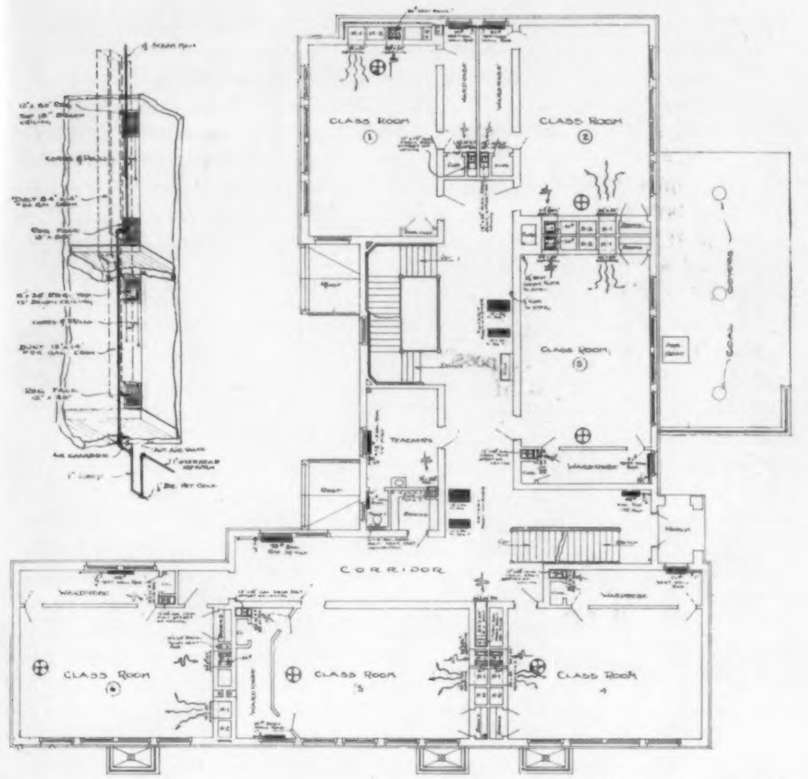
The schoolhouse being ordinarily symmetrical, it is well to place the fan so that the discharge will lie along the axis of the building and thus deliver an equal quantity of air in either direction. The primary chamber, which naturally adjoins the fan room, ought to have the fresh air inlet so located that dust, leaves, etc., cannot be drawn in. It is preferable to have the intake over a grass plot, and at the rear of the building, to avoid the dusty street. In thickly settled localities it may be necessary to construct a shaft to take the air from a point well above the ground. In such a case the architect will, of course, avoid placing it near the toilet vent outlets or the chimney. By providing doors in the wall of the primary chambers below the heater, air may be taken from the basement in the morning, thus permit-



BASEMENT PLAN

NATHAN HALE SCHOOL
BOSTON, MASS.

PARKER, THOMAS & RICE
ARCHITECTS



NATHAN HALE SCHOOL
BOSTON, MASS.

FIRST FLOOR PLAN

PARKER, THOMAS & RICE
ARCHITECTS

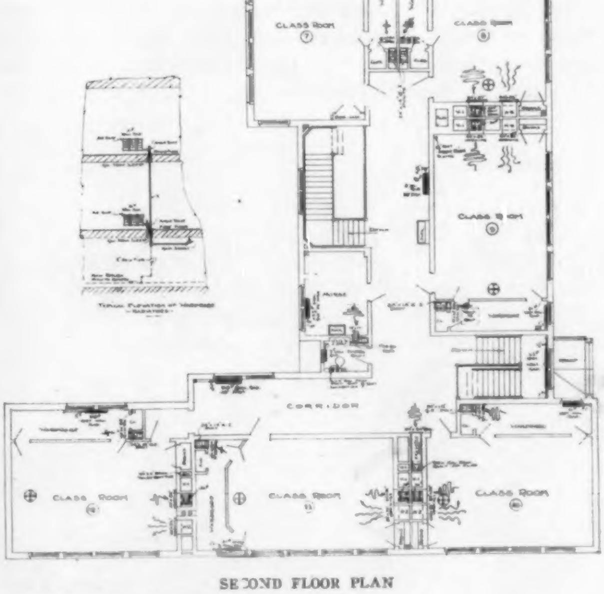
ting the building to be quickly heated to the proper temperature.

DESCRIPTION OF THE HEATING AND VENTILATING APPARATUS IN THE NATHAN HALE SCHOOL.

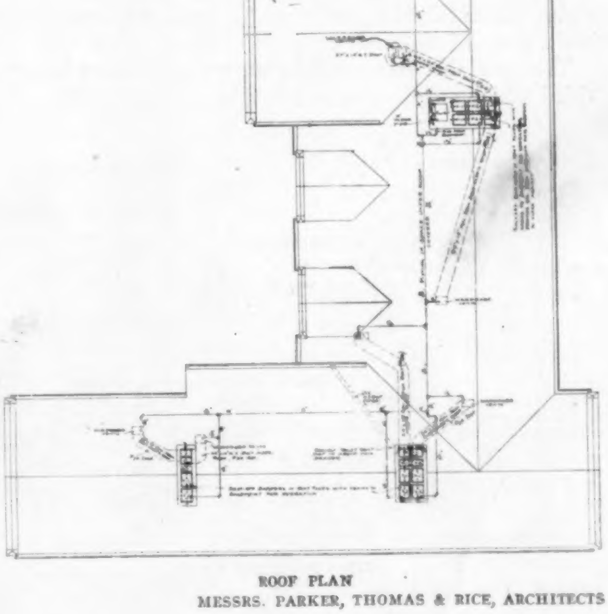
The Nathan Hale School, situated on Cedar Street, Roxbury, is a lower elementary school containing twelve classrooms, and is of fireproof construction throughout. The architects of the building were Parker, Thomas & Rice, of Boston. The heating and ventilating apparatus was designed by the Schoolhouse Department under the direction of the writer. On account of the size of the building and the fact that there were no classrooms in the basement, a low pressure gravity return heating system was installed.

There are two horizontal return tubular boilers each 54 inches in diameter, 15 feet 3 inches long and containing 60 charcoal iron tubes 3 inches in diameter and 14 feet long. The heating surface is approximately 749 square feet for each boiler. Shaking grates were furnished, each having an area of 22½ square feet. A damper regulator is provided to maintain a steam pressure of from 2 to 5 pounds on the system, although circulation will take place even when no pressure is shown on the gauge. The safety valves conform to the requirements of the Massachusetts District Police, and are set to blow at 15 pounds pressure.

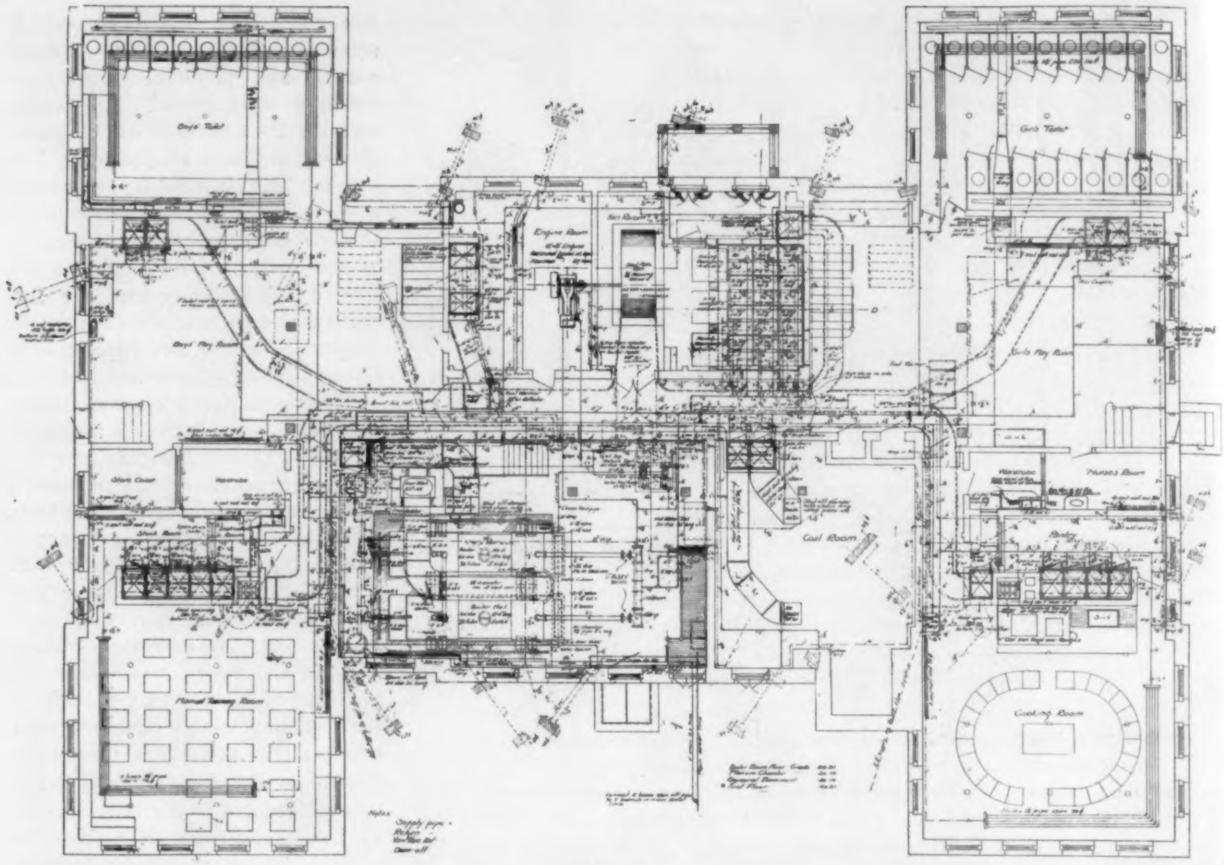
A hot water tank is installed near the front of the boilers, having a capacity of 95 gallons and containing a brass pipe coil under the control of an automatic tank regulator.



SECOND FLOOR PLAN
NATHAN HALE SCHOOL, BOSTON, MASS.



ROOF PLAN
MESSRS. PARKER, THOMAS & RICE, ARCHITECTS



EDWARD EVERETT SCHOOL
BOSTON, MASS.

BASEMENT PLAN

MR. EDW. T. P. GRAHAM
ARCHITECT

The radiation is as follows:

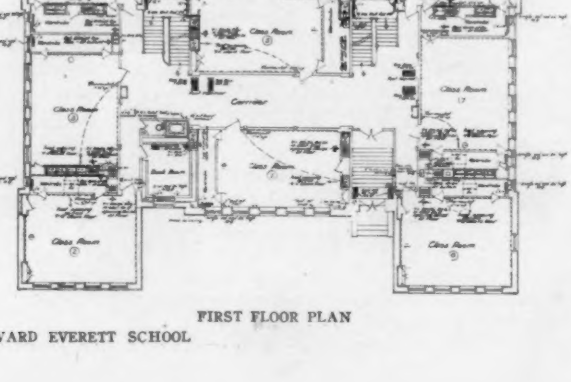
Pipe coils	179	square	feet
Vent flue surface	280	"	"
Direct radiators	1166⅓	"	"
Indirect radiators	4800	"	"
Foot warmer radiators	240	"	"
Total	6665⅓	"	"

In the vent flue from each classroom is placed a radiator containing 20 square feet. Each wardrobe vent has a riser of 1½-inch pipe.

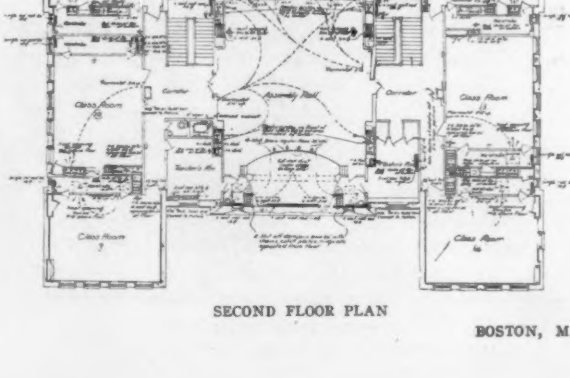
The vent duct from each basement toilet room is provided with an aspirating coil having 20 square feet.

The classrooms are all heated by indirect radiators placed in brick chambers in the basement. A cast-iron door opening into the basement is furnished for each chamber, to be used for night circulation when the fresh air windows are closed.

Classrooms with one exposure each have 360 square feet of radiation; those with two exposures having 420 square feet. The stack for each room is divided into three sections. In the first floor corridor are two foot warmers, each containing 120 square feet of indirect radiators, suspended from the basement ceiling and en-



FIRST FLOOR PLAN

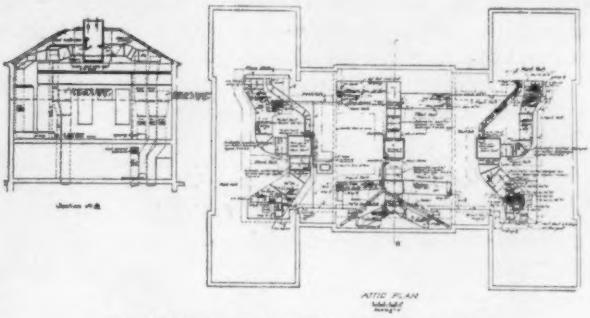


SECOND FLOOR PLAN

EDWARD EVERETT SCHOOL BOSTON, MASS.

closed in galvanized iron. They are arranged as shown in the detail drawing.

The piping system is laid out in such a manner that all of the aspirating coils except those for the sanitaries may be closed off. This is for use in extreme weather and at night.



EDWARD EVERETT SCHOOL, BOSTON, MASS.

All piping in the basement and attic as well as the risers and also the smoke flue and hot water tank are covered.

The classrooms are each 30 feet long, 20 feet wide, 12 feet high and contain 43 occupants.

The system is designed to provide 30 cubic feet of air per minute to each occupant, and the air supply to each classroom is therefore approximately 1,300 cubic feet per minute. The heat and vent flues to the classrooms and the vertical vent flues from the sanitaries and corridors are built of brick. The vent ducts from the wardrobes, teachers' room and nurses' room are galvanized iron, and crossing overhead in the attic space enter the brick ventilators. The heat ducts are 24 inches by 32 inches and the openings into the classrooms 30 inches by 36 inches. The vent ducts from the classrooms are each 24 inches by 30 inches and from the wardrobes 12 inches by 14 inches. The typical sections through the heat chambers and flues clearly indicate the method of controlling the volume of air to and from the rooms. The dampers in the bottom of the stack casings regulate the air supply to the stacks, and the volume dampers in the vent ducts can be adjusted to obtain the required outflow. For closing the system at night there are large dampers in the main vent ducts operated by chains extending to the basement.

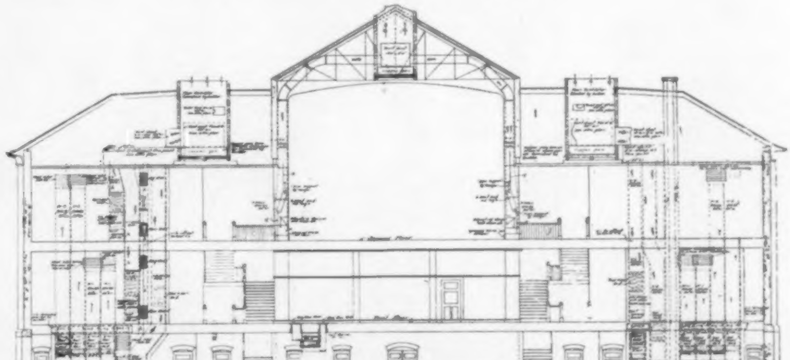
No guards or registers are placed over the heat and vent openings in the classrooms. At each vent opening the floor and baseboard are carried into the back side of the duct and the presence of any dirt is at once apparent. The heat openings have horizontal deflectors made of galvanized iron and painted to match the walls of the room. These openings are shown in Fig. 4 and Fig. 5.

A separate system of toilet vent ducts is run from the fixture to the top of the building. The water closets in the basement sanitaries are of the short hopper type, each having at the back an outlet 10 square inches in area. These openings are connected together by galvanized iron ducts which are increased in size so as to be equal to the area of the branches, as shown in Fig. 6. From the space back of the urinal slabs branch ducts are run as shown in Fig. 7, with an allowance of 8 square inches of duct area for each lineal foot of slab. In Fig. 8 is shown the method of ventilating the individual closets. Shut-off dampers are placed in the main ducts, which may be closed at night in extreme weather.

Description of the Heating and Ventilating Apparatus in the Edward Everett School

The Edward Everett School, which is located on Pleasant Street, Dorchester, is an upper elementary school, having fourteen classrooms and an assembly hall. There is also in the basement a cooking room and a room devoted to manual training. This building is also of fireproof construction. The classrooms are each 29 feet long, 23 feet wide, 12 feet 6 inches high, and it will seat 44 pupils. The general basement was originally planned to be 10 feet 6 inches high in the clear and the boiler and coal rooms 16 feet high. These dimensions were later reduced 6 inches. Mr. E. T. P. Graham, of Boston, was the architect of the building, and the heating and ventilating plans were prepared by the Schoolhouse Department.

A plenum system was installed for the reason mentioned earlier in the article for a building of this character. The two horizontal return tubular boilers are each 60 inches in diameter, 17 feet 4 inches long and contain 72 charcoal iron tubes 3 inches in diameter and 16 feet long. The heating surface of each boiler is about 1,012 square feet. The shaking grates each contain an area of 27½ square feet and are arranged to burn soft coal. A brass interval feed pipe is provided for each boiler, and there are two manholes, one in the top of the shell and the other in the front head under the tubes. The safety valves are set to blow at 40 pounds pressure. Fire tools, machinists' tools and a brass oiler set are supplied for the engineer. A damper regulator and a hot water tank are furnished as in the Nathan Hale School. There is also a small hot water heater for use when the large boilers are not in operation, as it is necessary to have a supply of hot water for the nurse's room during the entire season.



EDWARD EVERETT SCHOOL, BOSTON, MASS.

A steam pressure of 25 pounds is carried in the boilers to operate the engine and pumps. This is reduced from 2 to 5 pounds for the heating system, which also receives the exhaust steam from the engine. An oil separator and a back pressure valve are installed, and provision is made for the engine to exhaust directly into the atmosphere whenever necessary. While the engine is running the condensation from the entire system is returned to a closed tank in the boiler room, and by means of a float valve it is automatically delivered to the boilers by feed pumps which are arranged in duplicate. There is also a gravity return connection to the boilers for use at night and whenever the engine is not being run.

Fresh air is taken into the building at the rear and is drawn through a primary heater consisting of drum pin indirect radiator sections connected in groups. The temperature of the air is controlled by mixing dampers operated by a thermostat in the main duct. An 8-foot, three-quarter housing, steel plate fan direct connected to a 12-inch by 8-inch low pressure center crank engine, delivers the air to a series of underground ducts, built of concrete, which supply the vertical risers to the various rooms. A supplementary heater enclosed in galvanized iron and suspended from the basement ceiling is placed in each fresh air riser and is under the control of a thermostat in the room. The assembly hall is warmed and ventilated in a similar manner and, in addition, has direct radiators placed under the windows and connected to additional thermostats. When not in use the air supply is shut off by dampers and the room kept at the proper temperature by the direct radiators. The foul air is withdrawn from the rooms through vent ducts which run to the attic space and gather into three main ventilators that extend above the roof. No hoods are provided over the tops to keep out the weather, there being instead a copper pan 12 inches deep located at the base of each ventilator, as shown on the cross sectional drawing, and provided with a drain, connecting with the conductor system. Adjustable deflectors are placed in the air ducts wherever branches are taken off. There is a volume damper at the base of each fresh air riser that is set so as to intercept the proper quantity of air for the room. The vent flue from each classroom and those from the assembly hall have volume dampers similar to the arrangement at the Nathan Hale School, which are adjusted to allow the passage of the proper quantity of air.

Large dampers are placed in the main vent ducts in the attic space and connected to diaphragms operated by air pressure from the automatic temperature regulating system, and controlled by brass cocks on a switchboard in the boiler room. This permits the building to be closed up tight at night. Aspirating coils are placed in all vent ducts as in the school previously described.

On the basis of 45 occupants in each classroom and 52 in each of the two basement rooms, and allowing 30 cubic feet of air per minute for each occupant, there will be required for ventilation an air supply of 22,020 cubic feet per minute. At a speed of 105 revolutions the fan will furnish 22,400 cubic feet of air per minute. When the assembly hall is in use the speed of the fan is increased to 127 revolutions.

All of the air ducts, with the exception of those which are below the basement floor, are made of galvanized iron. Provisions were made when laying out the steel framing to have spaces left to receive them. By referring to the cost schedule it will be seen that the sheet metal work represents a considerable part of the total cost. In the buildings which have been recently designed it is proposed wherever possible to have the ducts built of masonry instead of metal.

The radiation was installed in accordance with the following schedule:

Pipe coils	376 square feet
Vent flue radiators	480 " "
Direct radiators	1870½ " "
Supplementary radiators	2640 " "
Primary radiators	1920 " "
Foot warmer radiators	240 " "
Total	7526½ " "

The primary stack is made of drum pin indirect radiators arranged in groups. The supplementary radiators consist of the regular indirect pin radiator sections.

As stated above, the temperature of the classrooms is controlled by automatic heat regulation. Two air pumps are installed, one driven by steam and one by water pressure, to prevent shutting down the system in the case of the failure of either pump.

By referring to the drawings it will be seen that provision has been made to receive a year's supply of coal. The ashes are easily removed by an iron crane fitted with a rope hoist, and there is but a short haul to the sidewalk.

The contract price for installing the apparatus in the Nathan Hale School was $6,667, which was made up of the following items:

Boilers, castings and grates	$1,230
Boiler setting	600
Boiler trimmings	70
Tools, coal wagon, hose, etc.	91
Damper regulator	40
Hot water tank and regulator	115
Thermometers	15
Blowoff tank	40
Paper burner	55
Indirect radiators	825
Direct radiators	230
Vent flue radiators	70
Pipe coils	46
Radiator valves and air valves	100
Gate valves	225
Brass pipe and fittings	75
Iron pipe fittings	500
Iron beams and hangers	100
Galvanized iron work and smoke pipe	1,150
Pipe covering	375
Painting and bronzing	30
Labor and car fares	625
Freight and cartage	60
Total	6,667

The apparatus in the Edward Everett School cost $15,542, according to the following schedule:

Boiler castings and grates	$1,900
Boiler setting	900
Boiler trimmings	70
Tools, coal wagon, hose, etc.	110
Damper regulator	50
Hot water tank and coil	105
Thermometers	21
Blowoff tank	40
Paper burner	80
Indirect radiators	1,100
Direct radiators	400
Vent flue radiators	150

Pipe coils	150
Radiator valves and air valves	215
Gate valves	600
Brass pipe and fittings	150
Iron pipe and fittings	1,246
Extra gauges	80
Receiving tanks, pumps and governor	400
Iron beams and hangers	150
Galvanized iron work and smoke pipe	3,400
Painting and bronzing	60
Pipe covering	800
Labor and car fares	1,125
Reducing valve, back pressure valve and water relieve valve and steam trap	45
Oil separator and exhaust head	70
Fan and engine	750
Automatic temperature control	1,300
Cartage	75
Total	$15,542

Calling the assembly hall in the Edward Everett School equivalent to two classrooms and including the manual training room and cooking room we have an 18-room building. The comparative cost of the apparatus in the two schoolhouses is as follows:

Name of school.	Sq. ft. of radiation.	No. of class-rooms.	Cost per class-room.	Cost per sq. ft. of radiation.
Nathan Hale	6,665⅓	12	$555.60	$1.00
Edward Everett	7,526½	18	863.44	2.07

SANITATION OF THE MODERN SCHOOL BUILDING

By LEO H. PLEINS

In this age of progress, improvement in material entering into the construction of buildings is of such common occurrence that few, indeed, pause for a moment to consider the extent of the improvements that have been made in any special line, compared with what existed but few years ago.

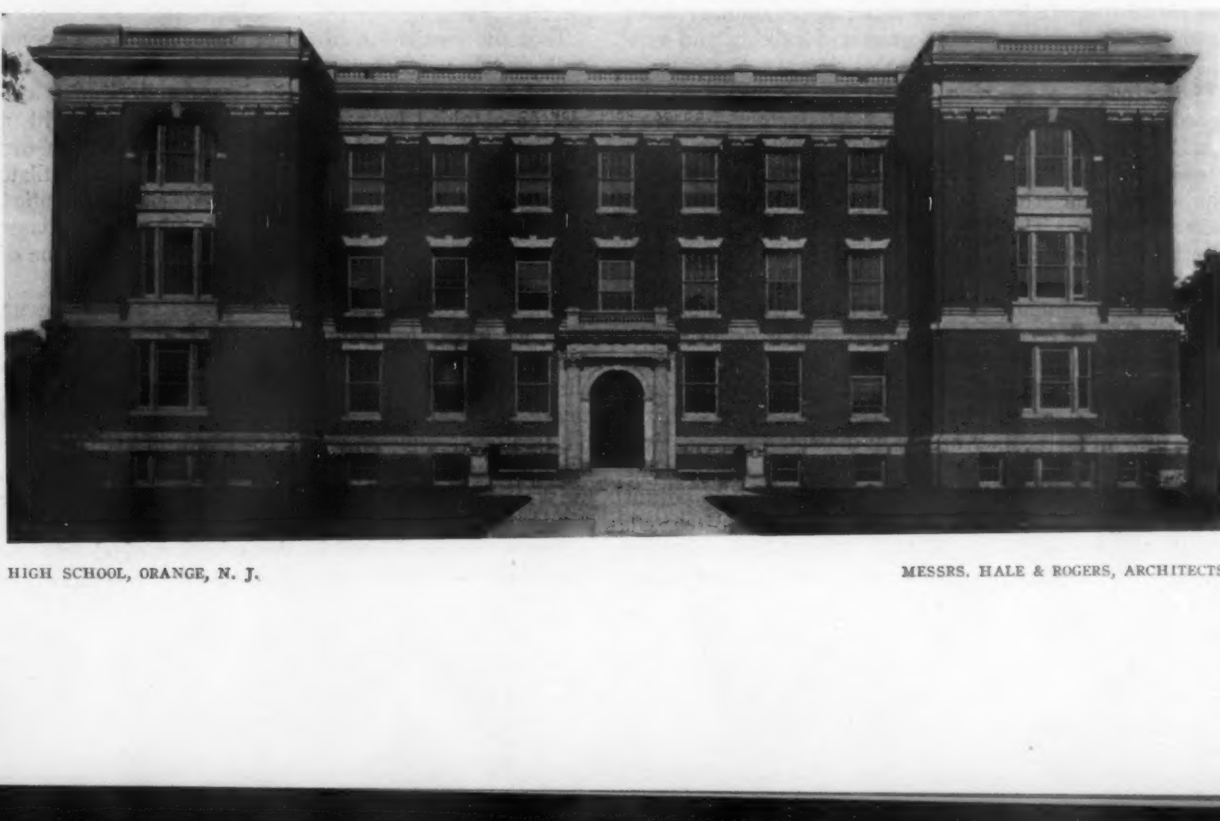
The assertion has been made, and its accuracy appears probable, that no class of material entering into the construction of buildings has been more improved or brought to a higher standard than sanitary plumbing. That there was great room for improvement in plumbing appliances is true, but it is also true that as great energy, skill and the scientific application thereof has been expended in this most important branch for real improvement as in any other direction that could be indicated.

This statement being correct, let us devote a little time to consider where this improvement is especially noticeable, and for such illustrative purpose we can take no better example than the modern sanitation of our public school buildings.

It is but a few years since the feeling became general throughout the country that the sanitary conditions of schools needed immediate attention and radical changes. Frequent epidemics, traceable to unsanitary, malodorous toilet rooms, were recorded and conditions found due to fouled and inoperative range closet systems of both the dry heated air and water-flushed type. That changes must be effected at once, if the lives of our children were not to be placed in jeopardy, was recognized by school boards, architects and engineers, and it was due to their united efforts, combined with the skill and intelligence of the leading manufacturers of sanitary appliances of the country, that the remarkable advancement existing to-day was brought about.

The first step recognized as absolutely necessary was the abolition of the range closet system and the adoption of an individual type water-flushed fixture of proper form and construction. Then began the evolution of the individual type and a practical advancement from closets technically known as hopper and trap, combined hopper and trap, to the siphon jet and combined hopper and trap with jet action type. The two latter types, known as washdown with jet and siphon jet, are the ones used to-day, and of these we will particularly speak.

The first individual closets were equipped with cisterns or flushing tanks operated by hand pull, or an automatic flushing tank operating at set intervals. It soon became apparent that it was necessary to provide some other method of flushing the fixtures; the hand pull was not satisfactory, owing to the forgetfulness of



HIGH SCHOOL, ORANGE, N. J. MESSRS. HALE & ROGERS, ARCHITECTS

SCHOOL AT POMFRET, CONN. MR. ERNEST FLAGG, ARCHITECT

children; the automatic flushing at set intervals was not sanitary unless the flushing was practically continuous, and this meant a great waste of water, the conservation of which is such an important item. This brought about the introduction of what was known as the "chain," and subsequently the "rod-acting, seat-operating" device, by means of which the flushing was accomplished when the seat was depressed, which action caused a chain or a rod attached to the rear of the seat to operate the flushing device of the cistern. It required only a short time to prove that the rod action was not satisfactory from a mechanical standpoint, as greater durability and simplicity than that possessed by this device was required. The principle of flushing the fixture by means of depressing the seat was found most satisfactory, however, and this was one of the causes for the production of an automatic seat-operating valve closet which met the requirements of school and public work most fully in every respect. The general adoption of this method of flushing proved its value as an effective and thorough flushing device and most economical in the consumption of water, an important item, and one which until recently did not receive the consideration it deserved.

Along with the improvements in closet and methods of flushing came the provision for ventilating closet bowls above the water line. Various types resulted, but it was found that vents 2 inches in diameter, the size first used, were too small, as they became clogged. The construction of bowls was therefore modified to permit vents of 3 inches diameter and over being constructed. Such fixtures are in use to-day. The objections found in regard to the 2-inch vents have been reduced somewhat by increasing the size. Still, experience has proved that unless such vents are connected to an extraordinarily efficient exhaust vent system, the method is not satisfactory, the danger being that if the exhaust be too strong, it will cause drafts; or, if not strong enough, it will fail to ventilate, with the possibility in either case of openings of vents in bowls becoming fouled unless frequently cleaned. This is not always possible on account of an insufficient number of attendants, or again, carelessness on their part may account for unsatisfactory results.

That the ventilation of closet bowls and toilet rooms is absolutely necessary is an unquestioned fact, and the proper ventilation of closet bowls and toilet rooms can best be obtained by providing each closet stall with a ventilator of sufficient area placed a few inches above the bowl that will remove both local odors and ventilate the room as well, instead of confining such ventilation to closet bowls only—this, especially, where an exhaust fan ventilating system does not enter into the scheme of the building.

Bringing the closet question down to the present time, we have, therefore, to deal with either the washdown bowl with jet action, or siphon jet type provided with a durable, simple, automatic seat-operating valve device, as the best adapted to modern sanitary work. Of the two types, the siphon jet is to be preferred unquestionably, but where cost is a vital point to be considered, the washdown bowl with jet may be substituted with the assurance of fairly satisfactory results. The main points to be considered in the selection of closets are that they be constructed of absolutely non-absorbent materials; walls as heavy as possible; waterway not less than 2½ inches full diameter, and not reduced in area at any point. The water surface in the bowls should be as large as possible in order to reduce the fouling surface in the bowl to a minimum, and it is for this very reason that the siphon jet bowl is so greatly superior to the washdown type. The depth of seal should not be less than 2¾ inches. The flushing rim should be oval and heavily rolled and the perforations so graduated in size that the flushing of bowl is as uniform as possible at the moment the flush takes place. All attachments to bowl, such as seat, hinges, valves, etc., should be made as strong as possible and not complicated, and the bowls must not exceed 14 inches in height. An excellent method to follow in specifications is to give the weight of bowls, size of waterway, area of water surface, depth of seal, weight of trimmings, etc., and provide a clause requiring that all vitreous earthenware be of the best hard-fired sanitary vitreous china, stamped with the trade-name of the manufacturer under the glaze, and the ware guaranteed against crazing or discoloration.

Thus briefly concluding the main desirable feature of closet bowls, let us consider their proper grouping in the toilet rooms. Closet stalls may be of wood, slate or marble to suit conditions. Slate makes an excellent and inexpensive sanitary material. In any event, whatever material is used, the arrangement may be the same. Wherever possible, and we believe this well be in every case, the closet stalls should be arranged in a double battery. If conditions prevent, the stalls may be arranged in single row or battery. In either case, the stalls should be provided with a 24-inch working space behind backs, in which all tanks, flushing pipes, water-supply pipes, soil and vent pipes may be concealed. At one end of working space, a door must be provided so as to allow of admittance for inspection or repair. If closets with local vented bowls or closet-stall ventilators are used, the working space will also serve the purpose of a vent chamber by capping the top of same. The connection to main vent ducts may be taken from top, bottom or rear of vent chamber as desired. The closet stall partitions should be kept 12 inches above floor at the bottom and from 5 feet 6 inches to 6 feet above floor at top; backs of stalls should extend to floor, especially if working space is used as a vent chamber.

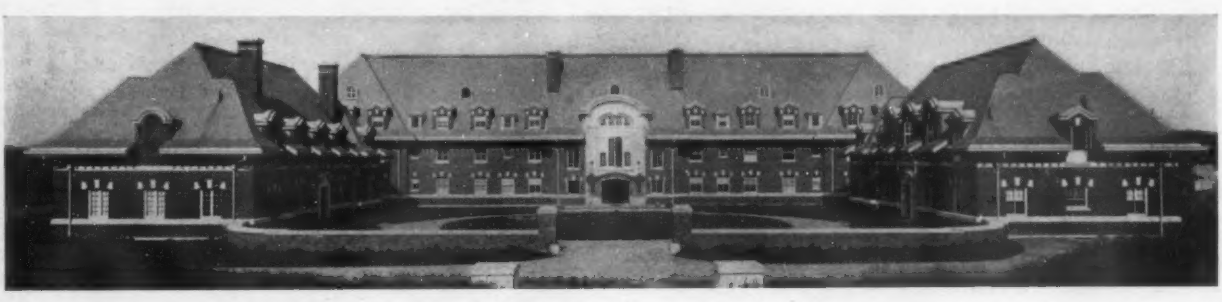
Whether stalls should have doors or not is an open question. The tendency at the present time in many localities is to omit the same. Where this is done the stalls need not exceed 3 feet 6 inches in depth, otherwise 4 feet 6 inches is the minimum. Doors, if used, should swing in and be so adjusted as to be open when stall is unoccupied. Stalls should be 30 inches wide on centers where possible, 28 inches is the least width permissible.

The next important fixture to consider is the urinal, which from a sanitary standpoint requires most careful construction. It is unnecessary to mention the various styles of these that have been used in the past, but instead consider the types of the present time. The essential features that a sanitary urinal must possess are that the exposed surface must be thoroughly flushed as frequently as possible and a body of water maintained to reduce offensive odors to the lowest degree; furthermore, the fixtures must not be too wasteful in consumption of water and, above all, the fixture must be ventilated efficiently.

It is regrettable that the most common type of urinal used in schools to-day does not possess these requirements, being nothing more than a slate or marble slab with a galvanized iron gutter. The flushing is ordinarily accomplished by means of a perforated brass washdown pipe. In order for such a device to be effective too much water is consumed, and the absence of proper ventilation makes it offensive in the extreme.

A superior fixture is an urinal constructed of selected black slate and of the ventilating type with a deep solid porcelain gutter, carrying a standing body of water of not less than 2 inches in depth, which is periodically flushed out by an automatic siphon trap. The flushing of the surface of backs is accomplished by means of a controllable overflow flushing device not liable to become clogged so as to distribute the water unevenly over the surface of backs. The bottom of backs is set above the water-line in gutter and kept about an inch from back edge of gutter forming a continuous vent opening and thus ventilating the fixture as well as the room in which it is placed. The floor slab should be countersunk and grooved to drain into the gutter. Such a fixture is not expensive and will be found entirely satisfactory. Frequently a fixture as described is made up of Carrara glass instead of slate which naturally makes it more expensive.

Recently a new and most sanitary type of urinal has been introduced into school work. It is an urinal of solid white glazed porcelain, 18 inches or 24 inches in width, 42 inches to 50 inches high with a projecting lipped bottom, sides, back and top all in one piece, glazed on all exposed surfaces excepting backs and having integrant shields projecting about 4 inches from face of urinal, thus forming partitions. These urinals



SCHOOL AT BRIAR CLIFF MANOR, N. Y. MR. H. VAN BUREN MAGONIGLE, ARCHITECT are set together, sides being ground if required. The bases are let into floor and provided with slate, marble or porcelain floor slabs. Each urinal has a nickel-plated brass spray flushing device or integral flushing rim which distributes the water evenly over the curved surface, and the base of each urinal has a brass strainer and plug and is connected to a 2-inch P-trap set into or below the floor. The flushing is accomplished by means of an automatic tank, set to operate as frequently as desired. Each urinal has a vent opening covered by a porcelain shield of 12 square inches area near the bottom so that perfect ventilation of the fixture is assured. There is no question but what this fixture is the best and most sanitary at the present time.

Standard siphon jet or similar styles of vitreous earthenware urinal are not adapted for school work. Toilet rooms should have floor drains and traps with not less than 3-inch waste outlets with both solid and perforated covers.

Among the most important fixtures in school work are drinking fountains, and these must, of course, be sanitary. The old-style faucet and trough with germ-ladened cup has been tabooed, and the present day demands a fountain which cannot become infected and transmit disease. For this reason the pedestal fountain with porcelain bowl and metal bubbling cup was designed. This has a constantly running stream of water and makes drinking possible without the lips coming in contact with the cup. If they did they could not become infected, as the cup is constantly being washed with clean water. Some objection to the metal cups was found on account of corrosion and discoloration where the water contained iron or sulphur. Another objection was made on account of the tendency of mischievously inclined children to push those in the act of drinking and thus cause injuries to lips and teeth coming in contact with the edges of the metal cup. Improvements have lately been made in these cups by making them of vitreous china with rolled and rounded edges.

This type of fountain appears to be the best. They may be placed in corridors or playrooms, and one fountain of this type will serve many more than one where cups or glasses are used. These fountains may be provided with self-closing faucets in order to be less wasteful of water, the faucet having a small opening in order to allow just enough water to run continuously to properly wash the edges of cups.

Other styles of fountains are those with which glasses are used, and of these there are numerous types. Some are recessed into walls of corridors or provided with projecting slabs and backs. The latter are often equipped with bubbling cup.

The remaining fixtures required in the equipment of schools are lavatories and slop sinks. The former should be of non-absorbent material, with slabs with or without backs, set singly or in batteries as conditions may demand. They should be provided with self-closing faucets of a durable type. Basins should have some approved type of pop-up waste instead of chain and rubber stoppers. The wastes and supplies should run to wall instead of floors wherever possible, and the lavatories be supported on concealed wall hangers or wall brackets, as such an arrangement prevents the accumulation of dirt underneath the fixtures. Each basin should be provided with a liquid soap dispensing device which is much more sanitary than the cake soap.

As a rule, cold water only is provided for lavatories. It is needless to say that a hot-water supply should be included in the equipment, especially if the school has a gymnasium where showers are necessary.

Janitors' slop sinks may be of porcelain, enameled iron or solid porcelain with integral backs or roll rim all around as desired; sinks must be supplied with hot and cold water.

Showers for gymnasiums should have stalls and dressing compartments of slate or marble, with doors to dressing stall and duck curtains protecting openings between showers and dressing stalls. The shower stalls should not be less than 3 feet x 3 feet inside and dressing stalls 3 feet x 2 feet 6 inches. The shower stall should have a porcelain or slate or marble countersunk floor slab with combined floor drain and trap in center with 2-inch waste. The opening between shower and dressing room should have a coping of slate or marble 6 inches high to prevent water from splashing on to floor of dressing room. The dressing room should be provided with a seat of slate or marble; stalls should be 6 feet 6 inches high above finished floor and bottom of partition should be let into floor 1 inch.

The showers should be of a plain type with 5-inch cast-brass shower head with removable face attached to a ball and socket joint so that the angle may be changed to suit the bather. The shower should be controlled by means of an approved type of non-scalding valve with check valves on the supplies, which should preferably come from wall or ceiling instead of arising from the floor.

The hot-water supply may be provided for by the use of a tank and hot-water heater of suitable capacity, or a tank and steam coil in same if a high-pressure steam system is available. In the latter event the use of an instantaneous automatic hot-water heater is preferable to a tank with steam coil, being more economical in the consumption of steam and having the advantage in that the temperature of the hot water can be better controlled. Fire standpipes of 2 or 2½-inch diameter running from basement to top floor with 1½-inch outlets on each floor must be provided for, each outlet to have approved pattern hose reels with 50 or 100 feet of unlined linen hose and hose valves.

The foregoing summarizes as briefly as possible what should be used to equip our modern schools in a sanitary manner necessary to properly safeguard the health of our rising generation. Beyond question, sanitary plumbing in schools also becomes an unconsciously absorbed lesson in hygiene by children and instills into their minds in a forceful manner the necessity of cleanliness in all things as an aid to health, comfort and happiness.

And this feature, especially in our larger cities, where the school life and the home life offers so wide a contrast, is in itself not the least important part of education, and tends to carry into the homes, by the future heads of families, a realization of the great importance of good sanitation.

THE AMERICAN ARCHITECT

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TO state that architectural development in America is ordinarily along lines of greatest demand is scarcely the pronouncement of a conclusion arrived at by a series of abstruse studies and observations. It is self-evident to all, and only exemplifies a phase of the universal law of supply and demand. And since the demand for school buildings in this country has been more insistent perhaps than that for any other single type of public structures, it is not surprising that much has been accomplished in the line of their development. It is indeed a long step from the primitive school house of our ancestors, consisting usually of a single room entirely lacking in equipment, with the exception of the wood-burning stove in the center surrounded by benches, to the modern school building of vast dimensions and most perfect appointments. The health and comfort of the pupil of the present has received the fullest consideration. The buildings are supplied with heating and ventilating plants that insure an abundance of properly tempered fresh air. The sanitation of school buildings has become a special study, and the progress made seems to leave little to be desired. The problem of correct lighting has also received much attention, and whether studying by natural or artificial light a pupil attending a modern school ordinarily subjects his eyes to the least possible strain.

BUT while the utilitarian side of the subject has received such generous attention, with most gratifying results, the architectural and esthetic problems presented have not been overlooked. In many communities the school building is among the most dignified of the public structures, if not, indeed, the only building that can lay claim to the possession of any architectural merit. In our larger cities the modern school buildings appear to rank architecturally with any of a public or semi-public character erected. The necessity for economy in cost of construction has limited the designers in the choice of materials and rendered necessary the adoption of some standard forms and materials not possessing the highest artistic merit, but in general the lines are pleasing and the effect of mass satisfactory. The improvement in this regard over the average school building of a few years ago is no less marked than that of the present day Federal building as compared with those erected before the Tarsney Act became operative, and the office of the supervising architect of the Treasury raised to the high standard of efficiency that has characterized it during recent years.

A CAREFUL examination of many plans for recent school buildings seems to establish the unfortunate fact that provision for the personal safety of pupils has not in general been made commensurate with those provisions intended to afford health and comfort. Buildings are not invariably made fireproof. Ample means of exit through wide corridors and by way of broad direct staircases are not always to be found. Other well-recognized means of safeguarding the lives of children in schools are too often omitted. It would seem that the first and most absolutely essential requirement of a school building would be safe construction. It should provide all the means of safety from fire and panic that human knowledge and ingenuity can devise. It is difficult to understand the attitude of some School Boards toward the comparatively small item of additional cost which building fireproof would involve. With the appalling catastrophes of recent years, due in great measure if not entirely to cheap non-fireproof construction and improper details of equipment before them, it is almost inconceivable that any body of men would sanction anything but the type of building affording the greatest measure of safety. If it were merely a matter of their own safety and not that of their children, non-fireproof buildings would not excite so much wonder and comment; but, as it is, the only explanation seems to lie in a charitable assumption of ignorance. Under all the circumstances it would appear to be the architect's plain duty to advise even to the point of insistence the construction of any school building more than one story in height of fireproof materials.

ANOTHER phase of the modern school building, and one quite apart from architectural considerations is found in the manifold uses to which it has lately been adapted. It is becoming little short of a social and neighborhood center. It is supplying many of the needs that in small towns are supplied by a town hall wherein lectures, concerts, debating contests and social gatherings are held. In summer its playgrounds are thronged with children, and the building comes to hold an attraction for the youth of to-day, whereas in former times he cherished a strong and deep-rooted dislike for the building and all that in his immature mind it typified. Taken all in all the need for and importance of obtaining school buildings of the highest type apparently transcends that for buildings of any other class. We have made notable progress, but much yet remains to be accomplished.

HOW WIND AFFECTS VENTILATION

The effect of wind against a building on its ventilation and heating was ably discussed in a paper presented by Mr. H. W. Whitten, of Detroit, at a meeting of the American Society of Heating and Ventilating Engineers at Indianapolis. Mr. Whitten premised that the most apparent effect is the inleakage of air through crevices, particularly those about movable windows and doors. In cold weather this inleakage becomes evident in the form of cold draughts which are often noticeable at a distance from the walls toward the interior.

The volume of this inleakage, Mr. Whitten continued, varies in proportion to the velocity of the wind, sizes of crevices, and means of egress of air from the building, and it is also affected in a small degree by the pressure exerted by the expanded warm air inside of the building. This pressure must be overcome before the outside air can enter. During the heating season this inleaking air, being of a lower temperature than the inside air is desired to be, must be heated. These phenomena are apparent and their effects are common knowledge.

Recent investigations have shown, however, that the variation in the volume of inleakage due to variation of wind velocity is much greater than was generally believed.

The least apparent effect, and in the opinion of Mr. Whitten the most important, is the outflow of warmed air through crevices in the sheltered sides of buildings. Windows and doors are constructed with the primary object of excluding draughts from outside, but are not so well adapted to prevent air currents escaping from the inside.

The wind strikes an obstruction, a building, is diverted from its natural course and is forced to pass by and over the obstruction. In doing this its speed is accelerated, the parted currents uniting at some distance beyond the building and resuming their normal velocity.

This action produces an area of low pressure in the lee of the building which acts as a partial vacuum. This partial vacuum acts as a continuous pump on the crevices of the lee sides. As the pressure of the inside warm air is naturally outward, the combination of this pressure with the partial vacuum outside produces a greater loss than is sustained on account of inleakage, assuming the aggregate amount of crevice on each side to be equal. This loss is greatly increased when other means than wall crevices are employed to admit outer air, such as cold air inlets for hot-air furnaces, supply inlets for indirect or fan systems, etc. This outward flow of air is not attended by disagreeable draughts and, unless special means are taken to detect it, is not evident to the senses.

Mr. Whitten mentioned some tests made by him last winter in this connection. In a rectangular school building with the ends facing north and south and stairway windows only in these ends, the east and west sides divided into rooms each having five 5 feet by 9 feet windows with usual clearance and sills on a level with the pupils' heads when seated, the heating was accomplished by a fan system designed to supply 1,800 cubic feet of air per hour per pupil with an inlet velocity of 750 feet per minute. With a northwest wind of 14.5 to 15 miles velocity and a temperature of 33 degrees, a room on the east side of the first floor, one room removed from the south end, showed an average rate of supply of 817 feet and a vent velocity of 340 feet per minute, inlet and outlet being of same size, the latter at the floor and the former 8 feet above and both on the side of the room opposite from the windows.

This showed a loss of 477 feet per minute. An air test showed 10 parts of CO_2 (carbonic acid gas) in 10,000. It was noted that there were frequent complaints from headache from the scholars. Other rooms on the same side showed losses of 350, 357 and 375 feet per minute, while a partly sheltered west side room showed a loss of only 160 feet, and another exposed to the strongest wind effect showed a supply rate of 410 feet and a vent velocity of 705. The average temperature of the east rooms at breathing level was 73 degrees, and at the floor 70 degrees, and of the west rooms, 68 degrees and 58 degrees, respectively.

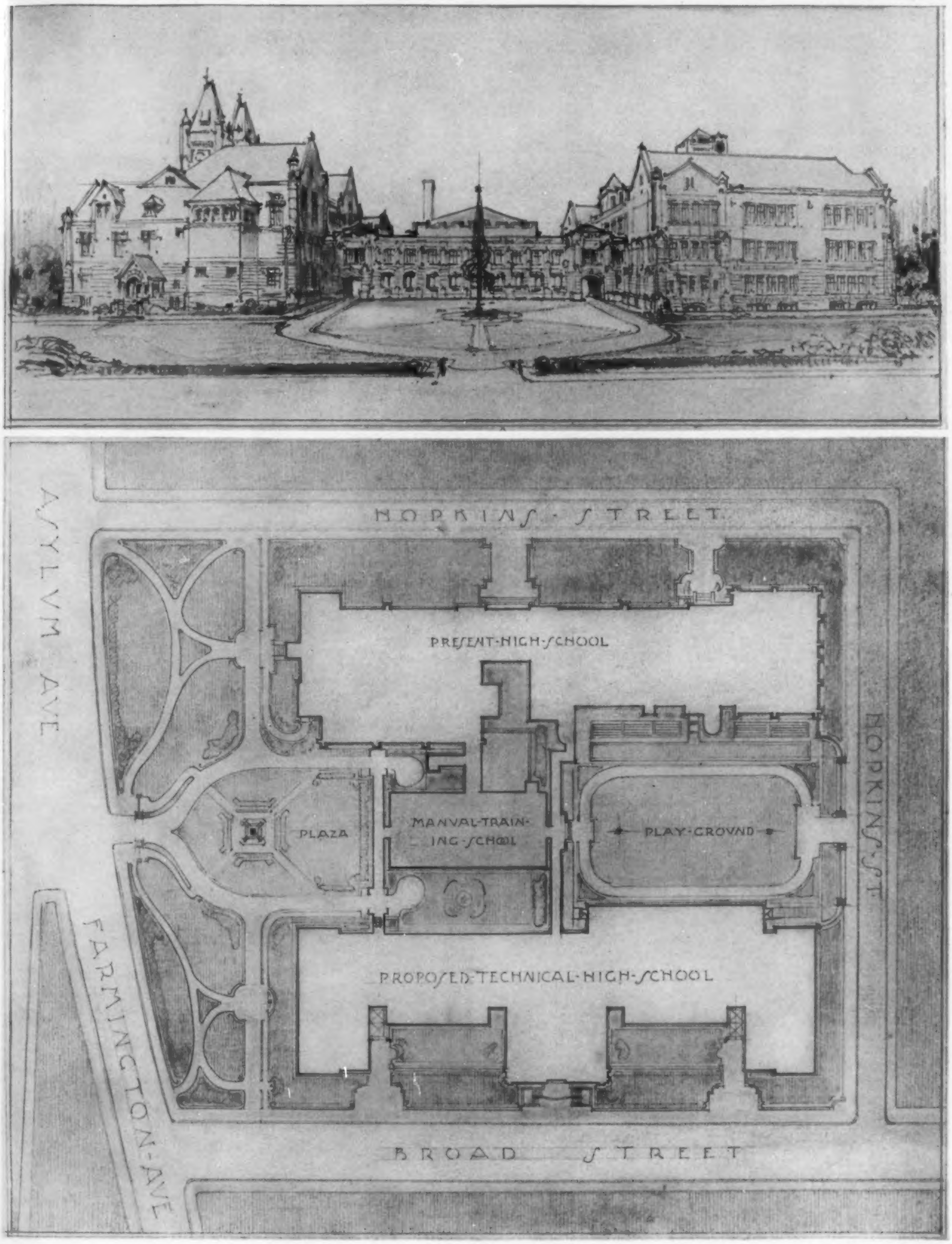
Another school building with an 18-mile wind and 30 degrees outside temperature, heated and ventilated by a gravity indirect system, showed an average loss of 20 per cent. from the supply ducts in the windward rooms and an addition of 60 per cent. to the vent velocity, while the leeward rooms showed an increase of 30 per cent. in the supply velocity and a reduction of 62 per cent. in the vent velocity.

Under other conditions where there were a few corridor windows on the north side and schoolroom windows on the other three points, the air supply was found to be 2,340 feet and the volume passing through the vent 1,451 feet per minute.

A test made some years ago by A. B. Franklin, of Boston, on a school building with a 25 to 30-mile wind blowing toward a majority of the windows showed the following supply and discharge of air in cubic feet per minute:

	At inlet	At outlet
Room exposed	1,536	2,367
" "	1,533	2,307
" "	1,996	2,838
" "	2,244	2,990
" "	1,694	2,391
" "	568	1,154
" "	933	1,404
" partly sheltered	2,200	2,368
" " "	2,301	2,288
" " "	1,602	1,773
" partly exposed	2,517	2,777
" " "	1,609	2,031
" " "	2,253	2,762
" " "	1,389	1,653

In a high school building the question was raised whether the heating contractor had put in a competent fan system. The supply seemed of sufficient quantity and temperature, but the rooms on the exposed side could not be satisfactorily heated. After shutting down the fan the supply ducts were closed in the rooms on the exposed side and with all the doors and windows closed it was found that as much air was being removed from the vents as the fan was supposed to supply. The wind at the time was of moderate velocity.—*American Carpenter and Builder.*



PERSPECTIVE AND BLOCK PLAN

The symmetry of the above plan is commendable. The proposed Technical High School is a practical modern school building, the same length as the present High School and its location serves to screen the Manual Training School, a somewhat incongruous building. The ready intercommunication between the three schools of the group is well provided for.

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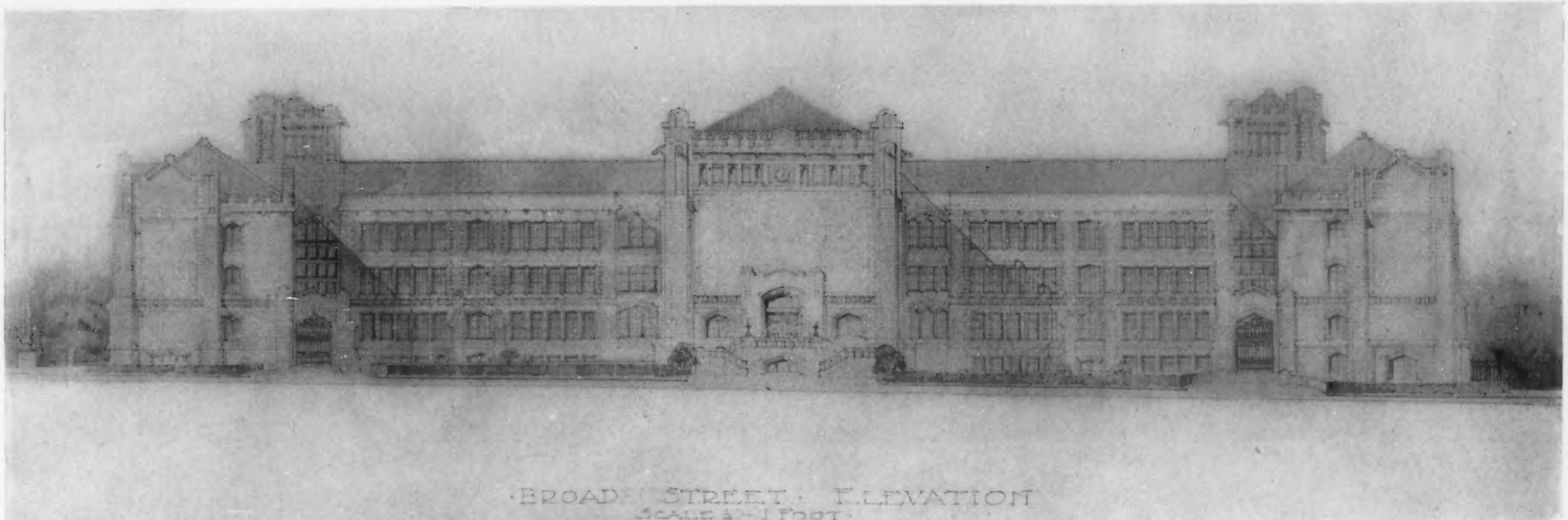

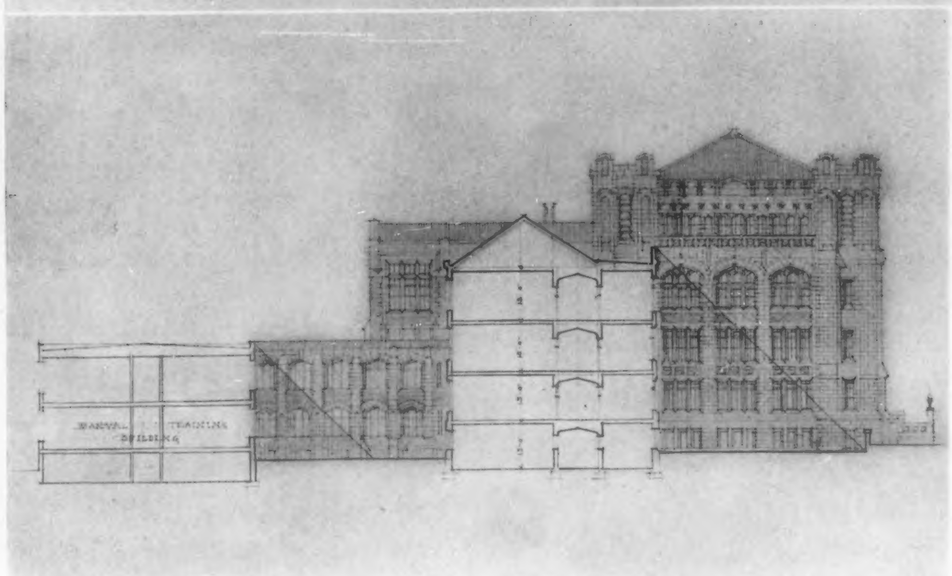

BROAD STREET ELEVATION AND CROSS SECTION, SHOWING SIDE ELEVATION OF CENTRAL PAVILION

These plans contemplate a fireproof construction of floors and partitions upon a steel frame with the exterior walls self-supporting, and bearing their share of the weight of the floors. In selecting the exterior materials for this building the architects suggested red brick with a brown sandstone trim, as best harmonizing with the buildings already erected. The cubage of this building is about 3,000,000 cubic feet, and the probable cost, as estimated by Mr. John M. Carrere, professional adviser to the Board was 20 cents per cubic foot, or $600,000.

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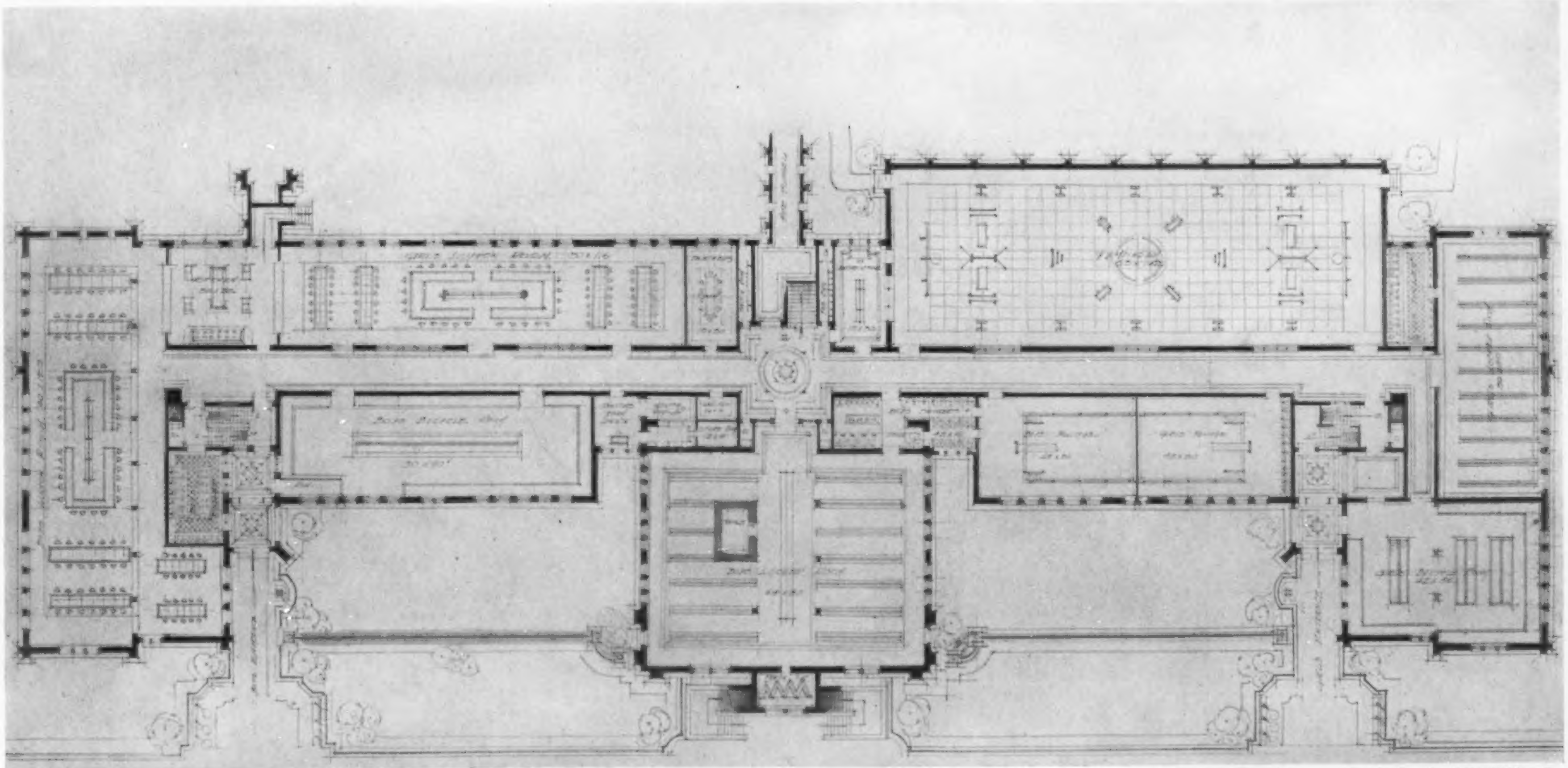

BASEMENT PLAN

Note that the gymnasium occupies all the space facing the playground through the first floor thus eliminating the noise from all classrooms. The baths and lockers naturally group themselves about the gymnasium, and occupy the south half of the basement.

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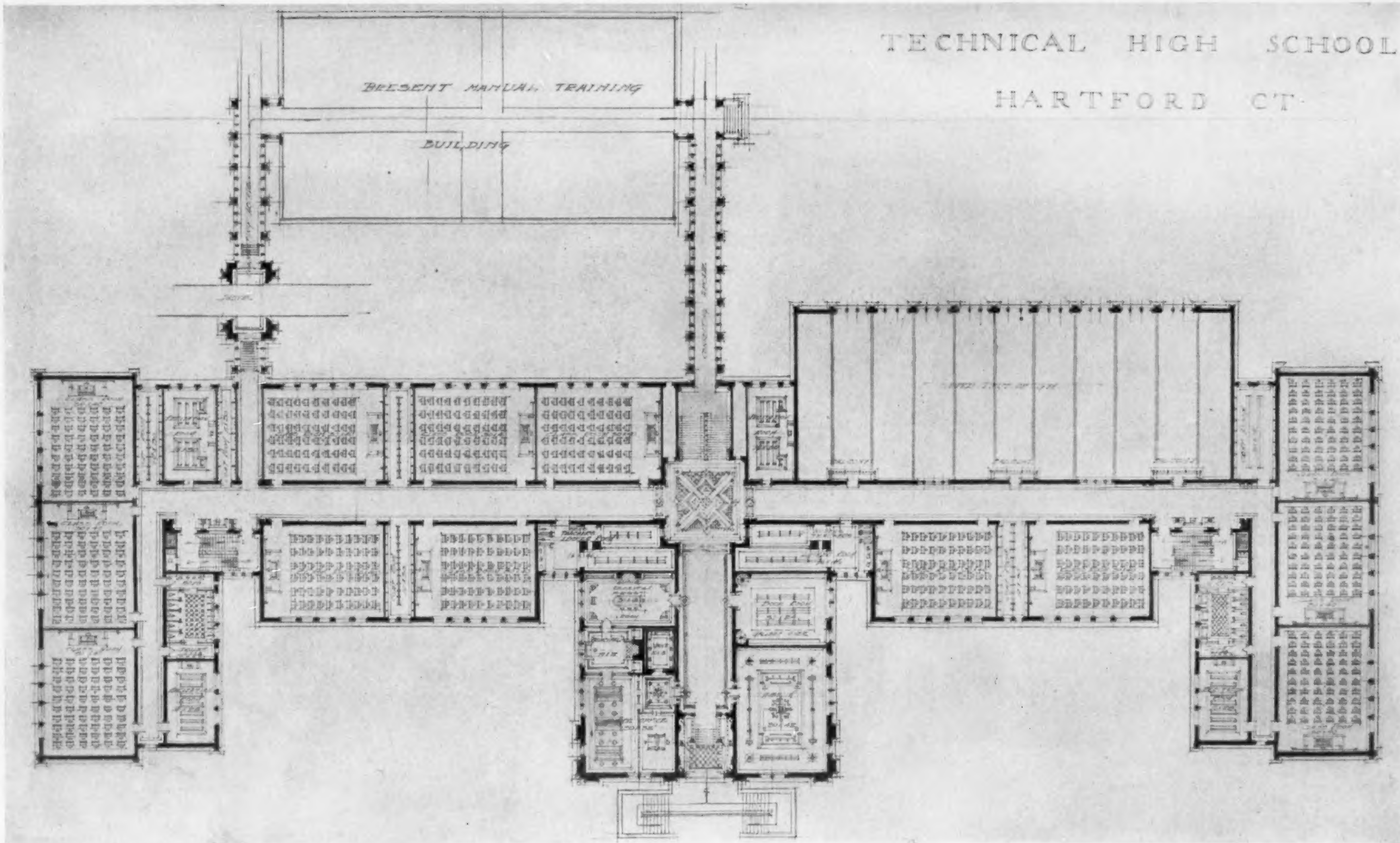

FIRST FLOOR PLAN

The classrooms are uniform throughout the building, 30 x 40 feet, with light from groups of five windows on long side of rooms, furnishing one foot of glass area for six and one-third feet of floor area. The requirements of the programme seem to have been admirably complied with in every essential detail.

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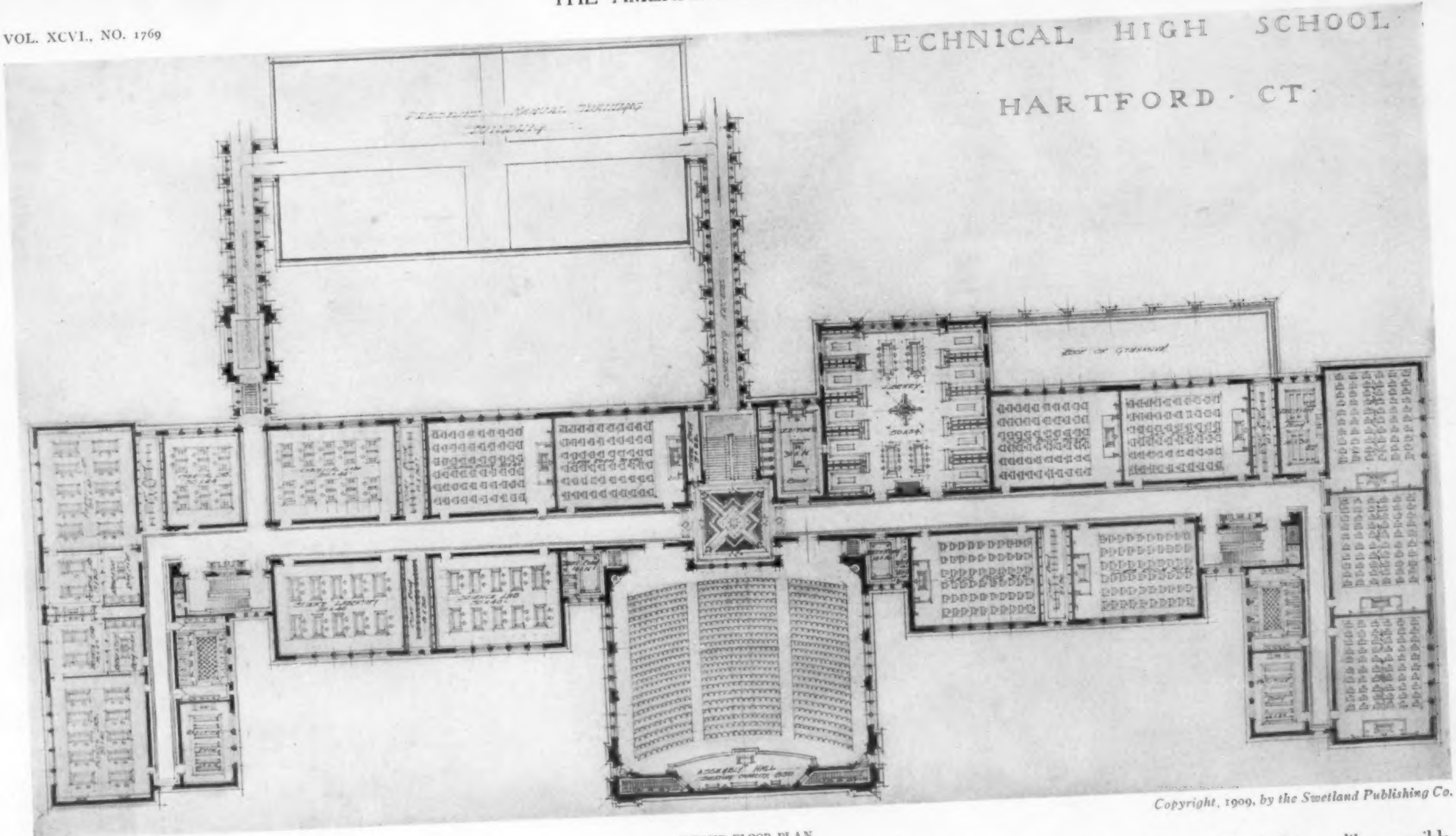

SECOND FLOOR PLAN

In the planning, careful attention has been paid to the grouping of the sexes in their proper ratio, which is established as eight to five. The assembly hall is readily accessible, and is reached by a flight of monumental stairs opposite the central entrance. Other features of the plan are the library and the laboratory group.

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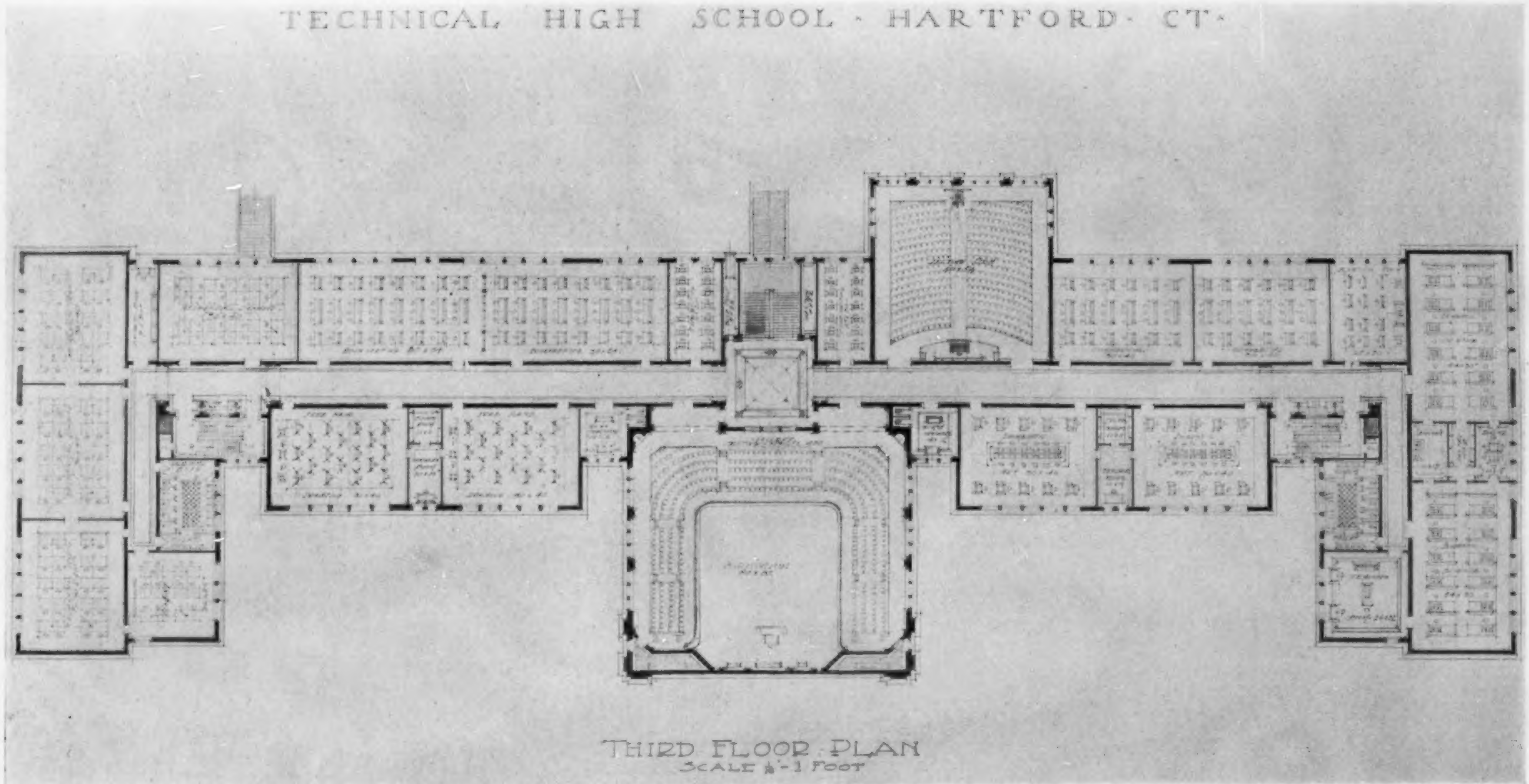

The principle features of the floor are the lecture room, auditorium, and drawing group. The domestic art and science groups are also on this floor. The boys and girls, throughout these various floors, have separate entrances at a central point in their classroom groups. Double interlocking stairways are placed between these entrances and the corridor, so that it is possible to reach any floor directly without crossing the building.

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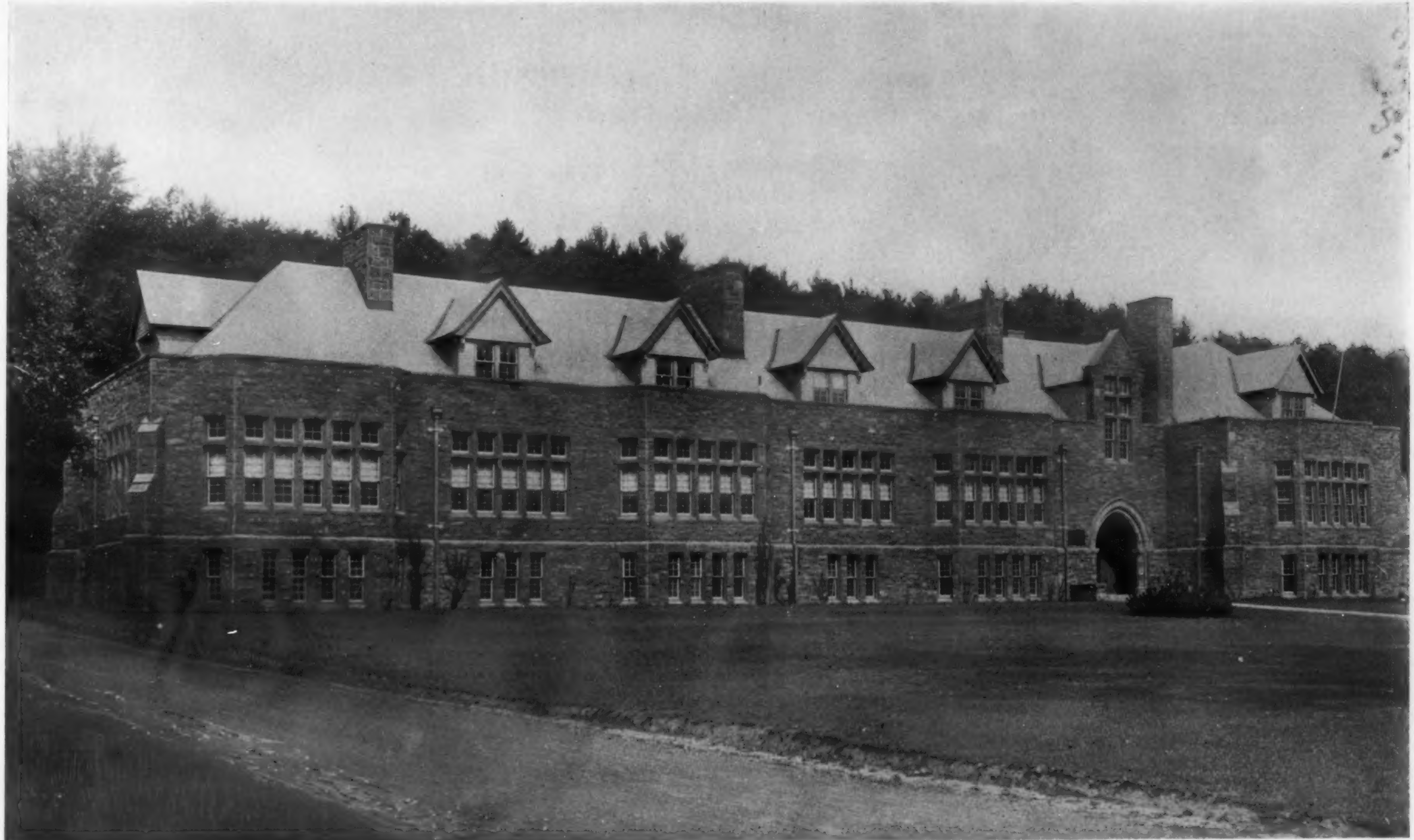
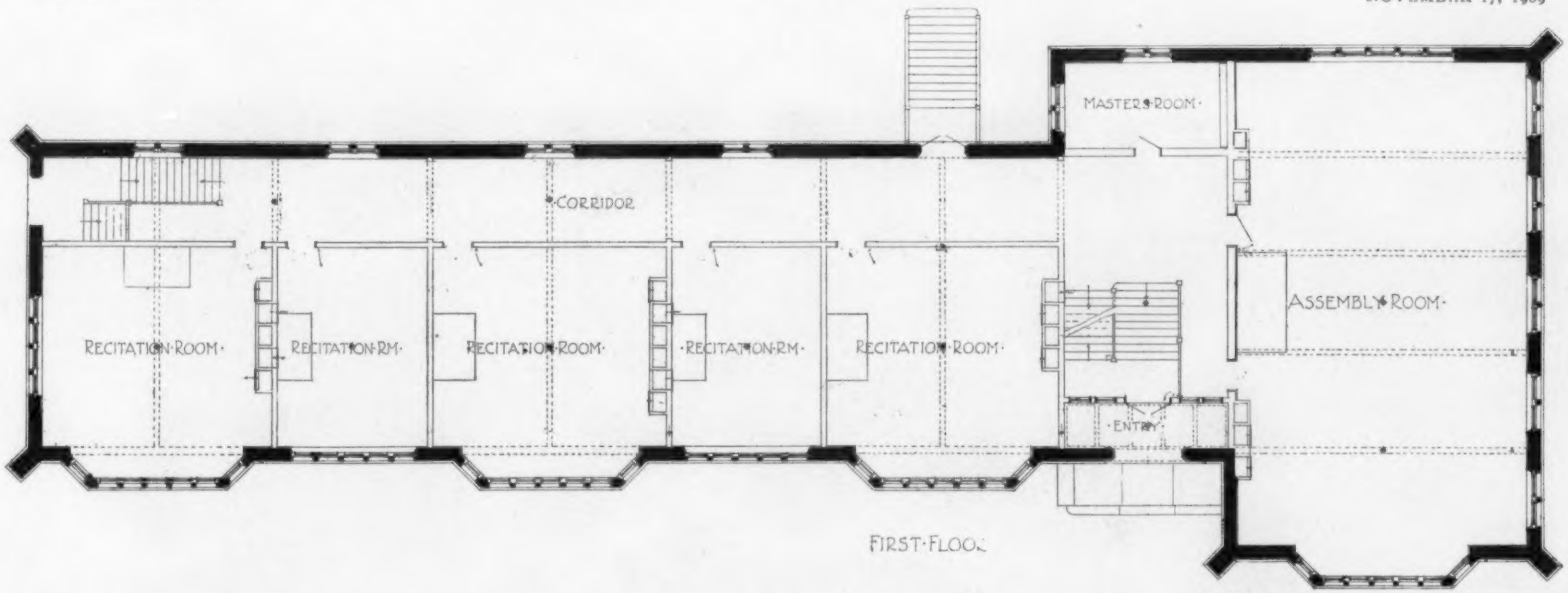


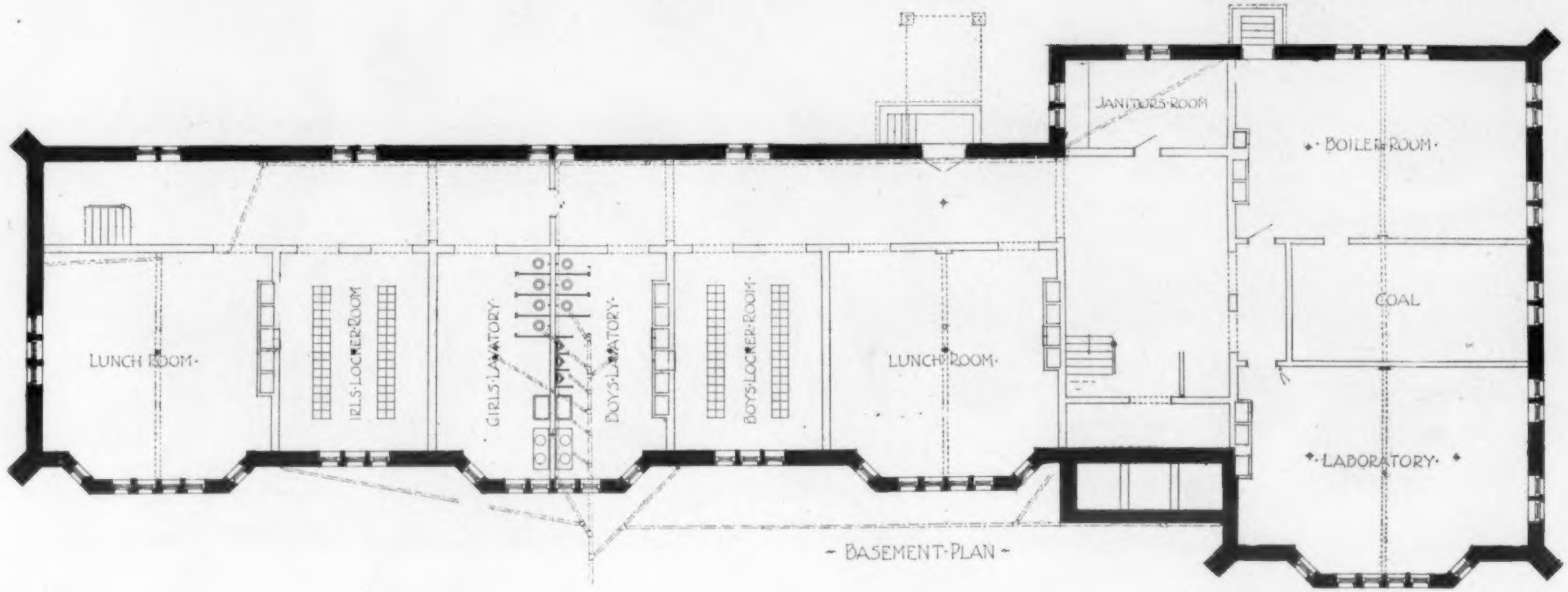
HIGH SCHOOL
SIMSBURY, CONN.

This building is built of local red sandstone with roof of varigated green slate. As the land available was large, and the background a picturesque one, it was determined to make the building practically a one story school. With the exception of a teachers retiring room and toilet there is nothing in the second floor, although it has been arranged so that additional recitation rooms may be finished there if desired. Building is heated by usual gravity system.

MR. E. F. HAPGOOD
ARCHITECT



FIRST FLOOR



BASEMENT PLAN

HIGH SCHOOL
SIMSBURY, CONN.

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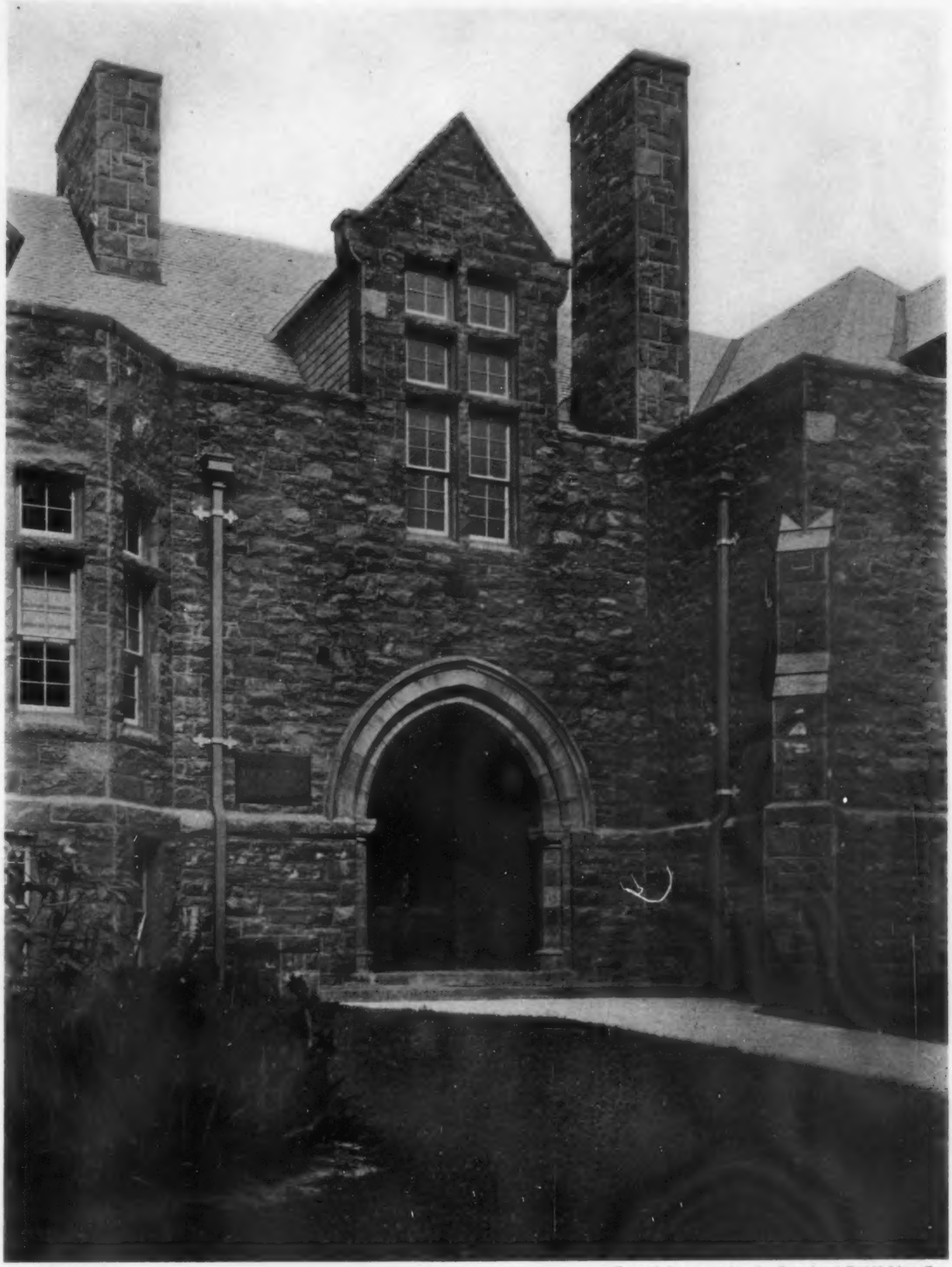
ARCHITECT



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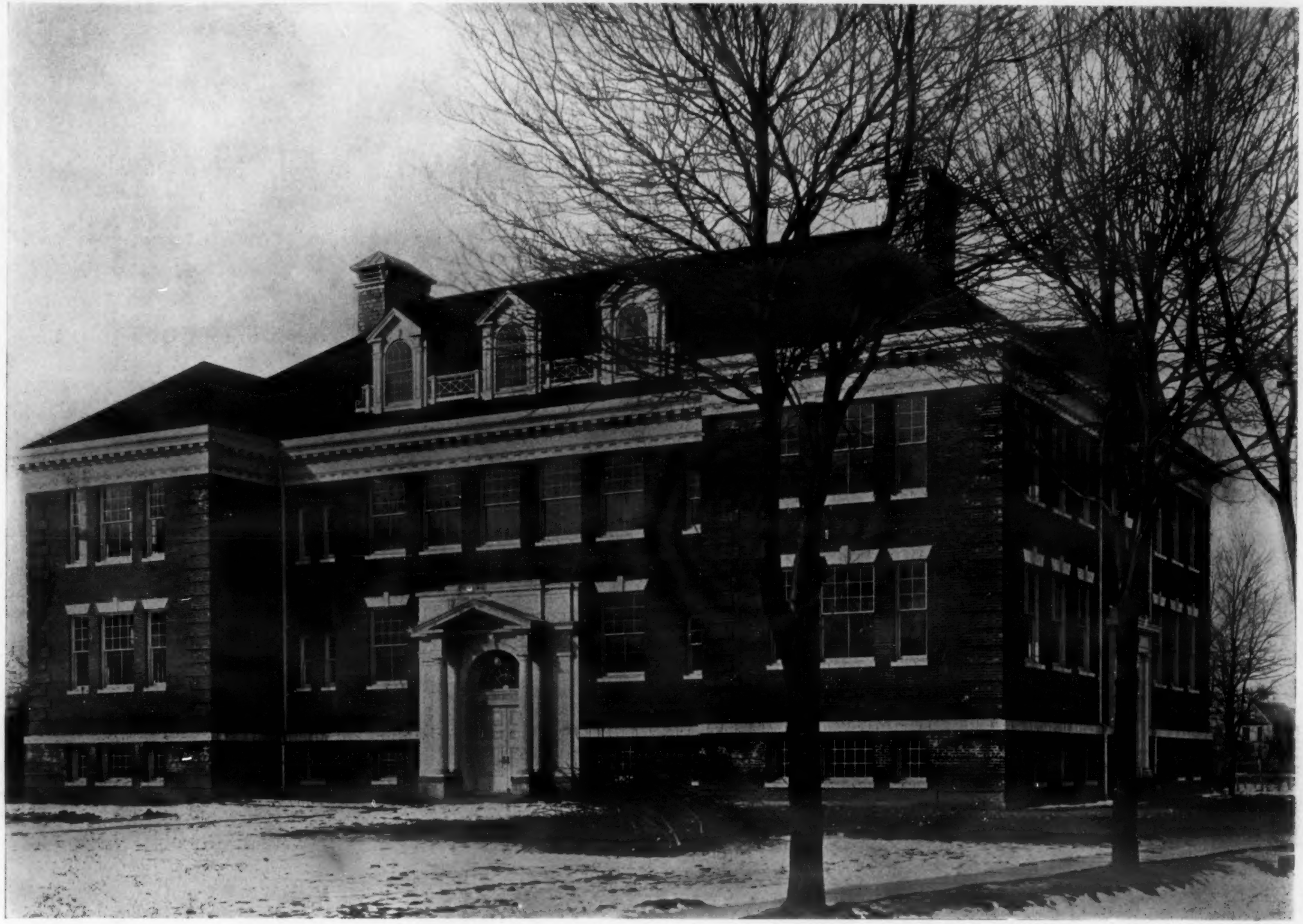

PUBLIC SCHOOL
METUCHEN, N. J.

The exterior of this school is built of dark red Clifford brick, laid up with dark wide joints. The water table, sills and lintels of windows, are of cream colored terra-cotta, matte glazed. The main and side entrances are of white pine, painted white, as is also the cornice of building. The roof is of red cedar shingles. Floors are of maple and interior trim of North Carolina pine. The walls are of hard plaster, and the ceilings metal.

Cost, $45,385.10, or 14 3-4 cents per cubic foot.

MESSRS. WALKER & MORRIS
ARCHITECTS

Cost, $45,385.10, or 14 3-4 cents per cubic foot.

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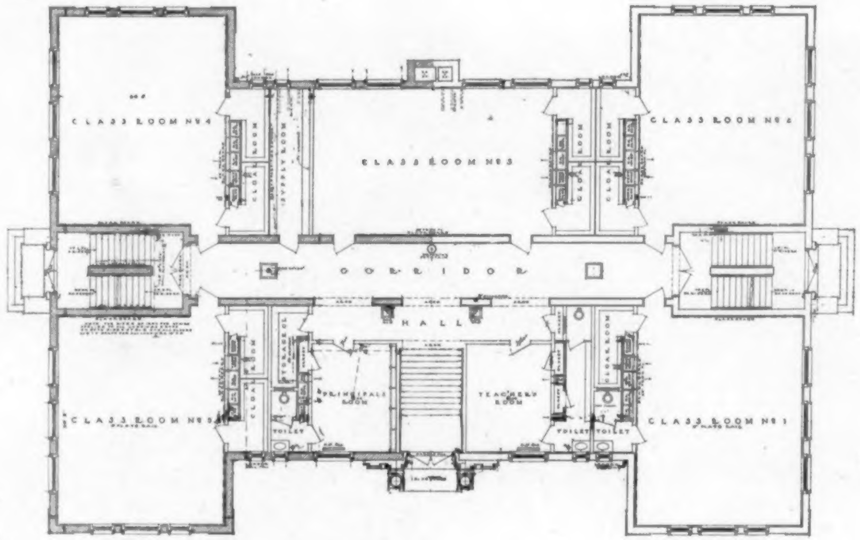
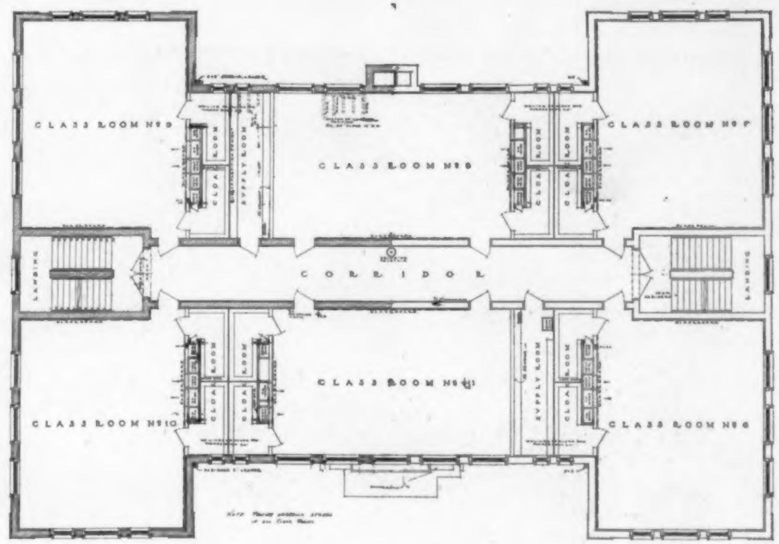
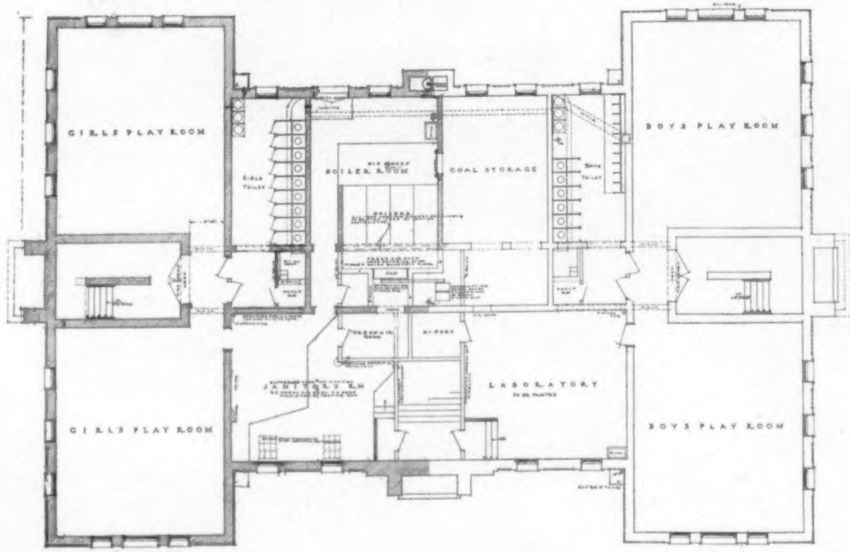
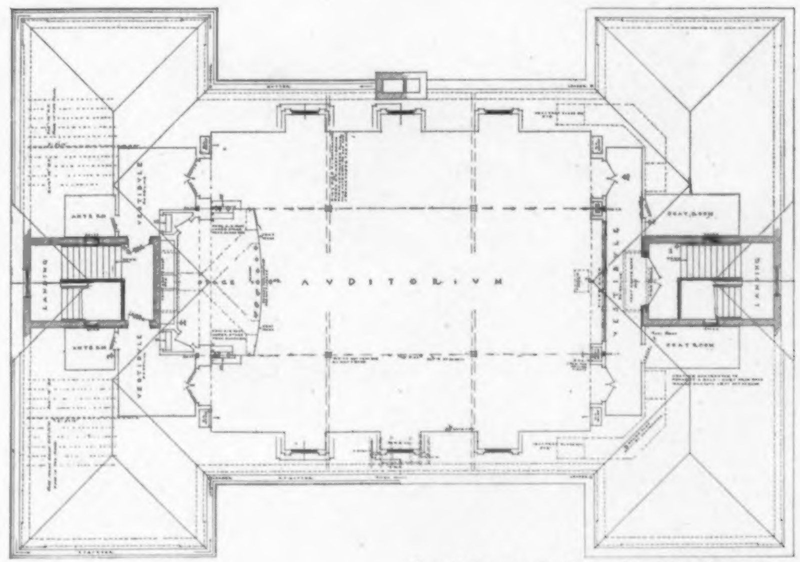


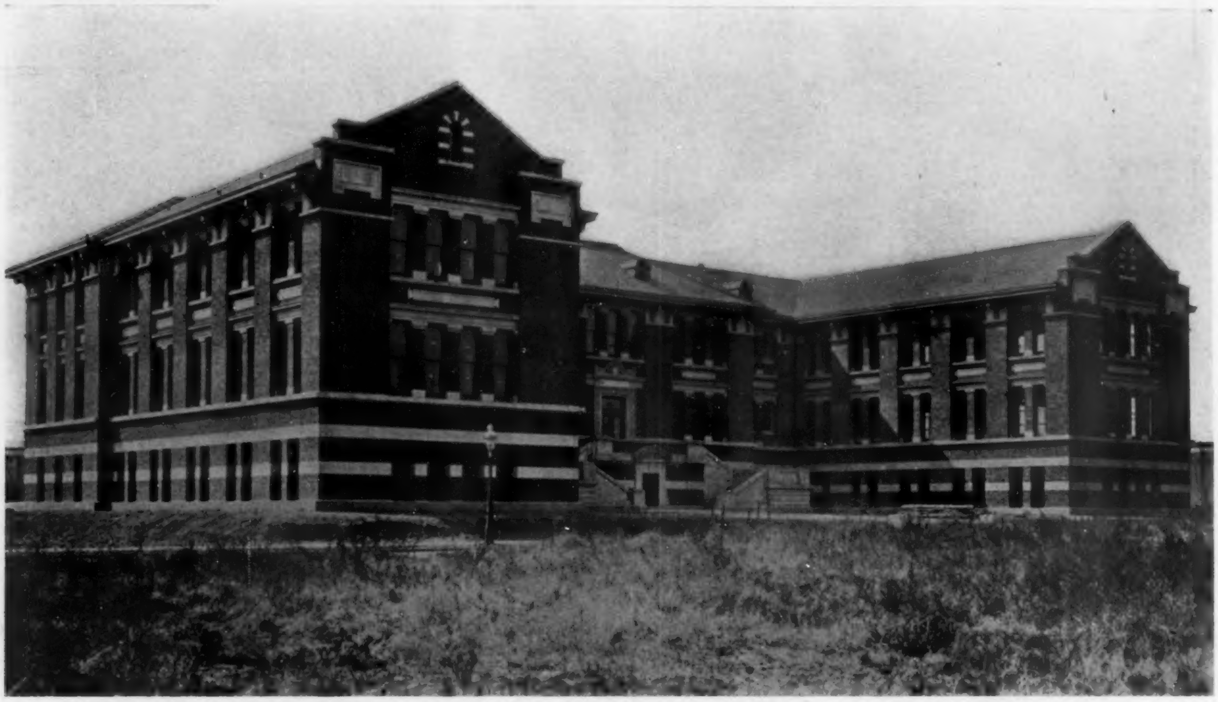






PUBLIC SCHOOL
METUCHEN, N. J.

MESSRS. WALKER & MORRIS
ARCHITECTS



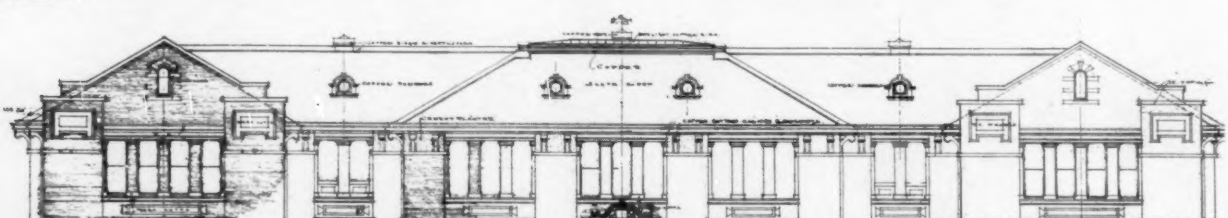
The David Ranken, Jr., School of Mechanical Trades, was founded for the purpose of teaching the Building Trades to young men at a nominal cost, and also with the hope of improving the standard of workmanship among mechanics by affording a means of a more thorough fundamental education, in mechanics, than is possible under prevailing methods.

Study of existing institutions of similar purpose showed well developed methods of instruction, but with inadequate housing. The building problem had therefore to be solved in practically an independent manner by the Architects. The site occupies the half of a city block and is about 450 feet long by 305 feet wide, bisected by a 20-foot public alley, which is expected will be soon vacated by the City.

The amount of money immediately available for building purposes was limited to about $150,000.00. As it was the desire of the founder to begin building operations immediately with a view to the early inauguration of school work, it was deemed advisable to begin at once the erection of a single building, arranged for immediate requirements, but planned to ultimately become one of a group of connected buildings covering the greater portion of the building site. It was determined to provide at once facilities for the instruction of classes in bricklaying, plastering, carpentry, plumbing and painting, with one other shop room to be used temporarily as an Assembly Hall.

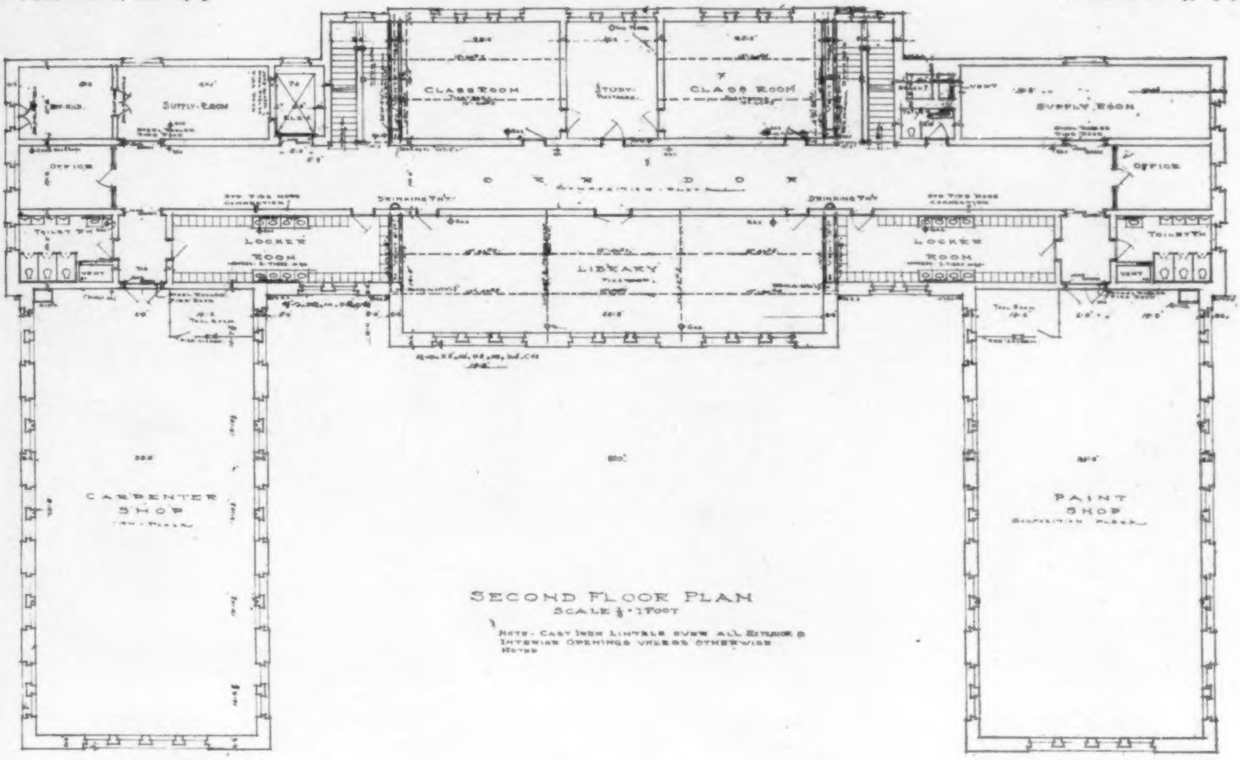
These six shops are contained in two wings of three stories connected by corridor with an Intermediate Building, containing the class rooms and a temporary Administration Office. Each shop is 35' x 70' with light exposure on three sides and separated from the main corridor only by the toilet and locker rooms. Across the corridor and directly back of each shop is a supply room for the storage of various materials for use in shop work. These are directly accessible from the Alley by means of the freight elevator. Part of the supply room assigned to the Carpenter Shop is occupied by a dry kiln for lumber. Except for doors and windows, no combustible material is used in the building, which is made as fireproof as possible. All partitions and walls are of brick. The floors are reinforced concrete with karbolith top finish and sanitary base. The main corridors are finished in light gray brick and the shops in ordinary brick, the only plastering being in the class rooms and offices. The sub-basement contains a heating, lighting and power plant sufficient for the present building, including power for electric motors to run the machinery necessary in the shops. The exterior is of rough brick with terra cotta trimmings, except the frieze, which is of plaster.

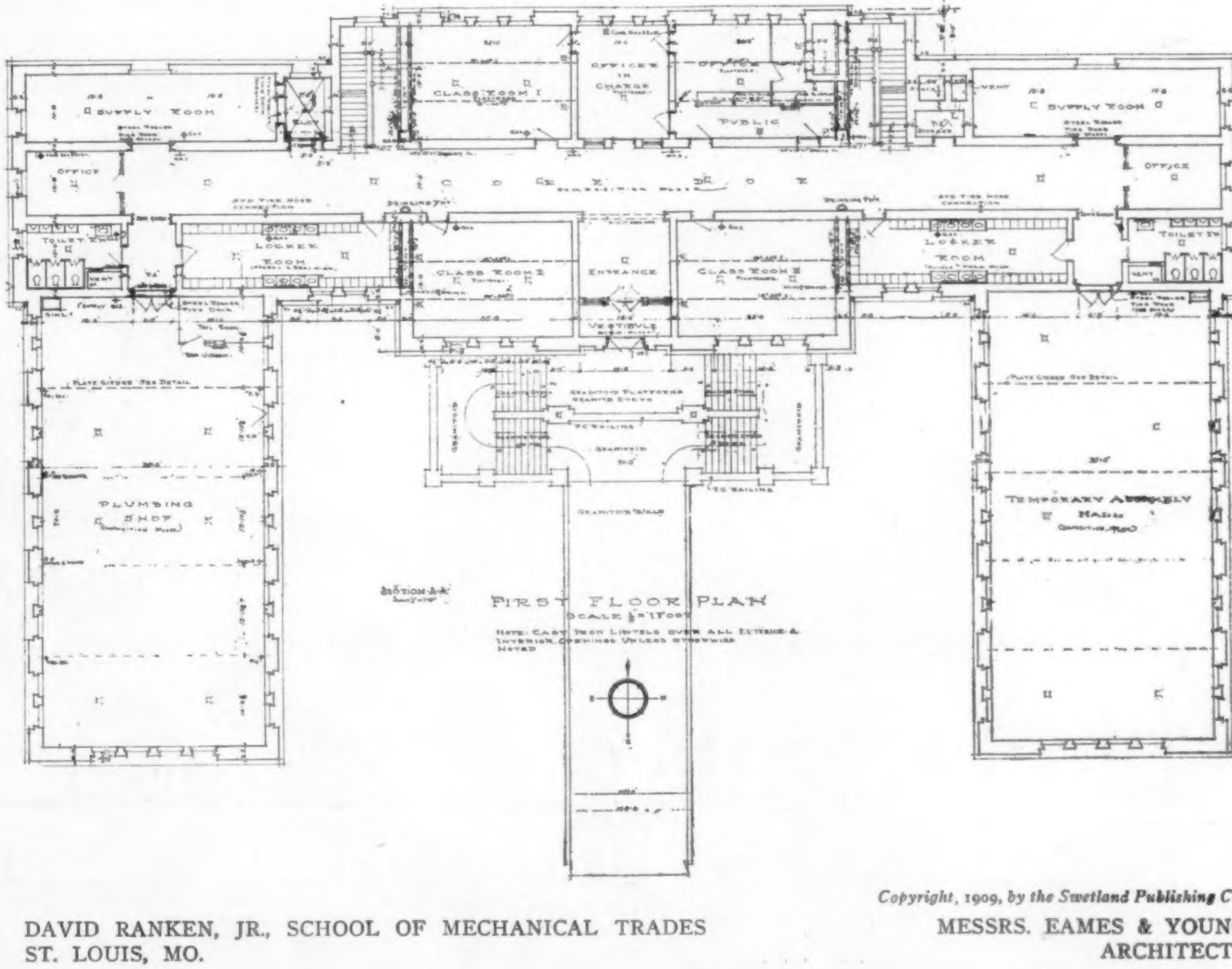
It is expected that this School will be greatly extended in the near future by the addition of an Administration Building, Library and Assembly Hall, and much more shop room, but the planning of these buildings is not sufficiently advanced for illustration.



DAVID RANKEN, JR., SCHOOL OF MECHANICAL TRADES
ST. LOUIS, MO.

MESSRS. EAMES & YOUNG
ARCHITECTS





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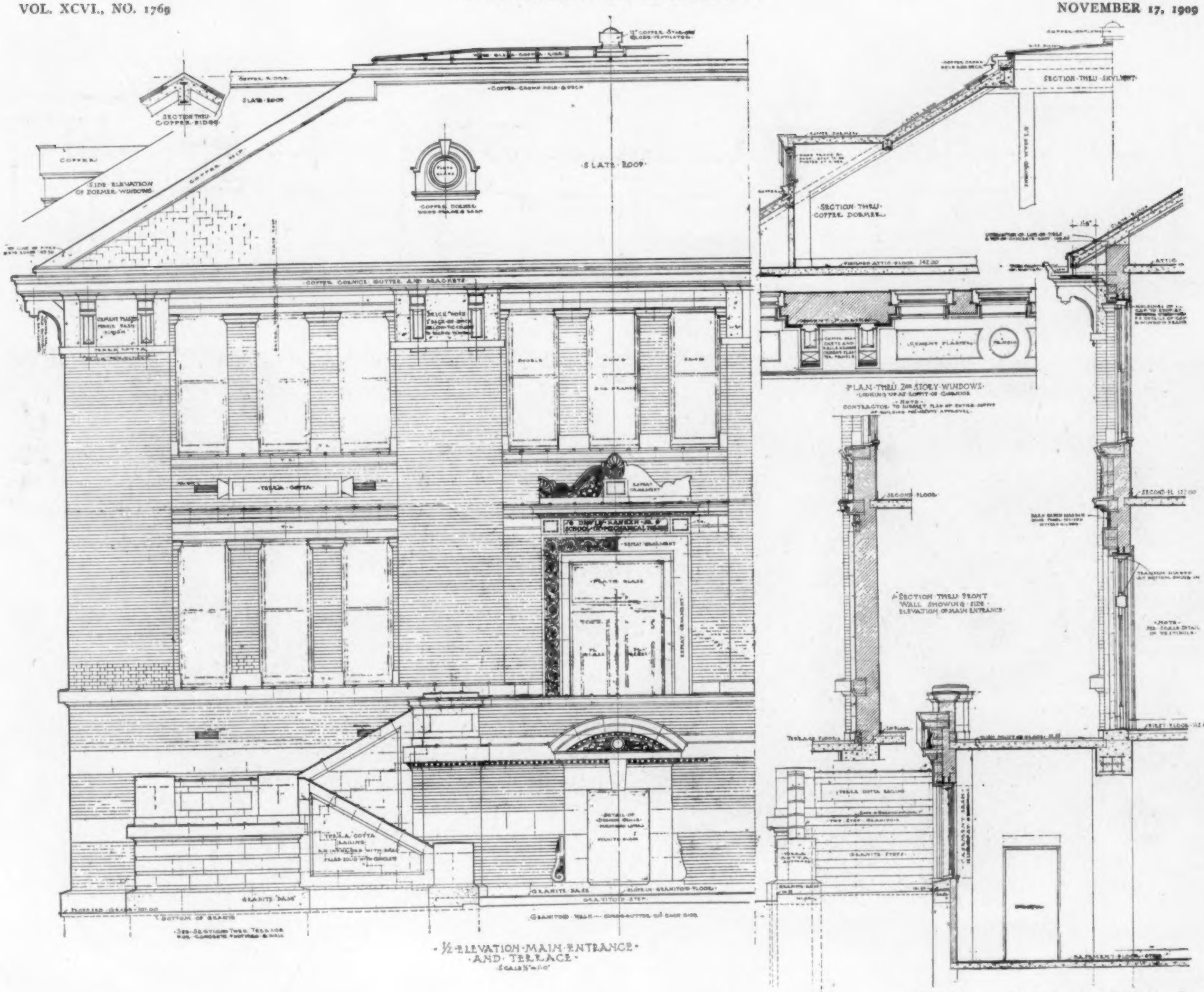

DAVID RANKEN, JR., SCHOOL OF MECHANICAL TRADES
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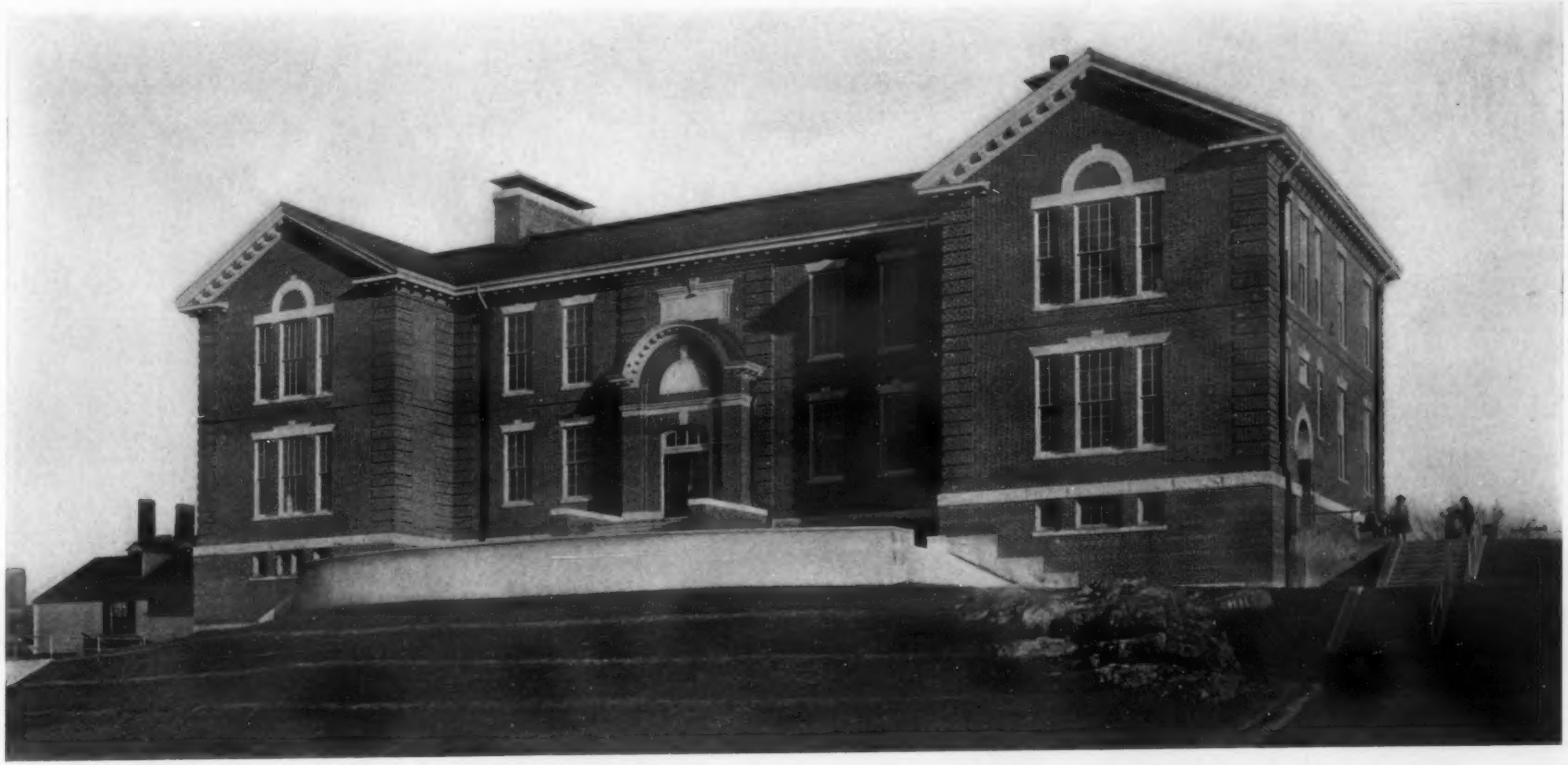
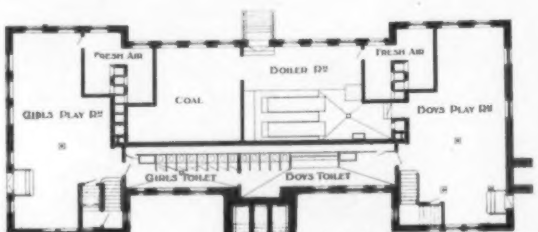
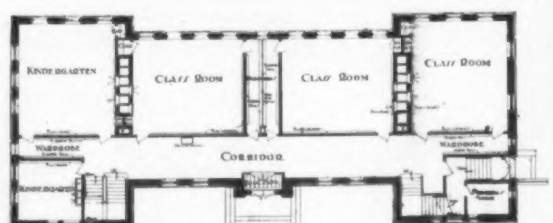
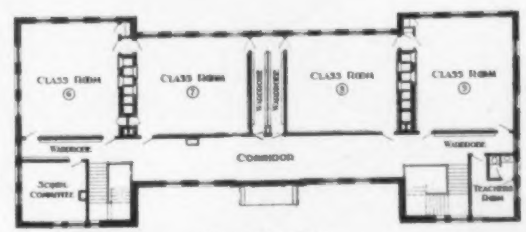




Basement Plan



First Floor Plan



Second Floor Plan

ELBRIDGE GERRY SCHOOL
MARBLEHEAD, MASS.

MESSRS. KILHAM & HOPKINS
ARCHITECTS

ELBRIDGE GERRY SCHOOL
MARBLEHEAD, MASS.

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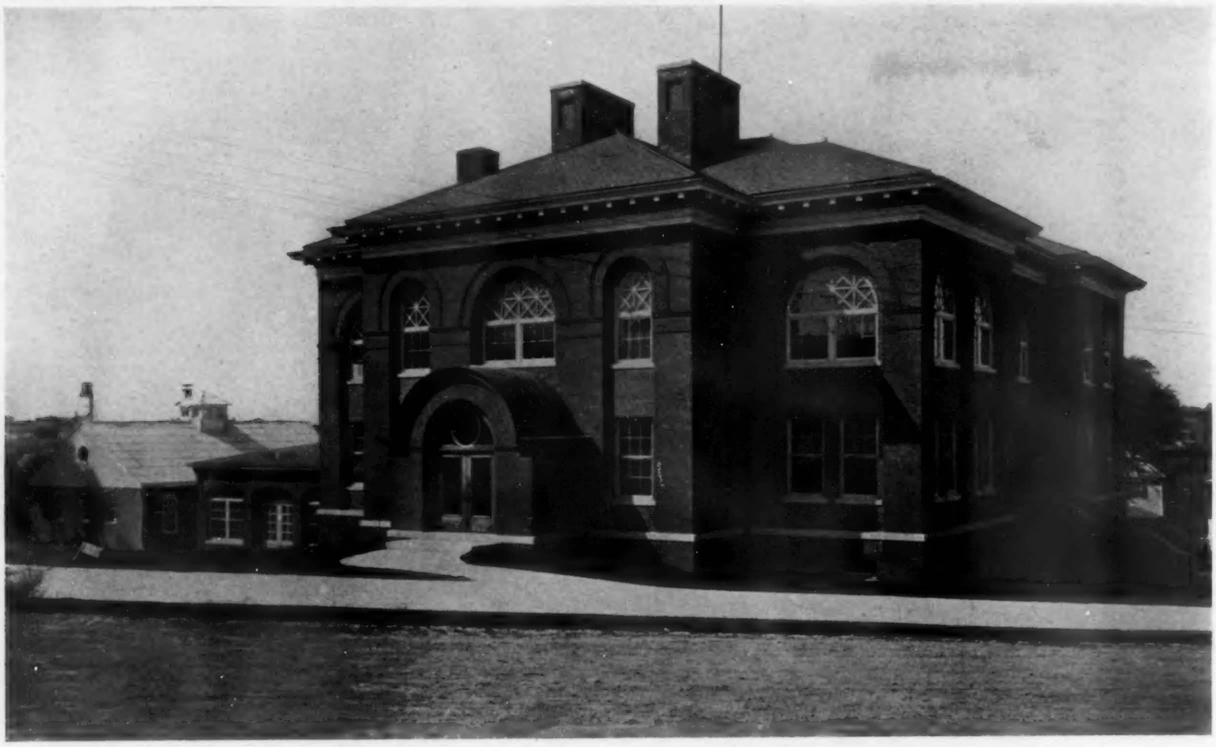
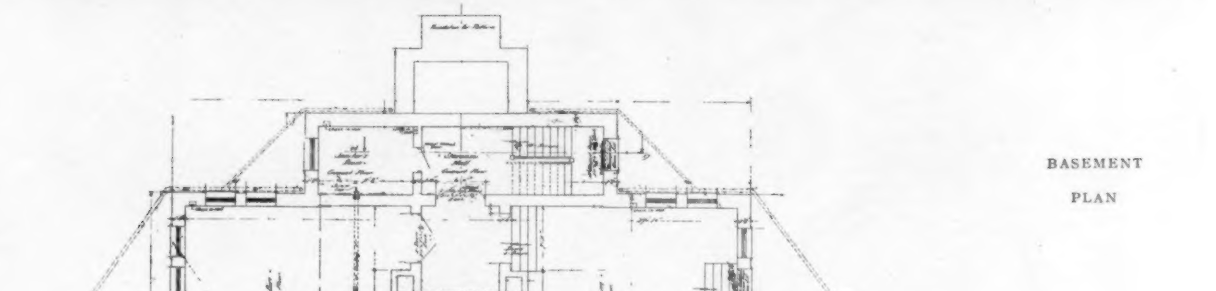
ARCHITECTS

MANUAL TRAINING AND INDUSTRIAL SCHOOL
NEW LONDON, CONN.

MR. DUDLEY ST. C. DONNELLY
ARCHITECT



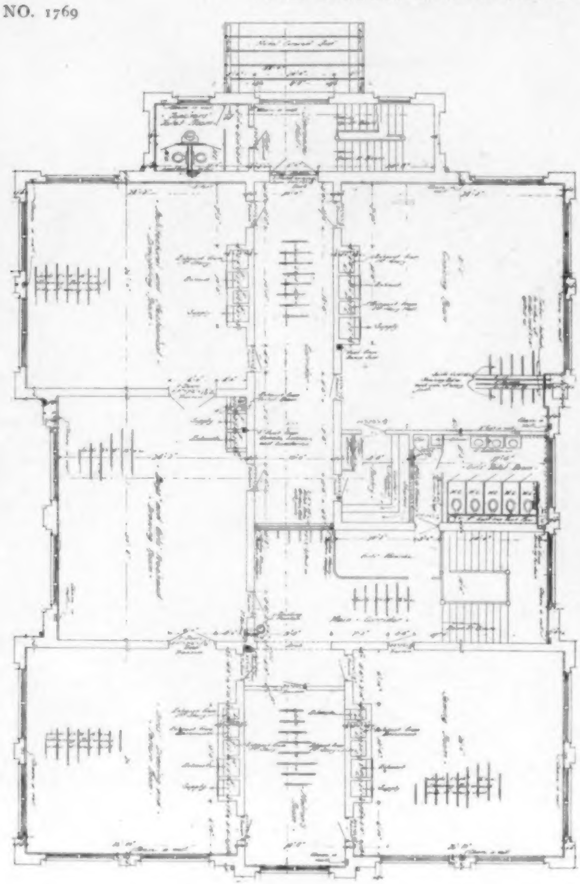


BASEMENT PLAN

MANUAL TRAINING AND INDUSTRIAL SCHOOL
NEW LONDON, CONN.

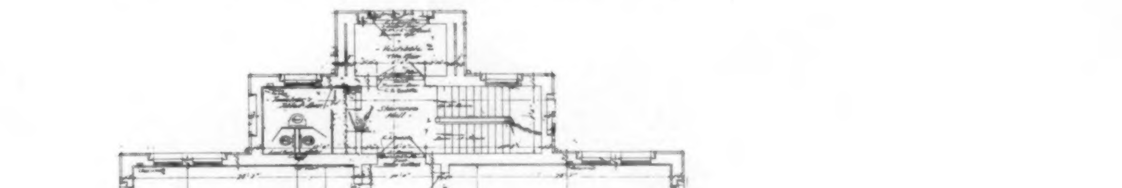
MR. DUDLEY ST. C. DONNELLY
ARCHITECT

FIRST AND SECOND FLOOR PLANS



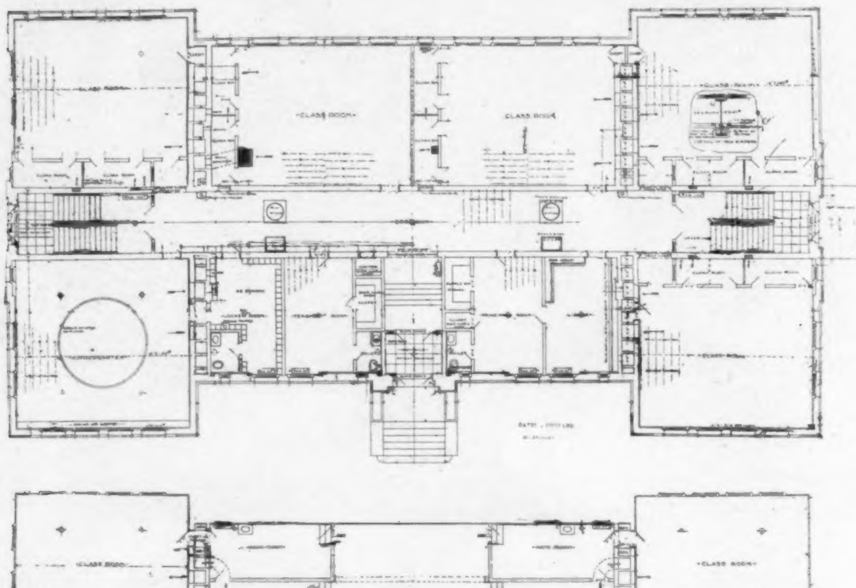
The location, while an awkward one, seemed to lend itself to this particular arrangement, enabling the shop and the heavy machinery to be placed therein, to have good solid foundation and to minimize the vibration and noise in the other portions of the building, the shop being located, as can be seen, in a wing, thus affording good light, both from the sides as well as from the roof, with ample ventilation.

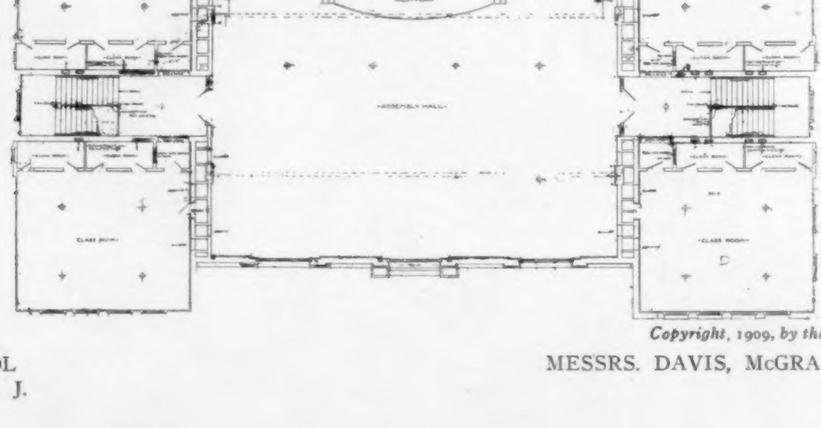
While it is unusual for a City as small as New London to have a school of this character, this one proves a success, as is shown by the large complement of pupils.



MANUAL TRAINING AND INDUSTRIAL SCHOOL
NEW LONDON, CONN.

MR. DUDLEY ST. C. DONNELLY
ARCHITECT





LIBERTY SCHOOL
ENGLEWOOD, N. J.

MESSRS. DAVIS, McGRATH & KIESSLING
ARCHITECTS

This school building contains nine (9) class rooms 24' 0" x 30' 0", accommodating 40 scholars each and one kindergarten room, 29' 0" x 30' 0", and a large assembly hall on the second floor, seating capacity 450. The staircases are located at the ends of a long central hall and are constructed entirely of iron, except for the treads which are 2" oak plank.

The principal's room, teachers' room and school library are located on the first story, convenient to the central entrance.

The finished floors throughout are of maple; the walls are plastered on wood lath; the ceilings plastered on metal lath. All flashings and gutters are of heavy copper.

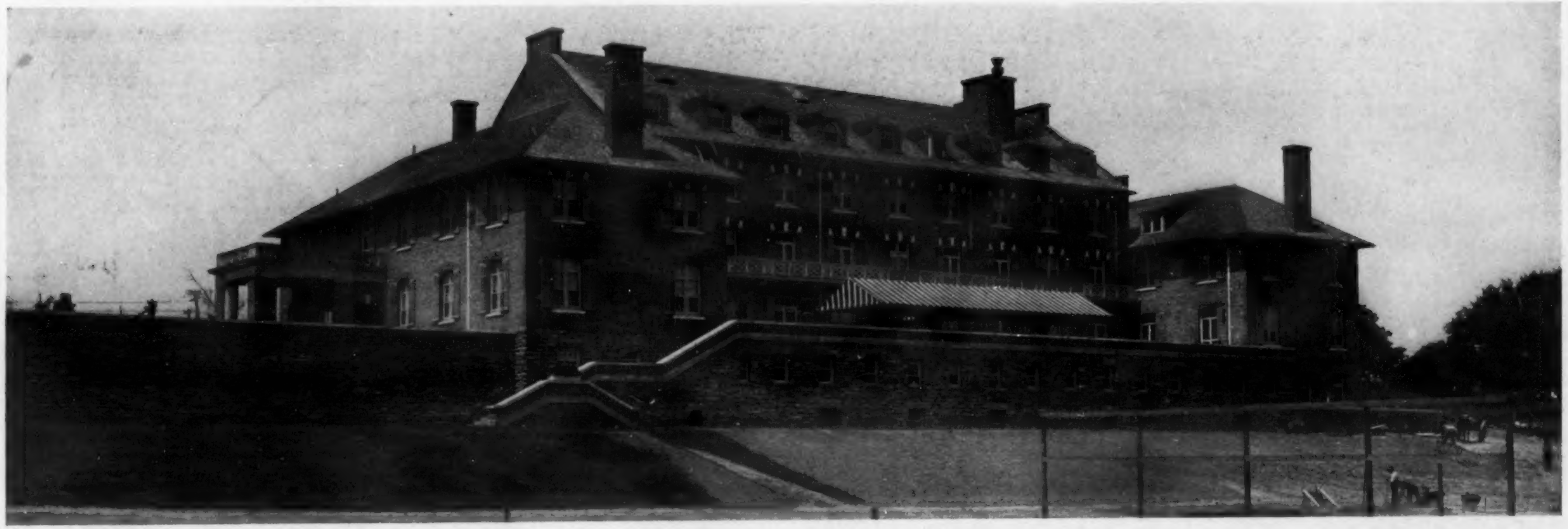
The exterior brickwork is laid up with local red brick, manufactured at Hackensack, N. J. The trimmings are of Indiana limestone.

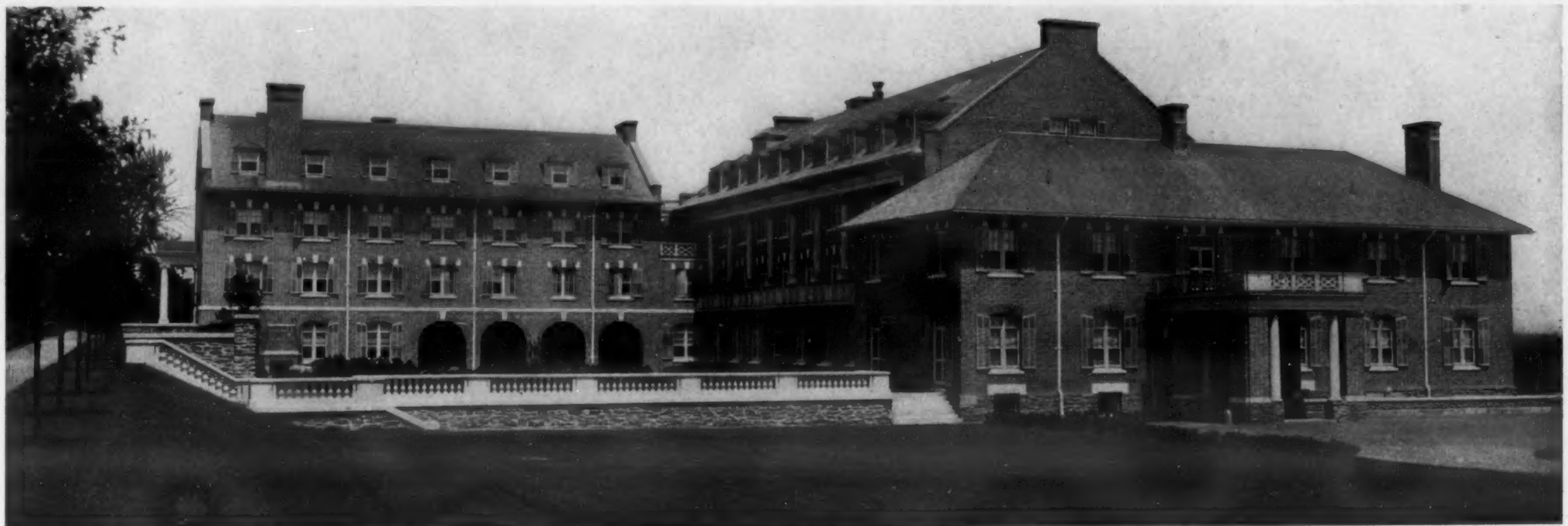
The heating system was laid out for a gravity system, supplemented with four fans located in the cold air chambers at the base of each stack of flues, the fans to be used only when gravity would not supply sufficient air. At the foot of each stack is also located a large hot air furnace and in addition to this a large steam boiler supplies heat to the corridors and coatrooms, also for asperating coils in the vent flues.

The total cost of the building, including Architects' fees, was $40,000. Cost per cubic foot, 8 1-2 cents.

LIBERTY SCHOOL
ENGLEWOOD, N. J.

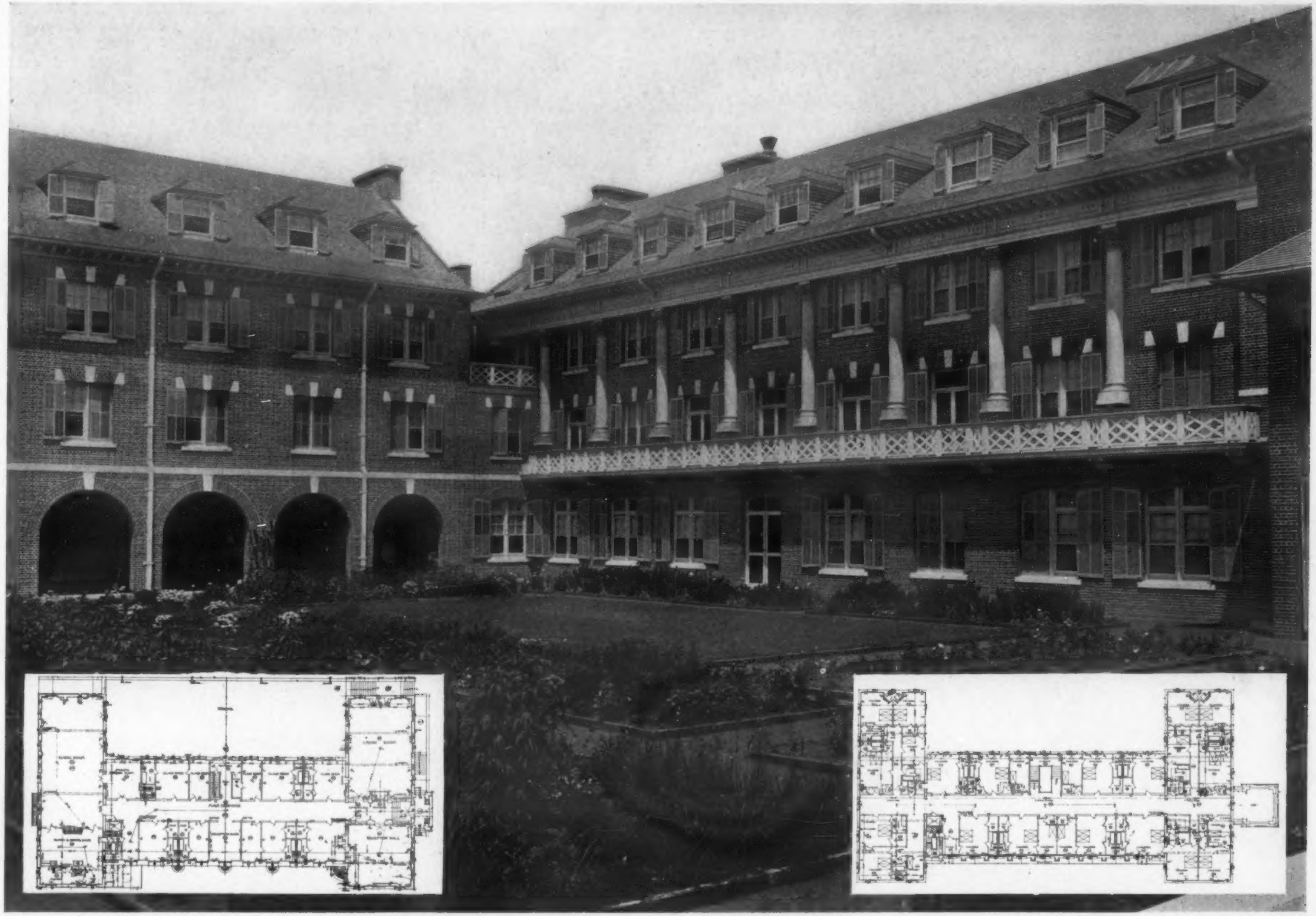
MESSRS. DAVIS, McGRATH & KIESSLING
ARCHITECTS





ELY SCHOOL FOR GIRLS,
GREENWICH, CONN.

MESSRS. CARRERE & HASTINGS,
ARCHITECTS



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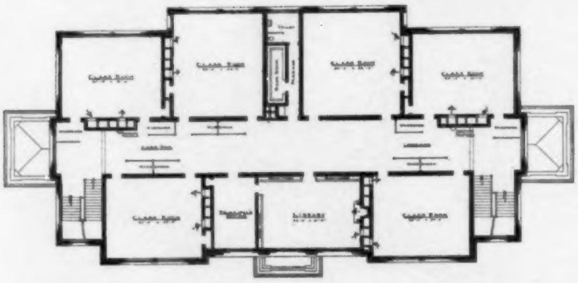

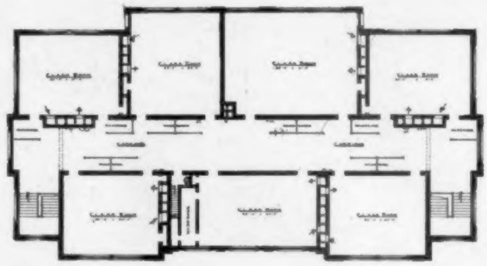

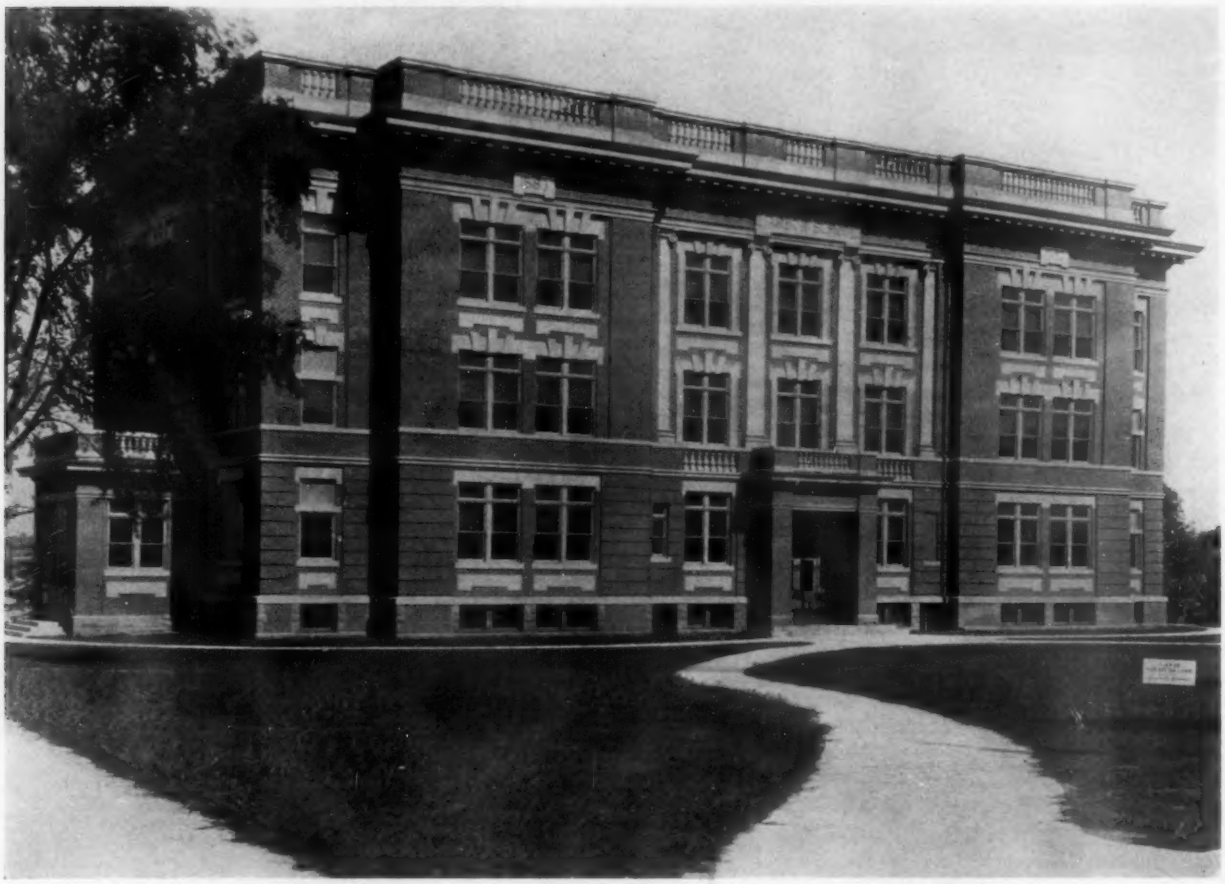

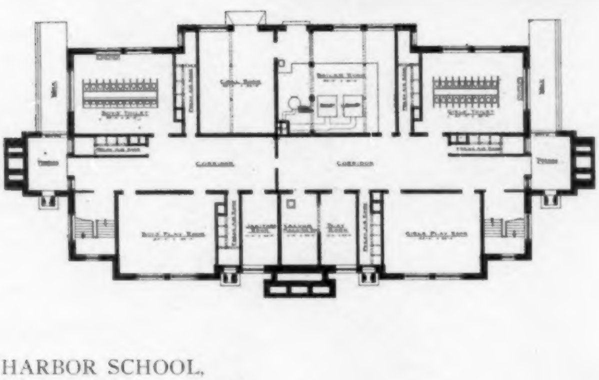

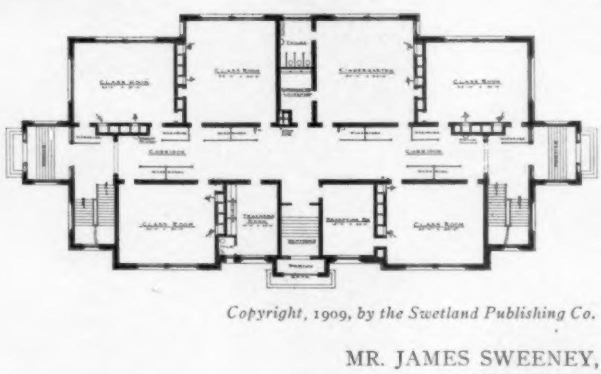

HARBOR SCHOOL,
NEW LONDON, CONN.

MR. JAMES SWEENEY,
ARCHITECT