DEPARTMENT OF THE INTERIOR

BUREAU OF EDUCATION

BULLETIN, 1924, No. 17

AMERICAN SCHOOL BUILDINGS

By

FLETCHER B DRESSLAR

WASHINGTON
GOVERNMENT PRINTING OFFICE
1925

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
45 CENTS PER COPY

II

CONTENTS.

	Page.
Introduction	ix
I. Location of a schoolhouse	1
II. Soil and drainage	5
III. Protection against dampness	5
IV. Planning:	
1. Basements	9
2. The classroom	11
(*a*) Dimensions	11
(*b*) Length of room	14
(*c*) Width of room	16
(*d*) Height of ceiling	16
3. Halls	18
4. Stairways	20
5. Cloakrooms	21
6. Toilet rooms	23
V. Construction and equipment:	
1. Floors	24
2. Stairways	31
3. Blackboards	32
4. Doors	36
5. Windows and screens	38
6. Classroom furniture and equipment	40
VI. Lighting	41
VII. Heating	51
1. Fireplaces	52
2. Box stoves	53
3. Jacketed stoves	53
4. Hot-air furnaces	54
5. Hot-water heating	57
6. Steam heating	58
7. Thermostats	60
VIII. Ventilation	62
IX. Toilets	66
X. Disposal of sewage	68
XI. Baths	70
XII. Swimming pool	71
XIII. Gymnasiums	73
XIV. Playgrounds	74
XV. Laboratories	75
XVI. Assembly rooms	85
XVII. School architecture and school improvement	89
Appendix: Orientation of buildings in Southern States	96

ILLUSTRATIONS.

FIGURES.

	Page.
FIGURE 1. Section of foundation	7
FIGURE 2. A schoolroom 22 by 30 feet, showing position of windows and desks, width of aisles, etc.	12
FIGURE 3. Section of floor, showing the use of deadening quilt	26
FIGURE 4. Floor with wooden joists and a thin layer of cement	28
FIGURE 5. Septic tank	69
FIGURE 6. A plan for chemical and physical laboratories	78
FIGURE 7. Plan for a village high school, so arranged that the hall may serve as an assembly room, with the main office as the stage	88

PLATES (FOLLOWING PAGE 100).

PLATE 1. Elementary school, Lawrence, Mass.: *A*, Perspective; *B*, Clinic.

PLATE 2. Elementary school, Lawrence, Mass.: *A*, Kindergarten; *B*, Ground-floor plan.

PLATE 3. Elementary school, Lawrence, Mass.: *A*, First-floor plan; *B*, Second-floor plan.

PLATE 4. Oliver School, Lawrence, Mass. (first-floor plan).

PLATE 5. Oliver School, Lawrence, Mass. (second-floor plan).

PLATE 6. Oliver School, Lawrence, Mass. (third-floor plan).

PLATE 7. General view, Greenfield (Ohio) complete school.

PLATE 8. Creston Junior High School, Grand Rapids, Mich.: *A*, Perspective; *B*, Ground-floor plan.

PLATE 9. Benjamin Franklin Junior High School, Newcastle, Pa.: *A*, Perspective; *B*, First-floor plan.

PLATE 10. Benjamin Franklin Junior High School, Newcastle, Pa.: *A*, Second-floor plan; *B*, Elmhurst Junior High School, Oakland, Calif.

PLATE 11. Elmhurst Junior High School, Oakland, Calif. (first-floor plan).

PLATE 12. Elmhurst Junior High School, Oakland, Calif. (second-floor plan).

PLATE 13. Lafayette Bloom Junior High School, Cincinnati, Ohio: *A*, Perspective; *B*, Basement plan.

PLATE 14. Lafayette Bloom Junior High School, Cincinnati, Ohio: *A*, First-floor plan; *B*, Second-floor plan.

PLATE 15. Junior High School, Adams, Mass.: *A*, Perspective; *B*, First-floor plan.

PLATE 16. Junior High School, Adams, Mass. (second-floor plan).

PLATE 17. Junior High School, Adams, Mass. (third-floor plan).

PLATE 18. *A*, Owensboro High School, Owensboro, Ky.; *B*, Thomas Snell Weaver Memorial High School, Hartford, Conn. (perspective); *C*, Thomas Snell Weaver Memorial High School (ground-floor plan).

PLATE 19. Thomas Snell Weaver Memorial High School, Hartford, Conn.: *A*, First-floor plan; *B*, Second-floor plan; *C*, Third-floor plan.

PLATE 20. Nicholas Senn High School, Chicago, Ill.: *A*, Perspective; *B*, Grounds.
PLATE 21. Nicholas Senn High School, Chicago, Ill.: *A*, First-floor plan; *B*, Second-floor plan.
PLATE 22. Nicholas Senn High School, Chicago, Ill. (third-floor plan).
PLATE 23. High School, Meadville, Pa.; *A*, Perspective; *B*, Ground-floor plan.
PLATE 24. High School, Meadville, Pa.: *A*, First-floor plan; *B*, Second-floor plan.
PLATE 25. High School, Waterloo, Iowa: *A*, Gymnasium (view of stage from auditorium); *B*, Gymnasium (view of auditorium from stage).
PLATE 26. High School, Waterloo, Iowa: *A*, Swimming pool; *B*, View of proscenium opening.
PLATE 27. Evanston Township High School, Evanston, Ill.
PLATE 28. Evanston Township High School, Evanston, Ill. (general plan).
PLATE 29. North Dallas High School, Texas: *A*, Perspective; *B*, Auditorium with spectators.
PLATE 30. North Dallas High School, Texas: *A*, Cooking room; *B*, Chemistry laboratory.
PLATE 31. North Dallas High School, Texas: *A*, Boys' locker room; *B*, Block plan.
PLATE 32. North Dallas High School (ground-floor plan).
PLATE 33. North Dallas High School (first-floor plan).
PLATE 34. North Dallas High School (second-floor plan).
PLATE 35. University High School, Oakland, Calif.: *A*, Front view; *B*, Bird's-eye perspective.
PLATE 36. University High School, Oakland, Calif. (first-floor plan).
PLATE 37. University High School, Oakland, Calif. (second-floor plan).
PLATE 38. Senior High School, Bay City, Mich.
PLATE 39. Senior High School, Bay City, Mich. (first-floor plan).
PLATE 40. Senior High School, Bay City, Mich. (second-floor plan).
PLATE 41. Senior High School, Bay City, Mich. (third-floor plan).
PLATE 42. Junior College, Wichita Falls, Tex.: *A*, Perspective; *B*, Gymnasium and boiler-room plans.
PLATE 43. Junior College, Wichita Falls, Tex. (ground-floor plan).
PLATE 44. Junior College, Wichita Falls, Tex. (first-floor plan).
PLATE 45. Junior College, Wichita Falls, Tex. (second-floor plan).

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
BUREAU OF EDUCATION,
Washington, July 16, 1924.

SIR: During the period of years since the World War there has been an unprecedented school building program undertaken to relieve congestion which developed under war-time conditions. This congestion is only partly relieved and schools will be built in increasing numbers during the next few years. More than a billion dollars will be expended for this purpose in the next half decade. It is highly important that these buildings should be constructed to meet the best requirements of instruction, health, and sanitation, with some regard for architectural appearance but imperative that economy should be used so far as is consistent with efficiency.

Those who are responsible for this program are turning to the Bureau of Education for advice and assistance. I have, therefore, asked Fletcher B. Dresslar, special agent of the Bureau of Education, to prepare this exhaustive study of American school buildings, and I ask that it be printed as a bulletin of the Bureau of Education. It will be of immense value at this time to State departments, county boards of education, city boards of education, and all those who are responsible for the building of schools.

Respectfully submitted.

JNO. J. TIGERT,
Commissioner.

The SECRETARY OF THE INTERIOR.

INTRODUCTION.

Since the publication by the Bureau of Education of Bulletin (1910) No. 5, entitled "American Schoolhouses" much progress has been made in school architecture from every point of view. In this revised edition such changes and such additions have been made in the text as will, it is hoped, bring this progress to the attention of school authorities in all essential details. The illustrations, both of floor plans and elevations of school buildings, are mostly new, and serve as an attempt to give a cross section of present acceptable standards. The preparation of this edition was undertaken with the hope that some additional helpful material might be brought to this service. The Commissioner of Education has requested some of the most prominent school architects of the country to furnish for this volume floor plans and elevations of a number of their most successful buildings. This volume will, in the main, show only high-school buildings, both senior and junior, and large buildings for grammar schools for city conditions. Those for the country schools will appear in another bulletin.

The author is under great obligation to boards of education, and especially to the school architects of the country who have so generously contributed photographs, drawings, and much service for the common good of American schools.

AMERICAN SCHOOL BUILDINGS.

I. LOCATION OF A SCHOOLHOUSE.

The first thing to consider in selecting a site for a school building is, of course, the convenience of all the children. The schoolhouse ought to be so situated as to make it most easily and safely accessible for the greatest number. But the fear of some possible inconvenience in this way to a part of the pupils should never allow more important considerations to be neglected. It is a matter of small moment that a few of the children be compelled to walk a little farther than the others, if thereby a better and larger school ground can be secured.

It seems to be a very difficult matter to get parents and boards of education to realize fully how important to the comfort, pleasure, and welfare of the children are large and well-situated school grounds. They can readily see that cattle and horses will not thrive and remain healthy when kept in small inclosures, but for some reason they do not extend the same consideration to their children. Hundreds of towns and villages and even many large cities could have large school grounds well located, instead of cramped quarters in the midst of noise and dust, if the people could be persuaded that the hardship imposed on children in walking a longer distance to school is far less serious than that of being housed in buildings, situated on small lots, hemmed in by other buildings, and immersed in foul air, dust, and the din of the hurrying multitudes. There is a show of reason in providing buildings near their homes for children in the primary classes; but those in the intermediate grades and the high school would be accommodated better, and more rationally treated from every point of view, even at the expense of a long walk, if, upon arrival at the schoolhouse, they could have before them a day's work in a pure atmosphere, freedom from the interruptions of outside life, and a place to play together.

While the location of the schoolhouse is primarily and necessarily the duty of a school board or of some special officer to whom this duty is delegated, it is nevertheless true that teachers, if prepared to advise in such matters, can often be of the greatest assistance by bringing before the minds of the people the important questions of playgrounds and of sanitary surroundings.

The lack of such professional interest was forcibly illustrated to me some years ago. I was engaged to teach in the high school of a thriving town where the people were hearty supporters of their public schools, and invariably evinced their interest by electing their most intelligent townsmen to positions on the school board. At the time in question three college men had been chosen, all of whom were leading physicians. During the previous year the same board had erected an additional building. A lot was chosen in the worst possible place. There happened to be for sale at the time a rather large block of ground in, topographically, the lowest part of town. It was a worthless piece of ground and had been shunned even by manufacturing establishments because it was too low and wet. Just to the east there was a livery stable, while to the west, one block away, there was a flouring mill and a railway with noisy, smoky engines frequently tugging their trains up a heavy grade. To the south, running along the edge of the grounds, there was a little stream which of necessity carried away much of the surface water from the public streets. The bed of this stream was scarcely 6 feet lower than the foundation of the building. Here, despite these and many other unfavorable conditions, a large brick building had been erected and into it hundreds of the children of the town were gathered. Think of what this means! Forcing all the children of a town who attend a high school to spend the best hours of the best part of their lives in a place not fit for a factory is not only a crime against the children but it is in direct opposition to the spirit, if not the letter, of the law. Besides much time is wasted in that school every day, for the teachers must often stop the recitations until the noisy trains have gone by. There is not the least doubt in my mind that if the teachers had been alive to the questions of school sanitation even in this one regard, they could have been instrumental in averting this serious blunder. The average business man does not think of these things, and it is the duty of the teachers to bring the facts clearly before the people.

Another very important question concerning the location of schools, especially in cities and villages, has to do with the avoidance of disturbing noises. It is a far more serious error to locate school buildings near railways, noisy factories, or busy thoroughfares than a first thought would seem to indicate. The rattle and roar of a noisy train or of a heavy wagon not only tends to disturb the pupils while at study but it is impossible to carry on a recitation in a satisfactory manner during such distractions. It may be argued that children soon get used to all such noises and pay little attention to them. Indeed, we have had thoughtful people tell us that it is good for children, for it teaches them to concentrate their thoughts, and thereby to neglect those things irrelevant to their work. But it must be remembered that although we learn to disregard very much of the stimuli with which we are constantly assailed, our nervous systems are continually exposed and irritated. There is a persistent demand and drain on the nervous system notwithstanding the mind may apparently be at ease. With most children mental concentration is an utter impossibility when distractions are present. They are drawn hither and thither by almost every passing stimulus, hence any unnecessary excitement should be avoided. The educational demands made upon the children of to-day are sufficiently great to exact of them all the energy available, and it is little less than criminal to place them in conditions that compel them to waste their energy. Most children who live in the larger cities are never in repose. They are bathed in this constant turmoil of noise both day and night, and as a result their nervous systems are levied upon incessantly to no purpose at all.

The rapid growth of modern cities suggests that in the near future radical changes must be made in the selection of school locations. The increasing values assigned to land near congested centers will of necessity limit the school grounds to the smallest possible space and tend to enforce the construction of taller buildings. With such restriction in the size of school lots the danger of fire will be greater, while noises, dust, and dirt will, in all probability, increase proportionately.

It would be more economical and far more hygienic for cities to set apart certain large areas in healthful localities, and use these for the sites of many school buildings, and, if need be, furnish free transportation to those children whose homes are at too great a distance from the schools.

There is in the city of Nashville to-day a four-story high-school building, recently completed, that accommodates something like 2,000 students. It is improperly oriented and has not a square foot of playground. In its vicinity street cars clang, automobile horns scream, and heavy trucks rattle; dust and smoke pour into the building from all sides, and all because no one foresaw what was to happen, or at least was willing to prevent it.

This edifice and the ground on which it stands represent an outlay of approximately a million dollars. Within a few years the building will doubtless have to be given up for another one better located; for the best school work can not be done here safely and economically.

The same building, or better, on a 10-acre school ground might have been had for less money and with less inconvenience a mile or so from this center of noise and dust.

Literally scores of similar illustrations of placing school buildings in noisy, dusty, and dangerous positions, with no room for playgrounds, could be cited for each State. There is still great need for the education of school officers in this important part of their work. Every school superintendent and teacher must be urged to exert all the influence possible to bring about further reform in this regard, else this sort of thing will continue indefinitely.

In recent years the consolidation of rural districts into larger units has made distinct and, in some sections, remarkable progress. Along with this consolidation have come better locations for school buildings, larger grounds, and great improvements in buildings, instruction, and sanitation. There has as yet been comparatively little change in cities from the old order of things, but a growing sentiment for school betterment has already operated, in some cases, in demanding and securing more extensive grounds and better locations for school buildings even at the expense of greater distances from the homes of the children.

It is often very difficult to secure proper light in the classrooms when the school building is situated in close proximity to tall buildings. Either the light will be partly shut off or the reflections will annoy and harm the vision. For the first reason it is a mistake to build too near a hillside. Unless each child can see some part of the sky while at his desk, the probabilities are that the light will be insufficient. Tall buildings and high hills so raise the horizon line that those who are sitting farthest away from the windows in schoolrooms so placed labor at a great disadvantage.

After a site has been selected, much trouble may be prevented by carefully considering the location and orientation of the building on the lot. To those who have not taught in schools these points will scarcely appeal in the light of their real importance. But the fact is that the proper lighting of a schoolroom and the usefulness of the average limited playground depend very largely on the way the building is placed.

If possible, the windows of a classroom ought to open toward the east or west, never toward the south, in the latitude of this country, and only in a few cases toward the north. Special reasons will be given for this preference in the discussion of the subject of lighting. It is enough here to remark that no amount of after adjustment can overcome the difficulties introduced by facing the windows in the wrong direction. (See Appendix.) In most climates the playground ought to be so exposed to the direct sunshine during the school year as to prevent, as far as possible, a damp or muddy surface. When the building is properly placed on the lot, the playground is not divided, and at the same time the sunshine is given free access to it.

II. SOIL AND DRAINAGE.

In the location of all structures for the habitation of man the selection of the soil upon which the building is to stand is an important consideration. This is especially true with schoolhouses, for it must be remembered that every sanitary precaution necessary in private homes should be enforced as rigorously in schoolhouses. All authorities agree that such buildings should be located on soil as free from moisture as possible. The matter becomes doubly important when we take into consideration the playground.

There can not always be a choice of soils, and where there is undue dampness the best of drainage should be provided, both for the ground on which the building stands and for the playground.

Other conditions being equal, an elevated site should be selected for the building, provided there is suitable ground attached for playground purposes; but where the available land is flat an adequate system of underdrainage should be arranged.

III. PROTECTION AGAINST DAMPNESS.

Concrete foundations with good wide footings are doubtless the best which can be used and when made with scientific care are much less porous than brick. But there must be a layer of some indestructible material, impervious to water, built into all basement walls and piers, otherwise dampness will find its way into the rooms above. Furthermore, this layer must of course be above ground, must be entirely hidden or inconspicuous, and must in no way detract from the strength or permanency of the walls.

It has been found that a thin layer of slate embedded in rich, fine cement mortar will break the capillarity in a wall of cement, stone, or bricks and thereby prevent the moisture from the ground rising above it. This material has also the advantage of strength and endurance. It has also been found that a thin layer or coating of hard asphaltum embedded in the walls will serve the same purpose and will in no way impair the strength of the walls. These damp-proof layers are not expensive, especially if asphaltum or some effective damp-proof paint is used, and there is no reason why they should be left out. Even a layer of tarred paper on the top of a wall will be of some service for years. Perhaps the best method of damp proofing foundations consists in the use of a thin layer of 1 to 1 cement. In addition the outside of all basement walls below ground should be coated with boiling tar or asphaltum before excavations are filled, for this will materially aid in preventing the absorption of the ground water by the walls, especially during rainy weather. Where basements are built this is a necessity, if the air within them is to be kept at all wholesome.

The figure on the following page will make clear the points herein enumerated.

Not only do rainstorms beat against the outer walls of a building and saturate them, especially if they are of brick, but frequently eaves are not supplied with gutters and spouts to carry away from the building the water shed from the roof. When this is the case it is certain that the walls of the upper part of basements will be saturated, even though the normal water line is much below all parts of the foundation. Furthermore, it is too frequently true that leaky eavespouts are allowed to saturate basement walls and those above ground.

The safe thing, therefore, is to provide all school buildings (dwellings as well) with strong, durable eave gutters, and a sufficient number of down pipes to carry off the water from even the hardest rains. These down pipes should empty into impervious earthen pipes or cement drains, so that the water will be delivered at a safe distance from the walls. It is very poor economy to provide gutters and pipes and then let the water pour on the ground at every corner of the house.

Schoolhouses should never be located where it is impossible to get a free and easy outlet for a drain through which the water line about the building may be kept always below the foundations and basement floors. The tiles for this drain should be farm drain tile, well burned so they will resist decay and safely bear all strain to which they may be subjected. The joints should be left slightly open and covered for some inches with coarse gravel or broken stone. It is a useless expense to fill the entire excavation with gravel or stone, for almost all the water finding its way into the tiles rises and enters at the bottom of the drain. The only need for gravel or broken stone at all arises from the fact that if the soil is sandy or a loose loam there is danger that enough of it will enter the joints in time to clog the drain. If the joints are sufficiently protected with coarse gravel or bits of broken stone to prevent the surrounding soil from entering, all requirements in this regard have been met. Almost no water drops directly down to the drain, and especially so if the ground surrounding the building slopes away from it, thus carrying surface water away from the walls. This drain should always be placed lower in the ground than the foundations, so that the water line will never reach the walls for any length of time. In general practice, if this drain is 8 inches lower than the basement there will be little or no trouble with ground waters.

This precaution is absolutely necessary for all buildings with a basement, for unless the water line is kept below the level of the floor of the basement it will be impossible to prevent water from rising in it. It is a mistaken notion, and a very common one, too,

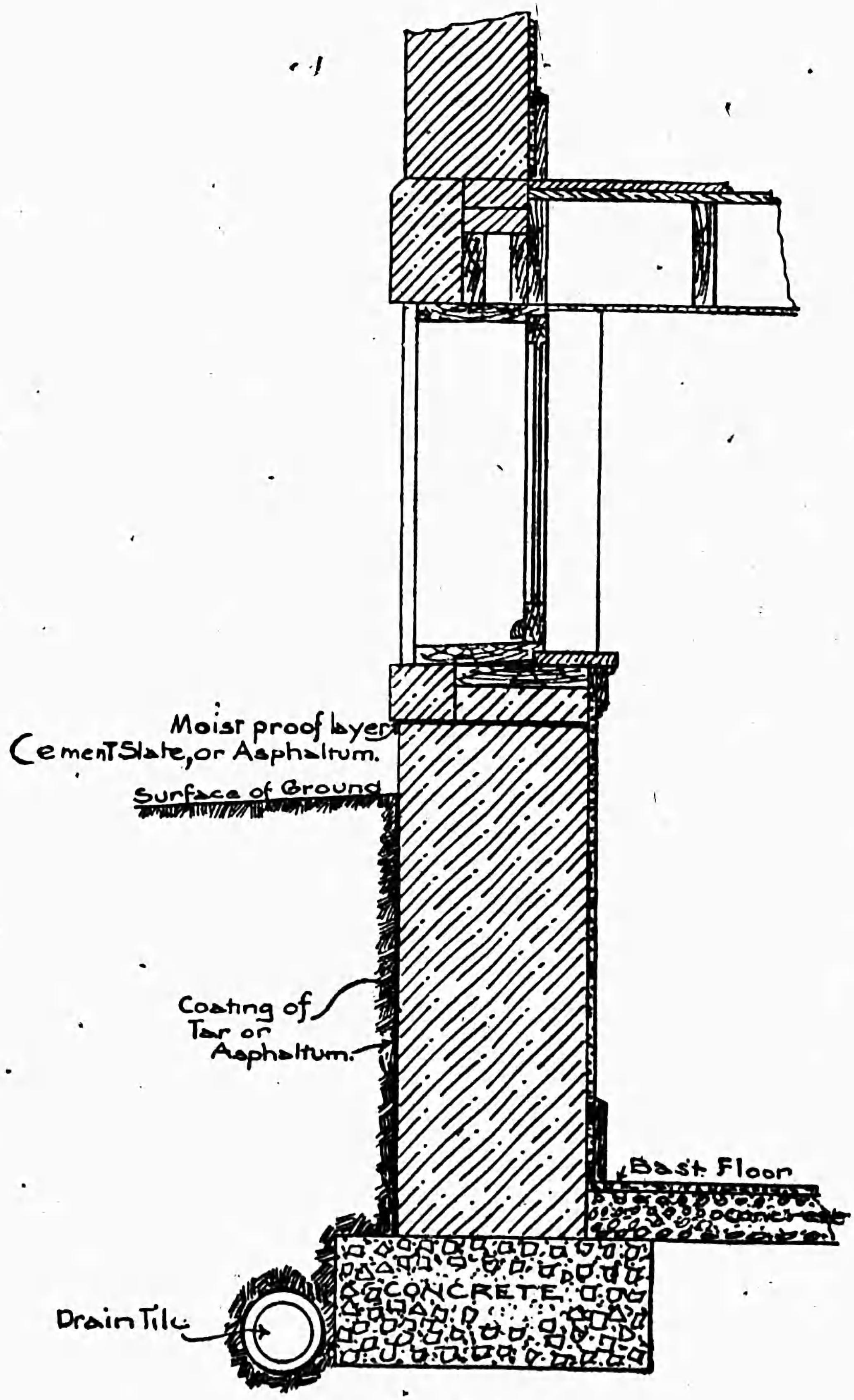


FIG. 1.—Section of foundation.

that if a basement is thoroughly cemented, both floor and walls, no water can get into it. Contrary to the belief of a great many people who are just beginning their experience with cement, it is not impervious to water, and under a comparatively slight pressure water will readily find its way through well set and carefully made cement floors. Unless, therefore, those who introduce basement floors into a school building have placed the building on high land, with the ground sloping away from it rapidly in all directions, they must encircle it with a drain as indicated in Figure 1, or it is perfectly certain that no reasonable amount of cementing within will prevent the water from entering. I am insistent on this point, for the reason that I have seen almost no end of trouble and much unexpected expense grow out of neglect in this matter. It is not expensive, save in rare cases where buildings are badly placed, to drain the ground as indicated. The tiles needed are only such as farmers use in underdraining land, and the labor required to put them down can be done by any ordinary workman, with the exception of the leveling, and even this requires no expert service in many cases. Generally speaking, such drains save more than they cost. For when these are properly placed a great deal less care is required in finishing the basement, and often much expense in cement work can be saved.

It is never well to run drains under a basement floor, especially if they connect directly or indirectly with a sewer system. In fact, it is unsafe to connect the outside drains with sewers, for the gases and odors given off by sewage may filter through the ground and render it unwholesome. All drains, then, should come to the surface, or empty into a trap, rendering it impossible for sewer gas to collect in or about schoolhouses. Furthermore, it is wholly unnecessary, even in the case of large buildings, to put any drains under the building, if drains have been placed all around them and deeper than the foundations or basement floors; for, since the ground under the building is protected from rains, no moisture can gather there unless it comes from the outside and is either forced up by the pressure of the waters on higher ground or pours in from the surface. But a drain outside will relieve all pressure from below and ordinary embankments will protect from surface water.

This drain should be about 6 or 8 feet outside the foundation walls, and if the tiles are sufficiently large and the drain has a sufficient fall to its outlet, the down pipes from the eave spouts can be made to deliver their water into them through solid and thoroughly waterproofed pipes. In this way all roof water can be quickly carried away. Common sense will teach those who undertake this to avoid overfeeding the drain pipes and to make sure the leaves and soot, which often gather on roofs in the fall time, do not clog the drains.

Sometimes in large and irregularly shaped buildings it is necessary to introduce laterals into the main drain in order to insure rapid, safe, and complete drainage of the ground all about the schoolhouse, but this can be left to the judgment of the architect, to be treated as the exigencies of the situation demand.

IV. PLANNING.

1. BASEMENTS.

It is highly advisable that a basement be constructed under all school buildings which are situated where adequate drainage can be provided. There are several reasons why this should be done, chief among which are the following:

A basement, when properly placed, provides a good location for engine rooms and central heating and ventilating plants. The noise and dirt incident to maintaining fires, removing ashes, and preparing fuel are least disturbing here, while the ducts designed to carry warm air from furnaces, or steam pipes from boilers, can be delivered into the classrooms more economically and effectively than if they had their source outside of the building. Of course, in large buildings, or for a group of buildings, it is far better to locate boilers in a separate structure if ample room is at command. But as conditions are to-day, nearly all heating plants for schoolhouses are located in the buildings themselves, and by the use of low-pressure boilers or hot-water systems there is comparatively little danger or annoyance. From the point of view of economy in construction there is often a great saving, for under ordinary conditions at the same expense more space can be provided in a basement than in any other part of the building. A well-constructed basement provided with good means of ventilation and underdrainage is one of the most effective agencies in preventing the rise of moisture in the walls and ground air into the classrooms and halls.

Room for fuel storage is quite important, and when thoroughly fireproofed the basement affords the most economical and convenient place. Naturally, this room and the furnace room should be closely connected and in every case made completely safe from fire hazards. This can be done by making the chimney safe, constructing the ceiling of reinforced concrete, and the walls surrounding of brick or concrete. Naturally, these rooms must be kept free from all ashes and cinders and all unnecessary combustibles.

Basements are generally used for the location of urinals and toilets. No one will say that this is an ideal location for them; but when due care is taken and good systems are correctly installed and intelligently kept there can not be very grave faults found with such location. There are some advantages and some disadvantages. One advantage lies in the ease with which they can be isolated, another their accessibility from playgrounds. The chief disadvantages lie in lack of light and ventilation and a tendency to liberty in basement not so noticeable in similar rooms above ground.

Playrooms in basements are not advisable unless these are near the level of the ground and are thoroughly lighted and ventilated. Cement floors are not satisfactory to play upon.

The ceilings of all basements should be at least 10 feet high, with not more than 4 feet of excavation. Even this is too deep if the soil is damp and the ground-water line high. For example, experience with a well-built modern high-school building situated on alluvial soil, with a long sloping rise behind it, taught me that the rush of water through such soil in wet weather is very difficult to meet. A thick cement floor would not keep it out, though the excavation was not greater than 3½ feet. Proper drainage, however, brought relief.

On ground easily drained and higher than that anywhere in the immediate neighborhood it may be advisable, for the sake of appearance and expense, to go deeper, but this will have to be determined by local situations and local needs.

It is always well to remember that where some advantage is gained by going deeper into the ground than here recommended, areaways can be resorted to for securing light and ventilation.

If basement floors are nearer the first-floor joists than 10 feet, it will be difficult to install the plumbing and air ducts for heating and ventilation, if mechanical systems are used, without placing them so low that they will interfere with the heads of teachers and janitors, and at the same time offer opportunity for the children in their play to hit them "just for fun." It should be remembered that if air is to be delivered mechanically into schoolrooms there must be large ducts, well protected from cold and with no sharp turns or elbows. The failure to do this has rendered many expensive heating and ventilating plants unsatisfactory. Invariably, if the basement ceiling is too low, sacrifices will be made in the inclination and size of these ducts, and if not rendered seriously defective they will necessitate more power to deliver the air needed. And just here it is well to emphasize the fact that basement plans deserve a great deal of study before they have been finally accepted. In fact definite plans and specifications for basements ought to include all the plumbing, furnaces, air ducts, etc., in order that one can see exactly what the completed basement will include, where every appliance will be placed, and how it will fit. Failure to do this leads to many maladjustments which give trouble from the very start. For example, suppose the schoolhouse is to be near a busy street where much dust is raised by passing vehicles. At once one will say that no air should be drawn from that side of the building into the schoolrooms, and that the basement arrangements must be made to meet this demand. Economy and practical sense both dictate an arrangement of the intake that will take advantage of the prevailing wind and not compel the fan to work against it. It is sometimes advisable to supply two openings for the intake of fresh air so as to be able to use the one best suited to the conditions of the day. These openings, as explained elsewhere, ought to be sufficiently above the ground to avoid dust and possible ground air.

On the whole, a good quality of cement makes the best floors for basements. Asphaltum can be used, but it is more likely to become rough and uneven and is more difficult to lay evenly and level. Still, it is more impervious to the rise of ground air than cement.

If finances will permit, the basement walls can be veneered with glazed light-colored brick or tile to good advantage. This treatment will greatly increase the light, render the walls more sanitary, and invite less defacement. Such walls are easily cleaned and kept bright and fresh. This treatment of toilet rooms, wash rooms, and bathrooms in basements is especially recommended.

Too much pains can not be taken in placing piers and walls in basements so as to intercept as little light as possible. Frequently, instead of a solid supporting wall, piers supporting cross beams can be used, thereby rendering the basement more open and airy and increasing the light. Sometimes arches can be constructed of brick or concrete, accomplishing the same ends without in any way increasing the expense or weakening the building.

2. THE CLASSROOM.

The primary unit of a school building is the classroom, and no definite plans for a building can be thought out until a decision has been reached as to the size, form, and number of classrooms desired. Since the number will vary to suit local conditions, it is not necessary at this time to discuss this point; but the size and form of classrooms are matters which ought to be decided in accordance with hygienic and pedagogical principles, and it is necessary to consider these points rather carefully.

(a) DIMENSIONS.

The size of the classroom for elementary school purposes ought to approximate the following requirements:

It should be sufficiently large to seat properly from 35 to 40 pupils, and at the same time have sufficient space left for aisles and the requisite furniture and apparatus. This limit as to the number of pupils is based on the theory that no teacher ought to be asked to teach more than 35 or 40 pupils, even though they all belong to the same grade and are doing approximately the same work. It is not infrequent, however, to find more than 50 pupils to a classroom in the intermediate grades. One effective way to render this impossible is to make the room of such a size that when the seats for 35 or 40 pupils, the maximum, are properly placed there will be no room left for crowding in any more. This may seem a rather indirect way to prevent overcrowding in a room, but all practical schoolmen know that as long as there is room for more they are likely to be crowded in. A room 22 feet wide and 30 feet long will comfortably seat this

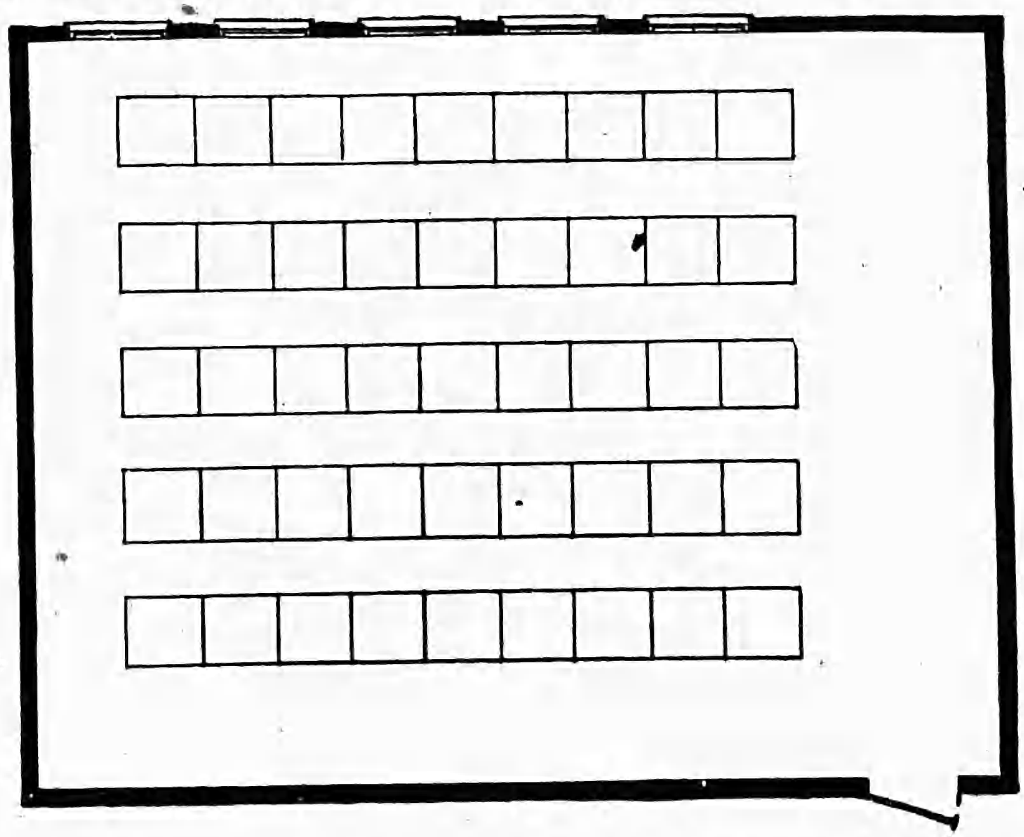


FIG. 2.—A schoolroom 22 by 30 feet, showing position of windows and desks, width of aisles, etc.

number, allowing ample space for aisles, blackboard workers, and space for reference table, sand tables, or any other pieces of apparatus regularly needed.

These dimensions are reduced from those recommended in the original edition of this bulletin for the reason that public opinion has developed during the past 10 years to such a degree as to permit such a reduction. In general, teachers are not called on now to handle so many children and hence the classroom can be reduced in the interest of economy of construction and upkeep. During the past 10 years little or no regret or dissatisfaction has been voiced by school officers because of these reduced dimensions. Therefore, these dimensions in length and breadth of a classroom for elementary grades are recommended with the assurance that they have proved acceptable in practice and of course have introduced decided economies in construction and care.

If the reader will take the time to study the floor plans of buildings from all parts of the country reproduced in this volume, he will get an approximate idea of the prevailing standards now carried out in practice.

It must be held in mind, however, that the figures given are for classrooms of buildings designed for the elementary grades only. Classrooms for high-school buildings should not be so standardized, because of the varied sizes of classes to be taught. Each building for high-school classes should have several sizes of recitation rooms, lecture rooms, and special rooms of various kinds, and the proper dimensions of these can only be determined by a careful study of the courses offered. It is very poor economy to teach a small class in advanced Latin, mathematics, or any other subject in a classroom large enough for four times the number of students. This, however, is often done, because the architect or the one responsible for the planning did not make a careful study of what high-school students do, and how the number of pupils are proportioned to the subjects offered. Manifestly, however, the general hygienic requirements set forth for elementary students should be adhered to for high-school students.

Elsewhere in this bulletin attention has been called to the fact that there should be considerable variety in the sizes of the high-school classrooms, both from the point of view of the economy of building upkeep and care and also from the point of view of the teacher. Objection has been raised by a teacher, let us say in Latin, to going from her regular classroom where she may have most of her references books, maps, charts, etc., into a small room for an advanced class; but in reality there is very little trouble about this, for such helps as are actually needed are not troublesome to supply nor to segregate from those needed by the general classes. Ordinarily, however, in large high schools several rooms are needed for instruction in each of the major subjects of the curriculum, and the handling of classes and supplies is correspondingly simple. Economically speaking it is a mistake to allow classrooms to be idle several periods a week simply because they are marked as rooms for mathematics, English, Latin or other subjects. Teachers sometimes are considerably disturbed, even disgruntled, when "their rooms" are of necessity used for classes in other subjects. Their contentions run about as follows: "This is my room with my books, references, charts, maps, and at times board work which should not be disturbed. I need some time to prepare my work for the class and naturally the best place to do that is in my classroom, hence there must be several periods in which my classroom is not to be occupied by any class." There is an element of truth and propriety in the foregoing statement, but most of the difficulties suggested can be eliminated by supplying departmental office rooms, library rooms, and study halls which are necessary for all large high schools. In general, then, at least three sizes of classrooms—not including laboratories and study halls—should be provided in large high schools. The largest of these should be designated for not more than 35 to 40 students, the middle size for about 20, and the smallest for about 10. Architects may easily plan buildings to meet these demands if those who are in charge of the schools will make such studies of their classes and class rolls as will set forth actual needs.

With this variety in sizes of actual classrooms there will be no need for excuse for shifting partitions or introducing the abomination of folding doors.

By reference to a number of the floor plans for high schools reproduced in this volume it will be seen that some variety in size of classrooms prevails. Generally speaking, however, buildings designed for not more than 300 or 400 students show less variation in this regard than those designed for larger numbers. This could have been anticipated on the basis of practical demands. Elective courses and increasing emphasis on sciences, English literature, modern languages, and commercial branches have broken up all first, second, and especially third and fourth year classes into smaller groups than was formerly the case. Here again, then, architects and school boards must consult teachers and study curricula and class registrations in order to plan conveniently and economically. The classrooms and recitation rooms of high schools can not be standardized in regard to amount of floor space as can those for elementary schools.

(b) LENGTH OF ROOM.

A classroom must not be so long that a pupil seated in the back of the room will have any difficulty, even with good light, in seeing easily and distinctly any ordinarily clear writing or drawing which the teacher may place upon the board in the front of the room, or such charts and models as are often used for the instruction of the whole class. It has been found by careful experimentation that the distance at which a normal eye can easily see well-written or printed letters an inch and a half high is about 29 feet. Burgerstein says: "According to my experience the distance at which a normal eye can see script 4 centimeters high, written rather heavily on a blackboard, is 9 meters (29½ feet)." He concludes that it would be a good thing, therefore, to limit the maximum length of a schoolroom to 9 meters.

(*Handbuch der Schulhygiene*, Burgerstein and Netolitzky, second edition, 1902, p. 116.)

Burgerstein says in a later book that, all things considered, one will find that a classroom 9 meters (29½ feet) long, 6 meters (19⅝ feet) broad, and 4 meters (little over 13 feet) high is about the proper size for serviceable use. (*Schulhygiene* [*Aus Natur und Geisteswelt*], 1906, Leo Burgerstein, p. 31.)

He says such a room will accommodate double benches for 50 pupils. His reasons for this size of room are normal requirements for vision, hearing, and the depth to which light will carry.

Schmid-Monnard and Schmidt practically agree with Burgerstein. They suggest that the width might be extended to 6½ meters (21 feet 4 inches). (*Schulgesundheitspflege, Ein Handbuch für Lehrer, Ärzte und Verwaltungs-Beamte.* Leipzig, 1902. p. 14.)

A room of this length will make it easy for a child who sits in a rear seat to hear distinctly when the teacher at the other end of the room speaks in a clear, distinct voice with moderate force and natural intonation. In the primary grades especially a large part of the instruction must of necessity be given orally, and since the children must hear the words of the mother tongue accurately if they are expected to learn to speak them correctly, it is of vital importance that their classrooms be adjusted to this demand. Unfortunately, many teachers have failed to cultivate a speaking voice that will carry well and at the same time maintain a good tone with distinctness. Poor spelling frequently results from inaccurate pronunciation and faulty articulation. This defect in school work was made clear by the investigations of Miss Wiltse, who found poor hearing responsible for much bad spelling. (Proc. National Education Association, 1892.)

It has been found by observation and careful investigation that the ordinary speaking voice, such as should be used in a schoolroom, will not carry with sufficient force beyond 30 feet to enable normal children to hear easily and accurately. It is very tiresome to have to strive to hear what is said, and the fatigue resulting from continued effort to hear is harmfully annoying and distracting. Furthermore, no teacher should be kept in a schoolroom that makes it necessary for her to tire her voice unduly or waste her time in repeating. Hence 30 feet is a safe length for hearing, vision, and the number of children properly in charge of one teacher.

In the length proposed I have allowed "ample room" for blackboard workers, for aisles, and for tables at the teacher's end of the room. By leaving an aisle 30 inches wide behind the last row of seats the pupils farthest from the teacher are well within hearing and seeing distance. In a shorter room there would not be space enough for passing and for work at the board, and especially so if, as often happens, the cloakroom must be placed adjoining the rear end of the classroom. Figure 2 illustrates a room of the length and width proposed, with the location of desks, the width of aisles, and the space at the teacher's end of the room.

(c) WIDTH OF THE ROOM.

The width of the schoolroom, where unilateral lighting is used, should never exceed twice the distance from the floor to the top of the windows, and where external conditions are unfavorable for good light even this width is too great. Most European authorities insist that the width of the room should not be greater than one and one-half times the distance from the floor to the top of the windows, and this demand is repeated by those already quoted. Naturally the row of desks farthest removed from the windows will receive the least light, but by grouping the desks as close to the windows as sufficient aisle space will permit, my experience is that in most parts of our country 22 feet is not too great a width. This will permit ample space for 35 to 40 single desks and still leave room for aisles, space for the teacher, apparatus, and the workers at the blackboards. However, one must not forget that light decreases as the square of the distance increases, and that those pupils removed the greatest distance from the light are those, other things equal, who need most attention when matters touching light are considered. Fortunately, our country as a whole is better situated with reference to latitude than most European countries, especially England, Scandinavia, Germany, and Holland. In these countries the winter days are very short and the early morning and the afternoon light is dull and weak. We can get, on the average, better light during the winter season in a room 22 feet wide with the same dimensions of window surface than most European countries can get with one 18 feet wide. I am certain that this is true for all the southern and for most of the western part of our country.

(d) HEIGHT OF CEILING.

The height of a standard classroom should be determined after due consideration of several factors. In the first place, the item of expense should be considered. Unless some real permanent and important pedagogic or architectural ends are to be gained, every foot saved in the height will reduce the cost much more than a casual calculation would indicate. If the building is to be constructed of brick, stone, or concrete, the cost of every foot increases with the height above the ground. For instance, if a 35-foot wall is required for the basement and two stories of classrooms, 1 foot more added to each story would cost more than a foot of the same wall lower in the building would cost. The cost would also be increased under certain conditions by reason of the need of making heavier walls, taller chimneys, longer and larger air ducts for heating and ventilation, and more extensive plumbing. Besides, every foot added to the height of a classroom adds so much more expense in keeping it in repair, and especially in heating it.

The item of expense is not, however, the most important factor for consideration, though it should not be minimized. Every foot added to the height of the interior walls of a schoolroom lifts the floor of the story above 1 foot, thereby increasing the length of stairways and making it necessary for all pupils whose classrooms are above the first floor to climb that much higher. From the hygienic point of view there is no special disadvantage in this for the boys, but it is an added hardship on adolescent girls. In case of fire or earthquake there is also increased danger. There is also a loss of time. If climbing stairs is disagreeable and tiresome to anæmic pupils, they will frequently remain in the classrooms during intermissions rather than go into the fresh air. Besides all these considerations the matter of acoustics deserves attention. Echoes are very distressing in any public assembly room, but they are serious disturbances in classrooms. Other things equal, rooms with tall ceilings are more troublesome in this regard than are rooms with lower ceilings. Architects have worked out no fast and safe rule which, if followed, will insure the best acoustic conditions. Since steel lath has been introduced for plastering and concrete construction is becoming more common, it seems that troublesome echoes are more frequent than ever before, and every precaution should be taken to deaden the walls in school buildings to prevent this grave annoyance.

Nevertheless, it is necessary to make a classroom sufficiently high to insure the proper placing of windows, adequate area of glass surface, and the conditions necessary for suitable ventilation.

Having considered these points even briefly, it seems that we shall not err to any great degree if we recommend that a standard classroom for the public elementary schools of our country should be 30 feet long, 22 feet wide, and 12½ feet high from finished floor to finished ceiling.

Naturally where the area of glass surface required to light the room will be more than one-sixth of the floor surface, and especially where a ratio of 1 to 4 is needed, windows will have to be spaced carefully. The decision, therefore, as to the exact height of a classroom ought to depend somewhat on local conditions with reference to the source and quantity of light generally available.

One of the objections which will be urged against making the ceilings of our classrooms 12½ feet in the clear is this: It will deprive the pupils of air space and hence make the problem of ventilation more difficult. At first thought this objection seems valid; but it is fully answered when it is stated that children need the same amount of fresh air per minute whether they are in a large room or a small one, and consequently after the initial supply is vitiated the same amount must be introduced in either case.

Where any system of forced ventilation is used, the only difference there would be between supplying a room 12½ feet high and one a foot higher would grow out of the fact that it would take a fraction of a minute longer for the children to vitiate the air in the room with the higher ceiling when the fan was not running at sufficient speed to supply an adequate amount. This difference is so small as to be negligible.

In rooms where the ceilings are 13½ feet high, and where the windows run to within 6 inches of the ceiling, there is a slight advantage if ventilation is to be provided by means of the windows alone. For, since warm air is lighter than cold air, there will be a little more pressure exerted to drive out the warm air where the windows are higher above the floor. This would create a slightly more rapid circulation, especially when outside air is much colder than that demanded in the classroom. But this difference in circulation will depend very largely on the management of the windows, and since teachers can not be depended on to keep the windows at all times properly adjusted this advantage may not be realized in a practical way.

In planning buildings for high-school purposes, the size of classrooms may vary a great deal, as suggested previously, in order to meet the requirements for different-sized classes. Some subjects attract a relatively small number of students, and it would be not only uselessly expensive to construct large rooms for such classes but would entail needless expense in maintenance.

3. HALLS.

From the teacher's point of view, there are some requirements in the construction of halls in school buildings that deserve more consideration than architects are at times inclined to give.

The units of the school building are the classrooms, which, of course, deserve prime consideration. But it is a mistake to sacrifice too much in the form, size, and lighting of halls in order that any specific scheme of classrooms may be carried out. I wish, therefore, to emphasize some essentials in the construction of halls and to urge teachers to see that these are called to the attention of architects and the members of boards of education.

They must be wide enough to prevent congestion while students are gathering in the morning or passing between classes and during intermissions, and especially at dismissals. It is not possible to specify definitely what the width of any hall should be without first calculating how many students are likely to use it at any one time, but there are certain ideals which ought to be considered. In large high-school buildings the main hall should be at least 14 feet wide; 16 feet is better. A hall 12 feet wide is more spacious for grammar grades than one 14 feet wide for high schools accommodating the same number of pupils. This is true because of the size of the pupils, and because it is rarely necessary for pupils in the grammar grades to pass from their room in a body save at intermissions. In high schools the rule is for a complete change of rooms for all students at the close of each recitation period. This at once makes it clear that the hallways of high-school buildings are used much oftener than those in buildings designed for the grammar grades. Besides, greater precautions are necessary at this stage of life in mixed schools to avoid all excuses for that familiarity which crowded halls would suggest. But aside from these reasonable and just claims for wide halls, it is always expedient to keep in mind dangers from a blockade in case of fire. Fire drills will lessen the danger; still, nothing but plenty of room will prevent trouble when a lot of people, old or young, lose their wits and stampede. A deficiency at such a time is too serious to call for further emphasis.

Another imperative need for wide halls is this: Spacious halls offer perhaps the best opportunity afforded in any part of a school building for the location of pictures, for mural paintings, and those touches of art which exert such a powerful, though silent and unconscious, influence upon the lives of young people. A cramped narrow hall will not admit of effective decoration.

Some of the illustrations presented in this bulletin will emphasize what has been said in the foregoing, and will doubtless suggest to school boards that it is not a waste of money to provide spacious halls.

Halls are more effective and less objectionable when there are no projections to obstruct and no constrictions to hinder. A long spacious hall, terminating at each end in a tasteful stairway with good light, is suggestive of a dignity and a decorum to which students will unconsciously respond.

The method of putting lockers all along hallways has some advantages, notably in their management and general care, but they are unsightly; they restrict hallways, invite congestion, are hard to ventilate and difficult to keep free from dust. The hallways of schoolrooms, when they are properly constructed and lighted, offer one of the best opportunities which the building affords for artistic treatment and æsthetic influence. A wide hallway, with good floors, neat panelings, artistic tinting, good light, and a few well-chosen pictures selected and framed to suit, will exert a greater influence on young people than "practical" Americans are prepared to estimate.

It is the general professional opinion that hallways should never be restricted or despoiled with rows of hat pegs or even closed lockers—open ones are an abomination.

Another essential is plenty of light. In this country it is almost universal to flank the two sides of a hall with classrooms, and depend on doors at the entrance and windows at the ends of the hall for light. In Germany it is the prevailing custom to have classrooms on but one side of a hall, and as a result they have better light in the halls in their newer school buildings than we do. The American plan of construction gives a more thoroughly centralized building, and for the same number of rooms a less expensive building, but it demands wider halls, and introduces a great deal more difficulty in supplying them with sufficient light. The German type of building introduces difficulties in heating and ventilation which the American type readily overcomes. One of the weakest points about our types of school buildings is that the halls are not generally attractive and are rarely well lighted.

4. STAIRWAYS.

In two-story buildings designed for high schools there should be at least two stairways from the first floor to the second, and in large schools there should be more. These stairways ought to be situated as near the ends or outer walls of the building as the plan of construction will permit. For when so located there is a natural division of the students into groups, and, generally speaking, this, in case of panic, will prevent that congestion on stairs and landings which is dreaded by all teachers who take precaution against loss of life in case of fire. Besides, this location facilitates passing up and down stairs between recitations. One hundred students in double file can easily descend a broad, well-lighted stairway in 35 seconds, and with proper fire drills can reduce this time considerably and with all safety, so that they can emerge from the building in a minute to a minute and a half. Experience has shown that 1,000 children, in a two-story grammar-school building furnished with four stairways, can be trained to get out safely in a minute if the stairways are properly placed and wide enough. Another reason for placing the stairways leading to the second floor near the ends or opposite sides of the buildings is the fact that fires, as a rule, originate in the central part of the building, or if they do not originate there the smoke is likely to gather there and render a central stairway dark and forbidding. Besides, there is a better chance for light near the outside walls and less inflammable materials, especially in brick, stone, or cement construction.

5. CLOAKROOMS.

The problem of supplying cloakrooms and lockers for high-school pupils is a very different one from that of supplying comparable conveniences for the grammar grades. Generally speaking, high-school pupils are moving about from room to room throughout the day, and they rarely if ever finish a session with a recitation in the same room in which they began; they have no room which they can properly call their own, though they may have a "class teacher," or one to whom they are attached for a term for special help and advice; they must have lockers where books and materials can be kept during the hours of the day when not in use, and of necessity these rooms and lockers must be located where general convenience demands. It goes without saying that in high schools there ought to be separate cloakrooms for the boys and the girls, and that where possible these ought to be well separated from each other in order to prevent crowding in the halls and also to insure greater privacy for each. In a large school there ought to be at least four of these rooms, two upstairs and two on the lower floor, the girls of the third and fourth year classes using the one upstairs, while those of the first and second years would use the one below, or vice versa, according to arrangement of classes. A similar provision also should be made for the boys. In small schools one for each sex will suffice. These rooms ought to have abundance of light, be well ventilated and warmed, and should be located where they can be readily supervised and frequently inspected. It is a mistaken policy and poor economy to stint in the matter of cloakrooms and lockers, with reference either to space or to furniture. Make these rooms neat and attractive, and then it is the duty of those in authority to see that they are carefully kept and in no way abused by the pupils. It is sometimes more than distressing to see how such rooms are misused, especially by the boys. Locker doors are broken open for no other reason than that a lazy boy will not go home for his forgotten key. Walls are defaced, and an air of general carelessness is likely to prevail. The safe thing is to make the rooms attractive and deserving of good treatment, and then demand that they be kept so.

In general, it is both unhygienic and inconvenient to locate cloakrooms in basements, and especially so when lockers are needed. These rooms are rarely well ventilated and lighted, are too far from the teachers for inspection and supervision, and they invite pilfering. Bicycle stalls can be arranged in basements, but the demands for these will be limited, and they will need comparatively little care.

In taking the position that cloakrooms or lockers for high schools should not be situated in basements, the writer is conscious that he is opposing a more or less prevalent custom. The basement is the place where architects frequently find it most convenient to locate them, and it is argued that there is little or no need for pupils to remain long in such rooms and that it is useless waste of space to locate them above the basement. It is readily agreed that it is less expensive to put them in the basement, but it does not always happen that the least expensive is the best or even the most economical in the long run. Of course, if a basement floor is not more than 2 feet below the surface, and the lighting, heating, and ventilation of the basement rooms are looked after with as much care and made as effective as in rooms above, there can be little rational objection to using well-appointed space in basements for cloakrooms. But there are so many basements in small or medium sized buildings 4 feet or more below the surface of the ground, with small windows and dark rooms, that it is rarely advisable to suggest this as a place for cloakrooms. In large buildings, where the problem of securing proper proportion does not call for bringing the main floor close to the surface of the ground, basement floors can be put at or near a level with the surface of the ground, and of course such basements would offer a convenient and sanitary location for cloakrooms. But even in large public high schools it is not altogether wise to make the basement a gathering place. The license suggested by a basement when so used will certainly operate to make any school more difficult to manage, for proper supervision will be very much more difficult to maintain.

Care should be exercised in making cloakrooms as neat, attractive, and sanitary as any other rooms in the building. If you wish to forestall defilement and lax discipline in any public institution, especially in schools, it can not be done more effectively than through hygienic toilets guarded with zealous care, or through tasteful rooms where students congregate, such as locker rooms, cloakrooms, gymnasiums, or assembly halls. It is rarely possible to make a basement locker room a pleasant, attractive place, especially for girls.

The form of lockers used will to some extent depend upon where they are placed; but for obvious reasons they should be well ventilated and at the same time strongly made, so as to offer no temptation to pilfering. When placed in the basement they are more exposed to meddlers and thieves than if placed on the floors above, and so must be more securely constructed and supervised more carefully.

In grammar schools each classroom must be provided with a well-lighted and well-ventilated cloakroom. It is not necessary to make separate cloakrooms for the sexes if such rooms are correctly placed, sufficiently large, and properly equipped. In small buildings of not more than four rooms it is often easy to arrange separate cloak rooms for the sexes, and when it can be done without inconvenience or undue expense, it is desirable; but in large buildings much confusion and its incident difficulties can be avoided by giving each classroom one common cloakroom. Entrance to the cloakroom should be from the schoolroom and at the end opposite the teacher's desk. This plan gives the teacher control, and prevents anyone from entering it during school hours without the teacher's knowledge. It permits of ventilation and heating as described elsewhere, and gives the teacher a clear wall at her end of the room. The room looks more tidy and there is likely to be less congestion in the front of the room. This change from the earlier edition has come about as the result of long and continued observations.

However, the advantages of this location are overbalanced at times by architectural demands for placing the cloakroom at the teacher's end of the room, in order to meet the legitimate call for external balance and symmetry.

6. TOILET ROOMS.

The satisfactory location of toilet rooms in school buildings has been one of the hardest problems with which we have had to deal. Many architects give far too little consideration to these necessities and quite frequently makeshifts are resorted to at the last. In small to medium sized buildings for elementary schools, in either a one-story or two-story type, a good, well-lighted, and thoroughly drained basement may be safely used for toilet rooms. But the troubles come usually in poor lighting, imperfect ventilation, defective drainage, and disagreeable congestion.

In large buildings, designed for the use of either elementary or high school purposes, especially for high schools, toilet facilities should be provided on each floor for each sex. The best arrangement is to open them directly from rest rooms or locker rooms and not into a common hall. By locating them in the rear of opposite wings of the building they are safely isolated, and can be lighted and ventilated properly. This arrangement will require, in a two-story building, six small rooms, two on each floor, and two in the basement. The great advantage in this plan is that, along with locker rooms, they can be assigned specifically to certain grades or classes and then these held responsible for proper and decent care. Ordinarily those located in the basement rooms are to be used in connection with the baths, and possibly gymnasium and athletic work. Such a plan prevents congestion, secures privacy with convenience, and, best of all, commands perfect light and easy natural ventilation. By arranging them directly over each other plumbing is much simplified and construction made easier.

Toilet rooms should be narrow, allowing no more space than is necessary for legitimate purposes, but with the stalls facing the windows. This will bring the front of the stalls near to the light, insure better ventilation, and, if the rooms are faced in such a way as to command the sunshine at least a part of the day, will materially aid in keeping them acceptable and sanitary. We can not emphasize too strongly the necessity of making these rooms as light as it is possible to make them. Schoolmen know that when more light is turned in not only better sanitary conditions prevail but a better moral atmosphere will pervade the whole school. It is really sinful to construct a schoolhouse in such a way as to make these rooms dark and offer opportunities and suggestions for moral laxness. It has already been suggested that these rooms should be narrow for the sake of light and sunshine, but in addition, by offering not one foot more space than necessary, the opportunity for possible congregation will be prevented. This is especially true with reference to boys' toilets. These should be made *no larger than legitimate demands dictate.*

V. CONSTRUCTION AND EQUIPMENT.

1. FLOORS.

That part of a school building which receives the roughest usage is the floor, and when laid improperly and of poor material is both insanitary and very difficult to keep in order. Perhaps there is no part of a school building which has so much to do with the general sanitation and neatness of halls and classrooms as the floors, and surely no part requires so much attention. It is a great mistake to be niggardly in expense when it comes to the material for floors, for in the end good floors are much less expensive, when considered merely from the point of view of length of service, than are poor ones; but good floors are also less expensive to keep in order and will save much janitor service.

It is proper, then, to ask, What are good floors for school buildings, and how are they constructed?

In the first place there should be, in those buildings not fireproofed, double floors. This is important for several reasons, but chiefly to prevent the inflow of damp or bad air from basements. The first or under set of boards should be rather narrow and well seasoned, but may be made of any durable wood and left rough, though of even thickness. They should be laid diagonally with the joists and made to fit closely. Over these should be carefully fitted some covering both impervious to the air and deadening to sound. If no material can be obtained combining these two qualities, then both fire proof paper and deadening material should be used. Tarred paper is effective in keeping out damp air, but its use is questionable on account of its inflammability. A good quality of asbestos paper or felt will serve the purpose of deadening and at the same time present a fairly good barrier to the entrance of moisture. It is more expensive than many other forms of deadening material used, but it has the advantage of being noninflammable. In small buildings, however, especially for country and village schools, it is far better to use heavy building paper than to use nothing at all. Whatever form of deadening material is used, builders ought to use it carefully, so as to keep the floor level and stop all the cracks from below.

Double floors soon save their cost, especially in cold climates and where fuel is high. I know of no figures expressing the exact proportion of this advantage of double floors over single floors, but a moment's thought will suffice to see a distinct saving.

From the hygienic point of view single floors on the first story of a school building ought not to be tolerated, for during the winter season—and this is almost always the school season—the children will suffer constantly from cold feet. Such a condition is not only annoying and distracting to teachers and children alike but fruitful of colds and bronchial troubles through the effects of impeded and uneven circulation.

The need of tight, air-proof floors for the first story of a school building has been emphasized because of the danger of cold floors, bad odors, and dampness. In the upper story the matter of noise is especially troublesome unless the floors are thoroughly deadened and made so secure as to prevent jarring. The problem of deadening the stairways, the floors of the halls, and rooms of the upper story is therefore a more insistent one than it is for the lower rooms.

In buildings thoroughly fireproofed the problem is rather easily solved, but in buildings where wooden joists and steel laths for plastering are used it is a much more difficult task. There are on the market a great many patent deadening felts or quilts designed for this purpose. Some increase the fire risk; others, if free from this fault, are not so made as to break up most effectively the sound waves and prevent their transmission to the ceiling below.

The method of deadening shown in figure 3 was designed to meet the requirements when the deadening quilt is used. This material is made of "cured eel grass" arranged in crisscross layers and then spread between two layers of paper which are stitched or quilted together. Experience with it shows that it is effective as a sound deadener when properly laid. It can be used effectively on inner walls, as well as on the floors. Perhaps the safest of all deadening material is asbestos board, or quilt, which can be had in most any market; but if this is used for deadening purposes chiefly, it must be of good heavy grade and carefully laid.

In this discussion it has not been my purpose to give directions to architects, because it is their business to have more extensive knowledge of such things than other people. The attention of teachers and members of building committees should be called to the need of making careful provision for good floors, and then of rendering them as impervious as possible to the entrance of cold or foul air and proof against the transmission of disturbing noises.

To some, who are used to conditions as they now exist in our best cities, this discussion of the need of double floors may seem out of place, or at least useless; but there are hundreds of schoolhouses being built this year in our country with single floors. It is to help to prevent a continuation of this error that the above was written.

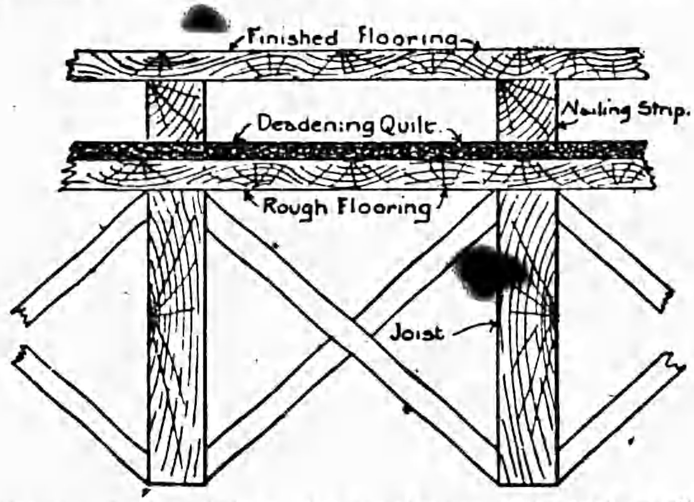


FIG. 3.—Section of floor, showing the use of deadening quilt.

In the next place, hardwood should be used for the upper set of boards, and so carefully selected that every board will be straight grained and free from defect of any sort. One or two slash-grained boards in the floor of a hallway or classroom will inevitably bring trouble. They splinter easily, gather and hold the dirt, take on a different color from the rest of the floor, and cause that untidy "spotty" appearance so disturbing to all who are sensitive to seemly things wherever found. It is, therefore, quite important that close supervision should be exercised over builders when they are laying floors. Somebody with authority and good judgment in matters of this sort ought to be in constant attendance to pass upon every board used. It is far less disastrous to use questionable lumber in wainscoting or walls than to use it in the floors. Floors are sometimes rendered unsightly and difficult to keep sanitary when hard pine boards, with streaks of pitch or rosin in them, are allowed to go in; for as these boards season and shrink this material will gradually work out, leaving gashes in the floor hard to keep clean and always unsightly. The best material to use is narrow boards of well-seasoned and carefully selected oak. Such boards wear evenly, do not splinter, are not affected greatly by changes in the weather, are easily finished, and give to the rooms an æsthetic character worth a great deal when considered in relation to management and good taste. But oak lumber of a good grade has become very expensive, and it may not be possible for school authorities to see their way clear to its use. Perhaps the next best available wood for schoolhouse floors is hard maple, sawn in narrow boards, of straight grain, and free from all defects. This makes a neat floor, takes a good polish if skillfully handled, and wears well if it is kept well oiled or waxed. It is softer than oak, however, and shoe tacks easily dent it. It requires more care than oak floors, and in this respect is not so economical. It can be made to fit together well, and is not readily affected by dampness, though more porous than oak.

Hard pine is generally the most available material, and when carefully selected and prepared makes a good, durable, and beautiful floor. Since this is the material most often used it seems fitting to consider it somewhat carefully. In the first place, the boards ought to be from 2 to 2½ inches wide. If they are wider it will be almost impossible to get them so well seasoned and so carefully joined as to prevent cracks from opening between them. They must have a straight, close grain, be free from pitch gashes, and sufficiently thick to prevent the tongue from splitting the upper edge.

They must be set carefully and fastened (blind nailed) with cut nails. Here again there is constant need of active, vigorous supervision in the laying of schoolroom floors. It is a fact, however doleful it may seem, that American workmen are not so careful when building for public as for private interests. Doubtless there are many exceptions, but experience is on the side of this general assertion. What would otherwise be a good floor may be badly marred and rendered unfit by dents from the hammers of poor workmen when they are blind-nailing the boards. Such workmen try to excuse themselves by saying that those dents soon close up. Yes, they do; but it is with dirt. Surely ceaseless vigilance, unquestioned authority, and special knowledge on the part of the supervisor is the price of good floors.

One specification with reference to floors in school buildings is frequently omitted from contracts, but is deserving of more consideration. After floors are laid and all the other work in the room is completed they ought to be planed or sandpapered to an even, smooth surface. Unless this is done it will be impossible to polish them well or to remove the stains incident to building operations.

In buildings of fireproof construction steel beams are used for joists, and usually the space between them is filled with brick and cement, or, better, with specially prepared earthen tiles and cement. A cheaper method consists in suspending a series of bent wires from joist to joist, so they will give strength to the cement, and then boxing up underneath and pouring in sufficient cement to fill the space. When the cement is set it has a firm grip on joists and wire. Then by screwing thin strips of wood on the tops of the joists the floor can be easily and securely fastened. Of course it is necessary to fill the space with cement flush with the tops of the strips in order that the floor may rest evenly and closely against the cement. This will effectively deaden the floors and render them thoroughly sanitary from the underside.

Where wooden joists are used the floors may be deadened with fair success and a complete double floor rendered unnecessary by the method illustrated in Figure 4.

This treatment reduces the risk from fire, but is more expensive than double floors with deadening materials and adds materially to the weight of the building. Doubtless many other ways can be de-

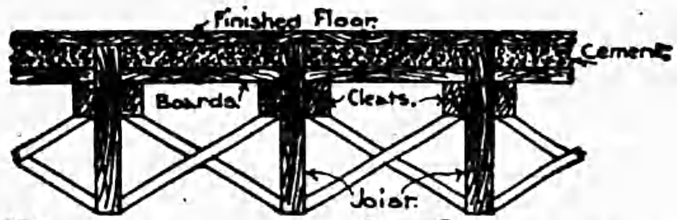


FIG. 4.—Floor with wooden joists and a thin layer of cement.

vised to deaden the floors more satisfactory to local demands than any here mentioned.

In buildings of fireproof construction a single floor is sufficient, for the materials used in fireproofing both deaden the floors and protect them from the cold air from below.

There is a growing tendency because of the increasing cost of wooden floors to substitute cement floors. But generally speaking, it is the writer's opinion that those who are specifying these and accepting them do not realize that cement, even though of the best grade, will not last so long as a well-cared-for hardwood floor properly set.

The proper method of caring for wooden floors is of comparative recent date, and we can look forward to longer usefulness in modern buildings for wooden floors than in the older buildings. If floors are scrubbed and soaked week after week with dirty water, we, of course, may expect rapid destruction of them; but if carefully waxed and oiled and cleaned with care we can expect longer wear from them than we can from any cement at present available.

If he who reads this statement is still in doubt, let him study stairway treads where slate, cement, and wooden steps have been used, and then compare those that have been properly cared for. He will be surprised at the lasting qualities of good wood.

But even if it should happed that cement floors will last longer, they are never so satisfactory nor so easily kept clean as wooden floors. Constant walking over them will loosen the particles of sand and cement and these will be swept out day by day.

On the whole, it is a mistake at present to put cement floors in classrooms, but halls, lavatories, and basement rooms, especially the latter, may be better off with cement.

The so-called dustless oil floor dressing has, when used with skill and judgment, proved of great service in protecting floors and preventing the dust and dirt from rising into the air. It is best to put it on sparingly, however, to prevent any possible odors, and more especially to prevent it from soiling clothing. A great deal of complaint is frequently heard on account of this, and not infrequently such complaint is justifiable, for there is no need to keep the floors saturated with oil to get the best effect. This trouble sometimes results from the use of an oil too thick and heavy, but usually from using it too often or applying too much at one time. When a thin coating of light oil is put on with a brush or better with a spray, made for this purpose, and all pellets of dust and dirt collected by this oil are removed from the floors daily, there ought to be little or no complaint from those teachers who value the cleanliness and healthfulness of the schoolroom more than their own convenience or personal preference.

In high schools where pupils are more careful to keep their shoes clean, and especially in those buildings where good hardwood floors are laid, it is best to wax the floors and keep them well polished. This method, of course, does not prevent so much dust from rising, and it requires more service to keep the floors in good condition; but with the use of dampened sawdust to gather up the dust when sweeping, and with due care, a waxed floor is most satisfactory.

There are several kinds of dustless oils on the market, and also many varieties of floor wax.[1] No general recommendation is needed, and indeed none could be made which would be found reliable under all conditions, for the different woods used for floors will need different treatment.

The floors of toilet rooms should be made of some impervious material, preferably tiles or terrazzo. This will enable them to be

[1] Clay recommends a wax polish for hardwood floors made in the following way:

	Parts.
Yellow wax	20
Yellow ozocerite	20
Linseed oil (boiled)	1
Raw sienna	5
Turpentine	25

Mix the two waxes over a slow fire, add the oil, and when cold add the turpentine. (See Modern School Buildings, by Felix Clay. London, B. T. Batsford, 1906, p. 286.)

washed out frequently or mopped up without much trouble. We have found that the only way to keep toilet floors neat and tidy and free from the odors due to infiltration is to make them right to start on and then keep them clean and sanitary under all conditions. A school superintendent who will permit school toilets to become indecent and insanitary, and at the same time make a show of æsthetics elsewhere, is deluding himself into thinking that partially hidden ugliness will be overlooked by the children.

Some insurance companies have objected to the use of floor oils, on the ground that buildings so treated have a greater fire hazard, and they have brought pressure to bear on many boards of education to prevent their use. This restriction is mere theory and reliable statistics are not available to prove it. On the contrary, it seems to the writer that there is about as much evidence for the use of oil as against it to prevent fire. In the first place, without some such treatment floors soon splinter, open cracks get abnormally dry, and wear through much more quickly. Besides fires do not start on schoolroom floors except where defective stoves are used and the floor left unguarded. If a fire gets such headway from a basement or furnace room as to come into classrooms or halls, then the building is probably doomed anyway. Some experimentation, though it was inconclusive, has caused the writer to feel that dry floors are more inflammable than those properly oiled.

The floors of halls in high-school buildings are subject to more wear than are those of the classrooms, and therefore require more care and deserve more consideration in their construction. There is a growing tendency to make the floors of halls of light-colored tiles set in a strong base of cement, or to embed in cement broken bits of marble of various colors and then to polish them to an even surface. Some modern buildings in this country have used plain cement. There are many things to be said in favor of tile floors. In the first place they can be made durable, they are readily cleaned, nonabsorbent, and render the hall lighter and more cheery than wood or any darker material. Tiles, however, are cold, but since halls are to be used chiefly for those who are passing to their rooms or from room to room, there can be little fault found on this account. Perhaps the most serious objections which can be offered to their use are that they are expensive and noisy. Good oak floors properly cared for will last a long time, and they are very effective when kept clean and well polished. But they require a great deal of attention, and in the end are perhaps more expensive than tile floors. If hard pine or maple is used, the precautions mentioned under the section on "Floors" ought to be kept in mind.

2. STAIRWAYS.

The stairways should be of fireproof construction, especially in a wooden building. The prevailing custom is to make wooden stairs in wooden buildings, and more resistant stairs in stone, brick, or cement buildings. A moment's thought is sufficient to show that in this regard wooden buildings need greater care in the construction of stairs than buildings of more resistant materials.

It is in no sense unreasonable to insist on fireproof stairs in all large two-story buildings, especially now that the material is within reach of all. Steel frames incased in cement, and with treads made of the same material render stairways reasonably safe against fires and also insure much greater permanency. The width of a stairway will of course depend in part on the number of students it is designed to accommodate; but in all cases it should be wide enough for two adults to ascend or descend abreast without crowding. In large schools there should be room for three adults on the same tread at once. In general, 5½ to 6 feet in width will give plenty of room. The height of the riser should not exceed 6½ inches, and the width of the tread be not less than 10 inches in the clear; 12 inches is better. There should be a rectangular landing approximately half way up, and this should be in width nearly double the length of the tread. Such a width will help to prevent blockades in case of fire and will insure better light on the stairs. It may be said here in passing that the habit of decorating this landing with potted plants, box seats, etc., needs questioning. If plants can be placed safely out of the way, there can be no objection offered. Some day we may have enough faith in the value of art and enough artists in our country to decorate the walls above these landings as well as in the hallways with mural paintings of a worthy sort, and then they will not seem so bare and cheerless.

Much has been written on the question of whether or not stairways should be boxed in or finished with open work, surmounted with a handrail. Those favoring the former method have cited instances where children have fallen over and received serious injuries where open balustrades have been used. But the danger from this sort of construction seems very slight, indeed, where due care is taken to make these high enough and sufficiently strong. The most objectionable feature of the open balustrade along stairways is the fact that in mixed schools they do not sufficiently shield the girls, as they ascend, from exposure to the view of those on the lower half of the stairs. At the high-school age, girls still wear short skirts, and in mixed schools, stairways thus constructed furnish opportunities which may be very objectionable. On the other hand, the boxed-in stairway is much darker and sometimes less acceptable from the standpoint of appearance. It therefore seems wise in building for mixed schools to recommend a balustrade with the lower part solid and the upper part more open.

Our best school architects are consistently specifying solid balustrades and also placing two or three metal ornaments of simple design on the rails to prevent pupils from attempting to slide down them, and there can be little serious objection to them.

When stair treads are made of cement, the corners next the risers ought to be left rounded instead of square, in order to facilitate keeping them clean. Dirt caught in rectangular corners is hard to remove and by reason of this fact is often left undisturbed. Where wooden stairs are used a triangular piece of tin made to fit the corners closely, saves much work in sweeping and gives better results in cleanliness. It is a wise procedure, in the construction of fireproof stairways, to use the very best cement obtainable, so that the treads may resist wear, stand level or nearly so, and especially to render the exposed edges strong and nonslippery. Handrails are needed on the wall side as well as along the outer side. These, however, should not extend more than 3 or 4 inches from the wall, and should be at least 3 feet above the treads. They are often too low to offer satisfactory assistance in going down the stairs, and there is far more need for them in descending than there is in ascending a stairway.

The short flight of steps through the main entrance to the first floor needs to be wider than those in the stairways proper, and can be constructed of stone or cement. The back stairways leading from the first floor to the basement can be more safely placed near the center of the building, for they are not likely to be used in case of fire.

3. BLACKBOARDS.

Nowhere in the world are blackboards used so extensively in schools as they are in America. They are essentially democratic and individual in their service, as contrasted with their use in countries where the teacher rules and guides with autocratic authority, and is the source of a large part of the information given to the pupils. A large area of wall space set apart in classrooms for blackboards assumes that pupils will individually present to their fellow classmates and to the teacher the results of their study, so that the free give-and-take of criticism will result in an independent, self-helpful assurance necessary to all good citizenship in our form of government. Blackboards are, then, not merely pedagogical conveniences but civic agencies worthy of consideration.

The history of blackboards is an interesting one, but for obvious reasons it would be irrelevant to recount it here. Suffice it to say, however, that they were used in Europe more than three centuries before they found their way into the schools of America. They were not introduced into our schools until the first or second decade of the last century, and were then merely blackened boards as the name indicates.

In the planning of school buildings, it is a matter of much importance not only to provide sufficient room for blackboards but to so place them with reference to the light that they will offer the fewest possible disturbances to vision. If the form of classrooms elsewhere recommended is chosen, the unused appropriate wall space in the back of the room, on the side opposite the windows and at the teacher's end of the room, should be prepared for blackboards. This will give approximately 60 linear feet of wall surface for this use. No blackboards should ever be placed on the same side of the room as the windows, and particularly between windows. To those who can recall the tiresome and painful effects of trying to see any work placed on a blackboard situated between windows, no argument will be needed to prove the wisdom of this prohibition. But there are still some school authorities who permit such a mistake, and to such as these it may be said that when the eye is adjusted to an object reflecting one strength of light it is out of adjustment for others reflecting either greater or less light. When a blackboard is situated between windows and a pupil at his desk undertakes to read any work written on this board, he must of necessity receive the light of the windows directly in his eyes. Such light being far stronger than that reflected from the written work on the board, his eyes automatically adjust themselves to the strong light, and hence he must either squint or strain the muscles of accommodation to see at all clearly. The evil effects of these eyestrains and maladjustments are too obvious to need further discussion. So a blackboard should never be put between the windows in a system of unilateral lighing.

Taking for granted, then, that the proper portions of the walls have been prepared for blackboards, how high above the floor should the lower parts of the boards be set? Plainly the answer will be this: They should be so placed as to give the children the use of the greatest amount of blackboard room while standing erect, or nearly so. In rooms designed to accommodate pupils of the first and second grades of the elementary schools the bottoms of the blackboards should not be more than 26 inches above the floor. For third and fourth grades, they can be set 27 inches; for the fifth and sixth grades, 30 inches; for the seventh and eighth grades, 34 inches. If these figures are followed for setting blackboards in rooms designed for elementary-school purposes they will not be far from the exact height required by the pupils. Of course some very tall pupils in the primary grades or some very short ones higher up may be somewhat troubled. It is necessary for architects to specify clearly these limits, or some closely approximating limits, else builders, when figuring on wainscoting or cutting it, will overlook these matters and set the boards too high for the primary classes. For rooms designed for high-school classes the distance between the floor and the blackboards should be not less than 3 feet. In rooms designed especially for classes in language or literature they can be put 2 inches higher with good effect, for while a student can make fairly good figures lower than this, he can not write well below this level. At the teacher's end of the room it is best to raise the blackboard at least 42 inches above the floor, for this board will be used chiefly by the teacher to indicate lessons and other general directions, and any point lower than this will not be easily seen by the students seated in the middle or rear of the room.

The next question for the architect to consider will be the width of the blackboards. On this point it may be said that not 1 square foot more of blackboard material should be placed in a schoolroom than is really needed. The reasons for this caution are these: Good blackboard material is expensive, and hence it would be a waste of money to put in more than is necessary. But a more important reason lies in the fact that blackboards absorb, under certain conditions, nearly, if not quite, 50 per cent of the light that strikes them. Since they are, for the most part, placed near those pupils who are farthest from the windows and who can least afford to lose the absorbed light, it is plain that no more blackened surface should be placed on the walls than real need demands. This is important. Where classrooms must be arranged to suit several grades of children, as is usual in village and consolidated rural schools, the blackboard 28 inches wide will be ample for the first, second, and third grades, for the fourth, fifth, and sixth, 32 inches, for the seventh and eighth, 3 feet. In high schools, especially in rooms designed for mathematics and art work, boards should be 40 inches wide.

Some recent thoroughgoing, but as yet unpublished, investigations which were made under the direction of the author by Miss Rainey, then a graduate student in Peabody College for Teachers, definitely determined that a blackboard 3 feet wide set at the proper height furnishes all the surface children *actually use* in regular school work. So we feel certain that architects can save and vision be conserved by specifying accordingly.

The next point to consider and one of prime importance is the material to be used for blackboards. Wood is no longer advisable, and no discussion of this seems necessary.

A fairly good blackboard can be made by using a good quality of cement thoroughly colored with some dull black material and so securely plastered to metal lath on the walls that no hollow sound will be heard when the chalk is being used. This difficulty can be overcome by constructing a solid, even backing of wood for the lath. Care must be taken, however, to prevent the expansion in such a backing from cracking the cement after it begins to set, for the moisture absorbed by the wood will cause it to expand. If the inner walls are made of brick or cement, no such difficulty will arise. The cement must be put on evenly, the surface finished as smoothly as pure cement can make it, and colored with great care. A slight tinge of dark green mixed with the black will be acceptable. One chief difficulty in the use of cement for this purpose is the fact that it must be put on quickly after being mixed and usually not enough can be mixed at one time to finish a room. As a result of two or more separate mixtures, there is liable to be slight differences in color which will be noticeable when it is dry. Of course this difficulty may be overcome when several workmen cooperate. There is danger, too, that after a time the coloring matter will fade or leach out when the board is washed. A cement board is likely to be harsh at first and therefore to cut the crayon too freely. There are a number of patented mixtures using cement as the chief ingredient and all of these are open to these objections. It makes a comparatively inexpensive board, but should not be used in first-class school buildings. It is hard to keep clean, and will not last so long as slate or glass, and glosses easily.

Slate of a dull black color when cut in large slabs, carefully and evenly set, is perhaps the best material now readily available in this country. It is expensive, but will last indefinitely and with reasonable care can be kept comparatively free from the dirt and oil gathered from the hands of the pupils. The most serious objections to slate are these: It is noisy and the joints never fit very closely and evenly. This latter defect often causes the eraser to catch and this often knocks it out of the hand of the pupil. This is not only troublesome to the worker, but it will throw a good deal of crayon dust into the air. Unless slate boards are set and fastened firmly to the wall, they will warp and render these joints still more troublesome.

There are on the market several kinds of blackboards made of paper, paper-like material, or wood pulp rolled and pressed into sheets of any reasonable length. They can be colored to suit, and, when well set, are for a time fairly satisfactory. The main troubles with these are they absorb water when washed or during damp weather, become oily, and in time buckle and chip. Experience with them indicates that they will not stand hard usage very long and soon become dangerously glossy. It is not advisable to use such material in the best school buildings.

In England the best blackboards are made of glass. A sheet of glass of good quality and thickness is slightly but evenly ground on one side. The reverse side is painted the color desired, and when dry is firmly set with the ground side out. The color shows through so as to seem to be on the surface, while the roughness caused by the grinding cuts the crayon and thus leaves a clear white mark on a black background. It is very necessary that the grinding agent does not cut too deep and leave the surface too rough, for glass cuts the crayon freely and would, under this condition, introduce the difficulty of an undue amount of crayon dust, which, as every teacher knows, is irritating and harmful when breathed.

The great advantages of glass boards are obvious. They are easily cleaned, do not absorb moisture or oil from the hands, do not warp or buckle, last indefinitely—indeed they improve with use—and can be made to fit at the joints more perfectly than slate. They are not used to any extent in this country, but in many respects they are superior to slate, and in time will be used more extensively.

There are a number of other forms of boards, but slate or glass are the best. and in the long run are most economical. Of these glass is to be preferred. When this can not be obtained, slate should be chosen for all good buildings.

Since the first edition of this bulletin was printed glass blackboards have been used in a number of buildings in the Eastern States, but so far as can be learned have not been uniformly satisfactory. This was due to the fact that the glass was ground too coarsely and was in part poorly set. It is plain that the glass blackboard has not made much progress in this country and will not do so unless greater care is taken in its manufacture. At present the best advice to give is that which will dictate the use of a good quality of black slate.

4. DOORS.

Whether laws require it or not, no schoolhouse should be constructed with outside doors set to swing in. In many States there are laws now in force commanding outward swinging doors in all public buildings, including schoolhouses. Furthermore, some recent disasters, notably the one in Ohio, emphasize the necessity of so fastening outside doors that they may be easily thrown open from the inside. In the past few years patents have been issued for fastenings which render the door secure from the outside, although it will open readily at an 8 or 10 pound pressure from within. These make it possible to keep the building locked during school hours so as to prevent intruders and thieves from entering, yet in no way endanger the children in case of fire, for a small child can push them open. Recent surveys of school buildings in a number of cities in various parts of the country have revealed the fact that these safety devices have been poorly constructed and are frequently ineffective in preventing doors from being opened from without by intruders. Architects and contractors should be cautioned against specifying and using such devices unless they can be so set as to insure permanency and reliability. Theoretically they meet the needs, but practically they have not always been satisfactory.

The style of interior doors deserves some attention from the point of view of beauty and cleanliness. The ordinary stock paneled doors are not at all satisfactory. They shrink a good deal, catch the dust on the ledge supporting the panels, and are often easily split. The best doors are smooth on both sides from bottom to top, and built up of different layers of wood glued together, with the grain of the core and the outside running at right angles. The central or inner layer can be constructed of light, well-seasoned pine or poplar boards, tongued and grooved and thoroughly glued together, and running crosswise. Over these a veneer of wood, selected to match the finish of the rooms and halls and set vertically to the floor, is carefully fastened and glued to the core. This gives a comparatively light door, which will not easily warp or split. Such a door is readily kept clean and when properly finished is really more attractive than the regulation paneled door. These are not theoretical doors, but they are used in some of the best school buildings of the country.

In this connection protest should be made against the use of the so-called "carpet" strip, or threshold strip, so frequently put under inside doors to insure them swinging clear of the floor. These strips may and do have a reason for being in a home where carpets or rugs are spread over the floor in front of doors, but they are in the way, and serve no necessary purpose in the school building. They catch dust, make it hard to sweep or brush the floor, and in addition are stumbling blocks to the children. A level floor offers no impediment to a door set vertically and secured by strong hinges.

It is of course necessary to set a door slightly above the floor, so it will not drag when opened; but if the floor is carefully laid, the door frames vertically set, and the door solidly hung there will be no trouble. It is a great relief to get rid of the "carpet" strip for the sake of cleanliness, and the floor and room present a much neater appearance without it.

Save in those instances where it is necessary to transmit light to halls or inner rooms, it is a mistake to put glass in schoolroom doors or above them. A schoolroom needs privacy in order that the teacher and the children may do the most effective work. Besides, even if the glass be frosted or ground so as to render it merely translucent, a gust of wind or a bump from passing students may break it. Experience with such doors warrants advice against their use. A good many superintendents and principals, however, insist that it is helpful to have a simple pane of glass set high in the door so that they may in passing get a glimpse of classroom conditions without in any way disturbing the class and with the least possible loss of time. But, generally speaking, such observations are not of much use and at times may be misleading. Then, too, it is more than likely that passers-by will disturb the children unnecessarily and even unintentionally.

Transoms serve no purpose save that of offering some little aid in very hot weather by permitting a draft from the room into the hall. Transoms rarely fit closely and at the same time work with sufficient ease to make it possible to use them when needed. With the plenum system of ventilation they are troublesome, because of the leakage from the room. They are often neglected, and hence usually dirty. They furnish a ledge for the accumulation of dust and cobwebs, and thus often give a room an untidy appearance. It is better in general to dispense with all transoms, for they are more trouble than they are worth and waste much money in construction.

For the purposes of cross ventilation it is much better to insert breeze windows above the blackboards, as described elsewhere in this bulletin, than to depend on transoms over doors; for breeze windows when properly constructed are better placed and large enough to serve for effective ventilation.

5. WINDOWS AND SCREENS.

Of late years a great variety of window sashes has been devised in the attempt to give better illumination and easier methods of ventilation. In an investigation of the San Francisco school buildings, a dozen varieties at least were found in the newer types of buildings. Some were pivoted in the center both top and bottom, others at the sides, others were divided into sections and each section pivoted, and still others so constructed as to open outward or inward in various ways, all with the idea of opening a greater space for ventilation than could be done with the ordinary double hung window. But almost without exception it was discovered that these hinged or pivoted types were giving a good deal of trouble and many of them were so hard to handle that it was practically impossible for the teachers to manage them.

In cases of storms such sashes are likely to blow open, damage the building or occasionally injure a child. Experience shows that the best and safest type is the old-fashioned double hung window. Teachers know how to operate this kind of window and will generally do so, and, while it at best only permits half of the window space to be open at one time, it gives far less trouble, frequently costs much less, and is more practical. With this type it is easy to screen windows, while with the hinged or pivoted type it is frequently impossible. Theoretically these newer windows are very promising, but experience has proven that they are many times quite troublesome and unsatisfactory.

Again, let me insist on rectangular-topped windows that may be opened easily and readily rather than those fancy arched types set transom fashion. The latter obstruct the light and are open to the same objection in part as the hinged windows above described. Here, as frequently occurs, the simplest thing is the best. Heavy strong sashes should be specified for windows, and the glazing should be with comparatively small sizes of glass. Heavy sashes are needed because of the size of the windows and also because they will give ample contacts for the putty. A great deal of trouble has arisen in recent years because of the falling off of the putty, thereby exposing the glass to breakage and the sashes to rapid weathering. It seems that a very poor quality of putty is being used or it has not been put on properly. While this may seem a matter of small moment, it is worth attention because of the many troubles that grow out of it. This is especially important in the hotter and dryer regions of the South and Southwest. In colder climates all classroom windows should be provided with air deflectors so that the lower sashes can be opened without a resulting draft of outside air upon the pupils. These deflectors should be so constructed as to interfere as little as possible with the admission of light.

PLATFORMS.

There is no need in an ordinary schoolroom for a teacher's platform or rostrum. To many this statement may seem to be nonsense. But stop to think a minute. They are always in the way, they are hard to keep clean, they are rarely in the right place, and even when not fastened to the floor, they are too heavy to move easily. They are remnants from medieval days, when schools were dominated by the church, when monks were teachers, and when the work of the school consisted in listening to lectures and copying verbatim what was said. To-day the teacher, with books and helps of all sorts, merely guides, directs, inspires, and amplifies. In the primary grades more direction and help are needed, but they are given usually at the desk of the pupil or at the blackboard. But the teacher to whom this will seem an invasion will object, saying: "But how can I see my pupils when I am seated on the same level with them?" The best answer to this, and the only one that will convince, is this: "Try it and see." Another will remark, "It will take away the teacher's dignity." Well, if dignity is a matter of platform, then it is well to get rid of it. A teacher can not have too much true dignity, but this sort comes from within, and exhibits itself in wisdom, judgment, understanding, and genuine sympathetic help. Platforms and silken robes are for those who cling to customs belonging to previous centuries.

A good teacher has no need to spy on children, for the more they can work together the better the result. A neat table or desk and a simple chair is all the pulpit a regular classroom needs. Then almost the whole front of the room is free for workers and for such apparatus as the day's work will demand. Of course in science lecture rooms and in assembly rooms platforms and stages are needed. If you have never taught in a room without a platform, you will find much relief, especially in grammar-grade work. Your room will be neater and the space for moving about much less obstructed.

The foregoing was written more than 10 years ago, and while there has been a great lessening in these impedimenta, many new buildings are still being supplied with them.

As we have elsewhere stated another elimination from classrooms ought to be urged in this connection, and that is the "carpet strip" beneath the doors. If the floor from the hall is continuous through the door, and the door set to swing just clear of the floor, there is much relief from dirt, stumblings, and noise where nothing obstructs the entrance. It is good school hygiene to eliminate all that is useless both in building and in the program.

6. CLASSROOM FURNITURE AND EQUIPMENT.

Strictly speaking no discussion of classroom equipment and furniture is necessary here, but because of its indirect effect upon the building, attention should be called to a new kind of school desk which has been devised since the former bulletin was written. I refer to an adjustable and movable chair-desk, which can be placed at any part of the room, or taken from room to room without trouble.

Whenever it is possible boards of education and architect should consider together the question of school furniture. Boards of education should be guided by the advice of those who have technical knowledge of such problems.

A fixed case or cabinet is necessary for each classroom, where books and material may be kept safely and out of the dirt and dust. A comparatively small but neat table, with a comfortable chair, should be provided for the teacher in each room.

VI. LIGHTING.

It is safe to say that the demands made on the eyes of school children are greater now than at any previous time in the history of education, and therefore whatever can be done in the way of furnishing better light for our schoolrooms will serve to make school work less fatiguing and indirectly more interesting. And it must ever be held in mind that the problems of lighting, heating, and ventilating schoolrooms are far more complex and difficult than those connected with lighting, heating, and ventilating a living room at home. But it seems that this is a very difficult thing to learn, both for teachers and school officers. If children could be allowed the same freedom at school that they are allowed at home, and if they could have the same average amount of space at school that they have at home, then many of the suggestions offered here would be out of place. But at present, when a teacher must manage, direct, and teach from 40 to 50 children in a room so small as to afford in many cases less than 15 square feet of floor space per pupil, many difficulties are of necessity introduced. It requires persistent reiteration and striking objective illustrations of this difference between home and school conditions to bring teachers to act accordingly. The habits they have formed in their homes in these particulars must be overcome before they can be trusted to be careful of these things in their schoolrooms.

The problems connected with the proper lighting of schoolrooms vary to some degree in different parts of our country. California and all of the States of the Southwest enjoy more sunny days, and hence get more regular and continuous bright light than any of the Eastern or Northern States. Besides, in this same region the air is often freer from dust and smoke than it is farther north and east, and this renders both the direct and indirect light unusually strong. During several months of the year the landscape in the Southwest presents a wide expanse of browns somewhat dazzling to the eyes as it reflects the bright rays of the sun. To the north and northeast both the quality and quantity of the light is affected by the dazzling snows of winter or, in some places, the shades of summer. Taking all of these things into consideration, it is impossible to formulate rules which will apply equally well in all parts of our country. Most writers on this subject have, however, neglected to take into account these varying conditions, and have stated their rules and principles as if they could be universally applied, and school authorities who have tried to follow such directions without seeking advice concerning local conditions have, in many instances, made serious blunders.

In the northern part of our country where, during the winter season, twilight begins comparatively early in the afternoon, where the shadows are long at noontime, and where cloudy, dark days are of frequent occurrence, it is often necessary to require for each classroom an amount of window surface equal to one-fourth of the area of the floor. In the Southwest it will be perfectly safe to limit the total area of the windows to one-sixth of the floor space. It must be understood, however, that these rules will hold good only in those cases where the windows are properly placed and where rooms are of the proper shape and proportion. Furthermore, it is necessary for architects and builders to remember that these figures do not represent the combined space inside the window frames, but the actual glass surface through which the light can enter unhindered.

A schoolhouse should be so constructed and so placed on the lot as to admit into the classrooms the early morning sunshine or that of the later afternoon. In the latitude of our country, schoolrooms should never be lighted by windows facing to the south. If windows open into a classroom from the south, despite all that can be done with ordinary shades or blinds, bright rays of the sun will find their way into the room during the busiest part of the day and will inevitably dazzle and disturb the eyes of the children as well as those of the teacher. It will prove a mistake in nearly every instance to say that the teacher can so regulate the shades as to prevent all such troubles. If we were to grant that double shades can be regulated so as to shut out the direct rays of the sun, the fact still remains that very often busy teachers will neglect to regulate them properly, and consequently harm will result. During many years of observation on this point I have yet to see a single classroom properly lighted when depending on light from south windows.

While speaking on this point, though addressing his thought to the teachers of Germany, and, of course, to the conditions of German climate, Professor Foster, of Breslau, has said:

> No curtains have yet been invented which will keep back the direct rays of the sun and at the same time let the diffused light of the clear sky pass through. Ground glass has been recommended, but it is too dazzling and blinding in the direct rays of the sun, and during cloudy days it intercepts too much of the light.

Since the words here quoted were written many attempts have been made to solve the difficulties mentioned by the invention and manufacture of many kinds of shades, but we have yet to see a shade, whether green or gray, buff or blue, which, if satisfactory when exposed to the midday rays of bright sunshine, did not prove unsuitable during the earlier and later periods of the school day. Some one may say, however, that the teacher must adjust the shades as the conditions change during the day. But teachers do not adjust and can not be trusted to adjust the shades so as to maintain a regular light when windows open to the south.

But if it is difficult to use shades to regulate properly a south light it is more difficult and, let us say, almost wholly impossible to do so with the common shutters or slat blinds. I have found that even when these are new and all of the slats are in place, just as with the shades, they are very frequently neglected and therefore dangerous; but the difficulty is especially great when, after a short time, all the slats do not close equally tight. Through the chinks thus afforded pencils of light stream in, producing that peculiar painful adjustment of the eyes which not only induces undue fatigue of the eye muscles but also distracts the attention and annoys the child into a restless and careless mood. So the plain advice to give here is, do not construct your schoolhouse in such a way that windows will open from any classroom toward the south, for it is impossible to light the room properly in this way.

As a result of a year of scientific experimentation, conducted by Robert H. Southerland, the following results with reference to the proper orientation of school buildings were obtained:[2]

It was found that if a classroom faced toward the northeast there were only 165 desk hours of sunlight interference, while if it faced to the east 1,336, to the southeast 2,458, to the south 2,885, toward the southwest 2,190, and toward the west 828 desk hours of sunlight interference. By desk hours is here meant that direct sunshine will fall on the top of the desk during school hours, making it disagreeable and unhygienic from the point of view of vision to be so exposed. This means that if the windows of a classroom face toward the northeast there will be little interference as well as very little sunshine; if toward the east the classroom will be subjected to a complete sunning before school begins and we will have to shield the desks for about an hour or an hour and a half to prevent direct sunlight from interfering. After 11 o'clock there will be no further interference during the rest of the day and shades may be pulled up and the entire window used for proper lighting. When the windows face toward the southeast during most of the winter months, the whole classroom will be interfered with until about 2 o'clock in the afternoon. With the windows facing south during every clear day in the wintertime, even as far south as Nashville, shades must be drawn to protect the children on the first rows near the windows. In so doing, those farther removed from the windows are handicapped by lack of light. Furthermore, the sun does not pass far beyond the center of the room at any time, and while those near the windows are bothered all day long, there is no direct sunshine on the north side of the classroom. Southwest exposure brings difficulty all the after-

[2] These experiments were conducted under the guidance and at the suggestion of the writer of this bulletin.

noon, really beginning before 12 o'clock. It gives much greater interference than the west light, and at the same time does not purify the room as a whole so completely.

From the figures given it will be seen that there are far fewer hours of interference from the west than any other orientation. This is due to the fact that schools are out from 2.30 to 3.30 o'clock, giving only about an hour or an hour and a half of actual trouble.

Naturally there were two questions to be considered in this investigation, namely, how to get maximum sunshine in the classroom with the least interference by direct sunshine on the desks. By maximum sunshine is meant the maximum amount of space thoroughly sunned during the day. It is not a question of supplying heat, but a question of purification and direct sunlight interference, for in the first place we get the maximum space of a classroom swept by direct sunlight when windows face toward the east or west. We get the minimum space purified by direct sunlight when windows face toward the south, but likewise the maximum amount of interference. This interference must be considered of great importance, for shades must be drawn to protect the children from the dazzling light upon their desks, while, at the same time, other children will be deprived of sufficient light, and ventilation will be interfered with because the windows are thus covered with shades.

Taking these two sets of data into consideration, it was found that the best sanitation and least interference from direct sunshine was obtained when the classrooms faced either east or west. And as I am able to state without hesitation that the best orientation for classrooms is toward the east and west, this fact has been established beyond mere opinion.

Southeast and southwest exposures are especially to be avoided. The windows should be placed in one side of the room only, and preferably on the east side in the buildings of one room. They should be placed on one side so as to avoid cross lights and prevent the children from writing in the shadows of their own hands. The eyes of any pupil in the room will thus be relieved of the necessity of attempting to adjust themselves to unequal sources of light. Even as simple and as plain a necessity as unilateral lighting for schoolrooms is not understood by many who know naught of school conditions. A physician recently rebuked me for recommending this method of placing the windows, for he said that he believed it would be a very serious thing to thus compel the children to use only one eye in their work.

With unilateral lighting it is far easier to arrange for adequate blackboard space and to place it opposite the light, as it should be, than in any method of construction admitting light from both sides.

Furthermore, in large buildings it is practically impossible to plan for windows on more than one side on account of the necessary hallways and adjoining rooms.

The windows should be placed as closely together as safety of construction will permit, and well toward the rear of the room—that is, the windows ought to be located so as to be as far as possible to the rear as well as to the left of the pupils when seated at their desks. To make this arrangement of the windows possible, it is necessay to determine, before they are placed, the direction toward which the pupils will face. This will be more easily understood by referring to the drawing showing the proper position of desks and windows. (Fig. 2.) Pupils should receive the light from the left in order that when writing the shadow of the right hand will not fall directly on the point where the pen touches the paper. It follows, therefore, that if there be any pupils who use the left hand in writing or drawing, special provisions should be made for them so that they may sit with the right side to the light. If the majority of pupils were left-handed, plainly the advice should be given to construct the rooms so as to have the windows to the rear and on the right side.

It has been said that the windows should be placed on one side only, and preferably toward the east. The last statement in this rule, of course, could not always apply to school buildings containing more than one room. In buildings of two, four, or more rooms it will often be necessary to have the windows of as many rooms face the west as the east. It still remains true, however, that those rooms whose windows face the east, when other conditions remain the same, will be the most healthful and wholesome rooms because of the early sunning which they will get. And just here is perhaps the best place to say that while the north light is the most diffused and the softest which can be admitted into the schoolroom, it is unsafe to depend on maintaining the health of children kept in schoolrooms with windows looking only toward the north. These rooms will do for art work and laboratories, but not for regular classrooms. Every schoolroom needs a sun bath each day to keep it pure and wholesome, and it is contrary to the simplest and plainest rules of hygiene to construct a schoolhouse which will not permit of this mode of sanitation and disinfection. Also the first part of the last rule needs some slight modification in order to prevent it from deterring in certain cases. There are conditions in most of the Southern and Southwestern States, especially in the great valleys, which demand openings toward the north, not for the purpose of getting additional light, but for ventilation and cooling. In the warm valleys, during the early and later months of the school year, the heat is often so intense as to render it almost necessary to get the advantage of a breeze through the room. Under these conditions it is best to have some openings in the side of the room opposite the windows. Such openings have elsewhere been called breeze windows. If they open into a hall or cloister they offer no inconvenience from weather conditions or cross lighting. These openings need not be full-sized windows, but better, small windows set 8 feet or more above the floor. In case these are set in an outside wall they must be so made as to prevent rain from beating in, and covered on the inside with close-fitting opaque shades or curtains. This precaution, together with their height above the floor, will prevent such windows from admitting a blinding light into the eyes of teacher or pupils. In those sections of our country where there are many cloudy days during the winter and early spring, and especially in smoky cities, with tall buildings not far removed from the school ground, it is necessary, as I have elsewhere said, to plan for at least one-fourth as much glass surface to each room as there is floor space. The difficulty comes in the proper placing of so much glass surface in a single wall.

If, for example, the room is 30 feet long, 22 feet wide, and 12½ feet high, it would be necessary, according to this rule, to place in a wall 30 feet long 165 square feet of glazing. If the bottom of the windows are set 4 feet above the floor and the tops of them extend within 6 inches of the ceiling, the length of the windows would then be limited to 8 feet. In order, therefore, to get the amount of window surface demanded by this rule, 21 feet of wall surface would have to be used for glass. This would leave only 9 feet for mullions between windows and the corner supports. This would necessitate the extension of the windows too far to the front so that some of the children in the room would be compelled to sit through the day almost facing the windows. But it should be remembered that in a room 22 feet wide it requires a smaller ratio of glass surface to floor surface, other things being equal, to give equal illumination. Those children who sit near the windows have plenty of light and those farther away are handicapped accordingly. So when classrooms are reduced in width we may safely reduce the ratio of glazing to floor surface correspondingly. Hence, six windows 3 feet wide and 8 feet long will give ample light in such a classroom except in extreme northern climates or when buildings are badly placed.

It rarely does any good to attempt to make up the deficit of glass surface, if there be any, by setting windows in the rear of the classroom. Such an arrangement always disturbs the teacher, causes the children to work in their own shadows, and to get disturbing cross-lights. In the greater part of our country we have found that the ratio of glazing to the floor space need not be over 1 to 5. This will give ample room to set the windows properly and provide ample illumination. Hence, under ordinary conditions, there is no necessity for purposes of lighting to put windows in more than one side of schoolhouses properly placed and where the light is not cut off by fog, smoke, or high horizon lines.

In the earlier edition of this bulletin it was necessary to stress unilateral lighting far more than it is now for the simple reason that it was an innovation and people had to be convinced of its value. During the past 10 years practically all progressive communities and all capable school architects have accepted this as the best type of lighting. Hence there is no need at the present to enter into extended arguments pro and con. Furthermore, methods of building have made rapid progress and what once seemed to be a difficult type of building to construct is now easy. It may be repeated here that a classroom 22 feet wide is, other things being equal, better than one 24 feet wide. The farther north in our country the better results we get, in the way of satisfactory light, by reducing the width of the classroom and thus commanding good light with a smaller ratio of glazing to the floor surface.

The distance between the floor and the lowest part of all classroom windows should be greater than it is usually made, in order to prevent the light from shining directly into the pupils' eyes. The window sill should be at least 4 feet above the floor, so that all light falling upon the desks would come from above the level of the eyes of the pupil when seated at his desk. This is an exceedingly important direction, for, when windows are so constructed, the danger of misplaced and disarranged shades is minimized. Some of the European cities require that the bottoms of the windows must be placed as high above the floor as the tops of the pupils' heads when seated.

In order to get the best light and the most of it for the amount of window surface, it is absolutely necessary to run the top of the windows as near to the ceiling as possible, for it is plain that 1 foot of window surface near the ceiling of the room will do more to light the room than 2 or 3 feet near the bottom. The tops of the windows ought to be at least 12 feet above the floor, for this will insure sufficient light to those pupils seated farthest from the windows.

Ten years ago there was a tendency among school architects to introduce into schoolhouses a coved or curved ceiling line. This tendency was condemned at that time and reasons given why it was a mistake. During the intervening years this mistake has been corrected, and it is a rare thing to find architects specifying such construction. The main reason for condemning this practice was, as can be inferred from the above discussion, that it necessitated dropping the tops of the windows too far below the ceiling line.

As mentioned elsewhere, no pupils should be seated at a greater distance from the windows than that equal to twice the height of the tops of the windows from the floor. And this, too, only on the condition of the proper amount of window surface. Where it is impossible to get sufficient light from ordinary windows, due to errors in plans or to conditions over which builders have no control, prismatic or ribbed glass may occasionally be used with profit. As the result of a series of tests made by Professor Norton, of the Massachusetts Institute of Technology, it was found that by the use of this ribbed glass, set in the upper parts of windows, the illumination on dark days could be increased under certain conditions from 40 to 50 per cent.

The proper arrangement of shades for the windows is not an easy matter. Blinds ought not to be used at all, for the reasons spoken of above, and for the further reason that they are far more expensive than common roller shades, and frequently become hard to manage.

The best arrangement of roller shades which has been devised consists in using two separate sets of shades for each window, both fastened at about two-fifths of the height of the window, the upper one to pull up and the other to pull down. Care must be taken to place them in such a way that they will not rub together when both are rolled up, nor leave a chink through which a stream of light may pass when both are unrolled. Special brackets have been devised for these fastenings and are now on the market. The shades should be wide enough to cover the window and extend over each side of the window frame, to prevent rays of light from passing the sides. This last precaution will save much annoyance later.

There is on the market now a type of shade which folds rather than rolls; fastens at the center above, and can be adjusted to cut out the light from any part of the window. It requires more care in handling than the roll type of shade, but if teachers will learn to use it and take the time to adjust it carefully, it will meet the needs better than any single shade.

There has been a great deal said about the proper color of the shades, and many experiments have been made to find the color and tint most satisfactory to the eyes of children, which will at the same time serve to prevent the entrance of dazzling light. Some have advised the use of an opaque dark green shade below and a translucent lighter green one above. This arrangement, however, can be satisfactorily only when the shade used above is sufficiently opaque and sufficiently dark to avoid that peculiar greenish light which makes for discomfort. Rowe, in his excellent little book on The Lighting of Schoolrooms, says:

> I have found bisque (a light sage) makes a very satisfactory color, not light enough to annoy or dark enough to exclude the light. This and lighter colors of the handmade tint and the Bancroft Sunfrost Hollands meet all the requirements of Cohn's light tester.

Since the light of the room is modified both in amount and quality by the color of the walls, it is in place here to speak of this. What color is best for the walls of a schoolroom? The answer to this question will be given by summarizing a report made to the school board of New York City by a committee of the best known oculists of the city:

(1) The wall space between the floor and the window sills and the chalk troughs should be a light brown.

(2) Side walls and ceilings should be a light buff tint, or a light gray. The red end of the spectrum should never be used in schoolroom decoration, for it absorbs too much of the light.

(3) Light-colored wood should be selected for the furnishings and furniture of the room.

(4) The color chosen for the walls and ceilings should be chosen for the most unfavorable days.

(5) The woodwork in the schoolroom should not be highly polished. Natural finish with a dull surface is best.

SUMMARY.

1. In those parts of our country far to the north, where the sun is low in the south a greater part of the school year, and in those locations where fogs and cloudy weather prevail or where the air is clouded with smoke, architects ought to allow to each room one-fourth as much glass surface for the purpose of lighting as there is floor surface. In the South and Southwest where sunshine is abundant and where the sun is higher above the horizon at noontime, one-sixth as much glass surface as floor surface, when the windows are properly placed, is sufficient. In general, where there are no hills, high buildings, or trees to obstruct the light, and where the atmosphere is comparatively clear, one-fifth as much glass surface as floor surface will suffice.

2. The bottom of the windows should be at least 4 feet above the floor.

3. The windows should be placed as closely together as safety of construction will permit and as far back toward the rear of the room as possible and to the left of the children when seated at their desks.

4. To aid in grouping the windows closely together iron or steel mullions should be used with the inner and outer sides having

rounded edges in order that the light from the windows may be equally distributed over the room, that as much light as possible may enter, and that no shadows may fall on the desks near the windows.

5. The windows should extend close to the ceiling, for the best and most effective light comes from the top of the windows and spreads over the entire room most evenly.

6. Where tall buildings or high hills raise the horizon line on the window side of school buildings, prismatic or ribbed glass should be used in the upper part of the windows, for this both scatters and increases the light in darker parts of the schoolroom. This sort of glazing should not be used on the lower part of the windows on account of the glare produced.

7. In hot climates, where during part of the school year a breeze is refreshing and acceptable, there should be placed, when possible, at least two small windows 8 feet above the floor in the side of the room opposite the windows. These breeze windows should be hinged to the lower part of their frames or placed on a pivot and covered with opaque curtains. Such windows are not for the purpose of light, but, as suggested, to afford openings for an alleviating breeze when conditions demand.

8. Sliding slat blinds or outside shutters should never be used in schoolrooms either to cut off the direct rays of the sun or for decorative effect, for they are both expensive and ill adapted for school purposes. The best means so far devised and at the same time the cheapest and most easily managed appliances for this purpose are double shades or the single folding shade recently put on the market. These double shades should be fastened at a point about two-fifths up the windows from the lower sill. They should be fastened in a specially devised bracket (such brackets are on the market), so that while one shade will close the upper part of the window from below, the other will close the lower part of the window from above. Care should be taken that these brackets are so constructed and so placed that no rays of light can pass between the two shades, either when rolled or unrolled. The shades should be sufficiently wide to prevent the rays of light from entering at their sides.

9. It is a very difficult matter to hit upon the proper color of shades and at the same time to get those sufficiently translucent to allow a maximum of light to pass through without producing a glare. In general, it may be said that a light unobtrusive green seems to be the most satisfactory. This, however, will in part depend upon local conditions and the proper situation of the windows. Green is a very troublesome color to handle in a schoolroom, and tests ought to be made in all cases before final decision is made. For it often

happens that a slight variation in shade or the quality of material makes a decided difference in the quality of light in the schoolroom.

10. The great amount of blackboard surface used in American schoolrooms tends to absorb much of the light. On dark days when these are not in use it has been found that great relief can be afforded those children who sit at the desks farthest removed from the windows by drawing down light curtains over the blackboards. Professors Basquin and Scott report that "by the introduction of screens over the blackboards" they found that in rooms receiving unilateral lighting they could by the use of such screens increase the light at the darkest seat in the room 50 per cent.

11. By reducing the width of classrooms to 22 feet it is much easier to get proper illumination for all the children than it was in the old type of classrooms 24 to 26 feet wide. In this room, five rows of desks are placed while in the older room six rows of single desks were set. The distance, therefore, of the last row of children from the windows was greater in the old type of classroom than the one I am now advocating and hence their desks were not so readily illuminated.

VII. HEATING.

Before entering upon a discussion of the various methods employed in heating schoolrooms, it will be well to consider briefly this question: At what temperature should the schoolroom be kept?

Very thorough investigations of this subject, especially those conducted by the New York Commission on Ventilation, have established the fact that a temperature of from 66° to 68° (with a relative humidity around 50 per cent) is the best for school work. Certainly 70° is the maximum allowable.

These figures may all be misleading, however, for the construction of the schoolroom and the methods of heat distribution enter vitally into the question. For example, one schoolroom with damp walls and poorly constructed floors may be quite uncomfortable at 68° F. at the breathing line in the center of the room, while another, with damp-proof walls and double floors with deadening felt between may be quite satisfactory with an even temperature of 66° F. One frequent complaint from teachers arises from the fact that there is too much disparity between the temperature at the breathing line for the children while seated and that for the teacher while standing. There is a real difficulty here, and it can be remedied only by double floors well deadened and protected from drafts and more effective methods of evenly distributing the heat. Naturally, heated air moving by the force of gravity will seek the upper part of the room, and unless it finds an exit there will remain until it becomes cooler than the ascending currents, when it will slowly descend.

Every school should be supplied with two or more accurate thermometers, so that the supervisor as well as the teacher may know the exact temperature maintained at the breathing line and at the floor line in all parts of the room. These are not expensive luxuries, but may serve to forestall a good deal of complaint and furnish indisputable evidence for the edification of all concerned.

Certain discomforts which were hitherto connected with breathing foul air are really due to working in overheated rooms. Dullness, headaches, and general heaviness of mental action may, and often do, find their immediate causes in superheated air, which by interfering with the elimination of body heat, upsets the normal physiological activity of the body. On the other hand, unless the children are comfortably warmed in cold weather, it is not only impossible to carry on the work of the school, but it is positively dangerous for them to be quiet. It is absolutely essential, then, to make provisions for adequate heating. This last statement seems to be a useless one, for it is a mere truism; but, sad to say, it is what one might with propriety call a theoretical truism rarely realized in practice.

1. FIREPLACES.

Old-time schoolhouses were heated by fireplaces, and, in general, those pupils close to the fire were too hot, while those at a distance were uncomfortably cold, for such a fire is more effective in creating drafts in a schoolroom than it is in giving out heat. In a room so heated there is a partial vacuum created, causing the outside cold air to pour in at every possible crack or crevice and to move directly toward the fire. The day of the open fire in the schoolhouse has almost gone, for, while it had some advantages, it failed to accomplish satisfactorily and economically its purpose. It was cheery on mild days and totally inadequate on cold days, but it was a good ventilator—indeed, too good. In comparatively recent years fireplaces have been constructed in such a way as to warm the fresh air and introduce it into the schoolroom through ducts above the fireplace. This style has a distinct advantage over the original in that it helps in preventing drafts and at the same time is more economical of fuel. But fireplaces in school buildings are inadequate and ineffective save in well-constructed buildings in mild climates. Even so, the trouble of keeping up the fires and preparing the wood is too great to commend them for use in a busy schoolroom. Most fireplaces and grates waste more than 90 per cent of the fuel. As an auxiliary to ventilation, when the heat supply comes from a furnace or through steam coils connected with the fresh-air inlets, the fireplace correctly placed is useful and effective.

2. BOX STOVES.

The box stove came next with its greater efficiency and economy. It heated the room but afforded no effective means of equalizing the temperature in the various parts of the room. When situated in the center of the room it was in the way, and because of the fact that it was out of the question for a pupil to sit near it when it was heated sufficiently to meet the demands of those occupying benches next the walls much of the best space of the schoolroom was wasted. If placed near the end or side of the room, it was ineffective for the room as a whole. The roastings to which the school boys of a generation ago were subjected remain yet as vivid impressions. Fortunately, vigorous outdoor employments and sports, together with short school terms, minimized the dangers. In early days the school buildings were often built in such a way that the wind swept under the floor at will. Double floors with deadening felt were not known, or if they were, knowledge in this case at least had no relation to virtue. Single floors with open cracks were the rule. The walls were made of studding, covered on the outside with one thickness of clapboards put on shingle fashion, and on the inside with wide boards tongued and grooved. Shrinkage was ample and hence the stove must be kept red hot in cold weather. Log houses well chinked were in some respects much better, but small and awkwardly fitting windows in these generally evened up the difficulties.

The great majority of the country schools in parts of our country are yet in the box-stove era, but the buildings are being more carefully made, and hence the children are somewhat better protected from the cold.

3. JACKETED STOVES.

The jacketed stove is the next step in the evolution of heating small school buildings. A jacketed stove, as its name indicates, is a stove surrounded with a casing or jacket, between which jacket and the stove there is left an air space connected directly by means of one or two ducts with the air outside. These ducts permit the cold fresh air from the outside to come in contact with the stove and when it is warmed to rise directly into the schoolroom. The jacket when properly fitted serves to keep this fresh air close enough to the stove to warm it, and at the same time to deliver it into the room well above the breathing line. It is well to provide the fresh-air inlets with dampers to be used during troublesome winds.

In recent years a great many varieties of jacketed stoves have been put upon the market, all of them using of course the same principle of heating fresh air and distributing it through the room and at the same time creating a circulation by exhausting the air in some fashion near the stove. They can be set in the corners of the room, draw the fresh air directly from without, and heat and deliver it to the classrooms directly. At one time it was thought of great importance to have an exit flue or a pipe attached to the stove and extend nearly to the floor. The theory was that as the warm expanded air swept upward and outward to the various parts of the room that the air would leave the room through this flue and thereby create considerable circulation. This theory works in part, but is not nearly so effective as many imagine. Much of the incoming air goes out around windows and doors and various openings in the wall, especially those higher up in the room. The heavier air lies nearer the floor and hence is not inclined to be drawn readily through the exit flue. In the former edition of this bulletin more stress was laid on the necessity of providing exit flues than now seems justifiable. The friction in these flues is often so great and their lack of sufficient draft so correspondingly poor, that a smaller amount of impure air is exhausted than was thought to be the case. I do not mean by this discussion to suggest elimination of these exits from jacketed stoves, but simply to warn schoolmen against *believing* that the jacketed stove *will ventilate* a schoolroom. It will aid much in very cold weather, but in mild weather it is of very little use in supplying fresh air to classrooms. The fact is a jacketed stove can not be trusted to ventilate satisfactorily at any time and not even passably, save in cold weather, but is of great service in equalizing the temperature in various parts of a classroom. But it is the best method of heating where a central system can not be installed. Every country school, or for that matter village school, not supplied with a central heating plant should be supplied with jacketed stoves.

4. HOT-AIR FURNACES.

Hot-air furnaces are so well known that any extended description of them is unnecessary. Suffice it to say that the furnace of a hot-air heating system must be placed in a basement or at least in a room lower than the space to be heated unless mechanical contrivances are utilized to drive the heated air into the building. Like any central heating system it has the great advantage of keeping fuel and other débris out of classrooms and confining the fire hazard to some central location where it can be guarded much more safely. Naturally the distribution of ducts leading to various rooms to be heated and the location of the furnaces are of prime importance. Very frequently disastrous mistakes are made in locating and properly proportioning the system of ducts to the various rooms. A hot-air furnace gives off heat quickly, and likewise, unless carefully handled, loses its heat speedily and hence is likely to cause a good deal of fluctuation in temperature in the classrooms. There are some serious objection in addition to the foregoing which may be briefly stated as follows:

There is danger that the gases produced through combustion, especially of coal or oil, will leak through the joints in the furnace and enter the air passing into the schoolrooms. The danger is especially marked when through carelessness of the janitor or the person who tends the fires the furnaces are overheated and then somewhat suddenly allowed to cool by opening the doors of the fire boxes. In cold weather, when it is necessary to heat the radiating surfaces very hot to supply enough heat in the rooms, the danger is more marked. It must ever be remembered that however tight the joints are made in the beginning, any furnace fire box is subject to great strain, through the expansions due to heating and the contractions due to cooling. These strains will in time open the joints and furnish opportunity for some of the carbon monoxide and sulphurous gases generated by a coal fire to escape into the air ascending to the rooms. The only remedy for such a defect is to make the heaters so large that it will be unnecessary to make them very hot to raise the amount of air needed to the temperature required. It is obvious, then, that an overworked furnace is the most dangerous furnace when leakage of gases is considered, and the most expensive in the cost of fuel and labor. The practical lesson to learn here is this: If a hot-air furnace is to be used for heating the air and delivering it to the schoolroom, it is essential to install one abundantly large, so as to heat all the air needed without the necessity of overheating the fire box. It is in no sense an exaggeration to assert that 75 per cent of the furnaces for heating schools which I have examined are too small for either safety, economy, or health.

In large buildings where this method is used it is good economy to have two or more furnaces in different parts of the basement and to adjust the fires accordingly. This plan of separate furnaces has the double advantage of preventing overheating and of making it much easier to introduce the air into the rooms without serious friction in the ducts and with a minimum loss of heat through radiation. For long air ducts, especially where there is much horizontal run, offer so much friction to the passage of the air through them and afford an opportunity for so much loss of heat that they are almost useless when depending on gravity for air movement; and even when a fan is used they are still ineffective.

When cold air comes in contact with overheated radiating surfaces it becomes dry and, as it were, parched. Such air is in effect desert air, and when introduced into a schoolroom will rapidly absorb moisture from the skin and especially from the lining membranes of the eyes and air passages. Such continual absorption renders the skin, and more specially the mucous membranes of the eyes, nose, throat, and trachea, dry and harsh. Such a condition, as everyone ought to know, offers ideal opportunity for pathogenic germs to lay hold of these delicate tissues and penetrate into their crypts. When the lining membranes of the air passages are coated with their normal moisture or mucus it not only serves to prevent these germs from so readily reaching the tissues but it also catches dust particles and thereby prevents them from being drawn into the lungs. After a ride in dust and smoke the condition of the lining membranes of the nostrils will bear witness to this fact. Besides, it seems quite probable, if not certain, that these mucous exudations may have germicidal properties which have hitherto escaped scientific detection.

All hot-air furnaces should be supplied with some means of moistening the air before it is introduced into the schoolroom. Especially is this necessary in cold climates where the amount of moisture mixed with the air is necessarily small and where its temperature must be raised 40° or 50° F. The expansion of the air thus taking place will further reduce the percentage of saturation very greatly, and serious and annoying dryness will result; and then we have a desert atmosphere in the schoolroom. The problem of heating is intimately connected with the problem of securing satisfactory humidity in the air.

Obviously, the supply of fresh air to the radiating surface of a hot-air furnace or, for that matter, to any heating surface used should enter through a clean passageway and from a point well above the ground. The walls of the passageway and the fresh-air chamber near the furnaces should be carefully constructed of glazed brick or lined with smooth, hard cement, in order that as little friction as possible will result as the air passes to the heating surfaces. The floors of these air passages should be cemented and kept scrupulously clean, for any dirt or dust that enters them will quickly find its way into the schoolrooms.

If the opening for the entrance of fresh air is placed 6 or 8 feet from the ground there is much less likelihood that dust from the playground, the roadway, or street, or contaminated ground air will be drawn into the schoolrooms. This opening should be securely screened so as to keep out the larger particles floating in the air during high winds, and to prevent anything from being thrown into it, such as apple cores, orange peels, or anything else that would vitiate the air or litter the floor. These passages must be carefully closed below and as far as possible made air-tight so that foul air may not be drawn into them from the basement. The location of the opening to receive the ingoing fresh air is a matter of much importance on account of the influence of winds, the danger from dust, and the need of drawing the air from the purest source possible. It has been found that if this air can be drawn from the south or warm side of a building there will be a decided saving in fuel. Carpenter says:

> It may be demonstrated by a properly protected thermometer that the average day temperature of air is higher on the south than on the north side of a building. The difference often reaches 10° F. An average of 5° F. would make it highly advantageous to take the air from the south rather than from the north side of a building. If an average rise of 35° F. is needed in the air temperature in ventilating work, then one-seventh of the heat required for that rise could be gained by choosing a south as against a north location for the inlet. (Heating and Ventilating Buildings, by Dr. Rollo C. Carpenter, pp. 451–452.)

The fresh air must be brought into the bottom of the heating chamber so that even on windy days there will be no possibility for reverse currents, and that at all times there will be as little hindrance to the easy movement of the air as possible.

All things considered, especially when an ample radiating surface is installed, when the ducts leading to the rooms are mathematically proportioned and not too long, and when proper means are afforded for humidifying the air, hot-air furnaces are fairly satisfactory in the milder climates of our country, and if carefully kept in repair there is no valid argument totally condemning them. The main troubles come through overheating, lack of humidification, and unbalanced system of ducts leading to the various rooms and neglect in upkeep.

It is unnecessary to state or discuss in this case the various rules used for determining the exact amount of radiating surface needed to meet easily and safely the demands to be made upon any system of heating.

These are matters for the expert engineer to determine, and a school board will act wisely when it seeks and pays for such advice. This caution, however, ought to be given: Some expert engineers—indeed, many of them—know little about the demands of schools, and it is always better to select for consultation one who has made a careful study of the peculiar needs of schoolroom heating, and especially one who has no connection with manufacturers of heating systems. One duty, and a very important duty indeed, which such an expert adviser ought to be called on to perform, is to test the plant when completed and be sure it fulfills the contract signed.

5. HOT-WATER HEATING.

In the past few years hot-water heating systems have been installed in greater numbers in school buildings than theoretically one could have anticipated, and yet there are some major difficulties with this system when applied to the heating of school buildings.

The one outstanding disadvantage and danger is that during severely cold weather, during vacations, the radiators, which, of course, are necessarily filled with water, will freeze and burst unless emptied or the fires kept burning. Were it not for this particular difficulty there would be no hesitancy in recommending hot-water systems for medium-sized school buildings, for in many respects it is the best system of central heating thus far devised. In the first place, it is far more regular and steady than either steam or hot air. It is more easily regulated, it is free from noise and "air-scorchings" and more economical of fuel. It is a little slower, however, than either of the other systems, but once the rooms are heated variation is very slight. It has one distinct advantage over steam. In mild weather, when only a slight increase over outside temperature is demanded, small fires will produce the result and keep heat going that in a steam boiler would produce no effect because obviously the fires must be heavy enough with steam heating plants to develop steam before any heat can be supplied.

Speaking in general terms, it is not safe to install a hot-water system in very cold climates, but in mild climates it can be used safely and satisfactorily if all necessary precautions are taken and the system is installed under the guidance of a competent engineer. There is far less expense attached to keeping up a carefully planned hot-water system of heating than any other known system. Naturally, it requires a greater radiating surface for a given space than steam, but offsets this difficulty with a much steadier and more regular heat. There will probably be in the next few years a rather striking growth in the number of hot-water heating systems installed in school buildings in the milder parts of the country, and this will doubtless be in the line of advancement.

6. STEAM HEATING.

The most generally used method for heating the larger school building is that of direct or indirect radiation or both from the radiators of a steam heating plant. Within the past 10 years low-pressure systems of steam heating have been installed in a great majority of the new buildings constructed. The one great advantage of steam heating lies in the fact that it is much easier to regulate the heat in the various rooms, and to proportion it properly, especially in large buildings, than any other system. Ten years ago it was practically universal to use, in connection with a steam heating plant, a plenum fan system to blow the air over the radiators into the various rooms. Later the split system was developed, in which a part of the radiating surface is located in the various rooms to be heated, and the rest left in heating chambers and connected up with the various rooms by inlet ducts through which fans operate to force in warm fresh air. This development took place on the theory that proper ventilation could be secured by the plenum system in which doors and windows of classrooms were always kept closed and air forced in and out by means of the fans. Recently, thoroughgoing investigations have somewhat changed our attitude in this regard and at the present time there is a growing tendency to depend more completely on direct radiation without the aid of the fan system. This point will be discussed more completely under the general heading "Ventilation."

Steam radiators placed in the schoolroom are often disconcertingly noisy. The hammering or slapping sounds which are not infrequently heard are very annoying and distracting alike to the teacher and the pupils. No way has been devised to get rid entirely of these disturbances, for they seem to be caused by the rising steam catching and driving back the returning stream of water produced by the condensation of the steam already used. In addition to this noise in any system of steam coils, the valves get leaky and the escaping steam will set up confusion, or the dripping water will injure the building.

All of the so-called vacuum systems of steam heating are designed to prevent this noise, and in addition to manage the steam supply in the radiators so that the temperature will be automatically regulated. But systems of this type, which I have seen in use and for which large claims have been made, are not free from beating noises, nor will they at all times properly regulate the temperature. Theoretically, they may be all that they claim, and if perfectly set and furnished may suffice in practice; but I am told by a distinguished engineer that thus far there is surely a discrepancy between the claims made for these systems and their practical workings.

Steam heating is better adapted to cold climates than it is to those parts of our country where mild to medium weather prevails through the greater part of the winter season. This system of heating, however, frequently requires more care than any other system now in general use. This is largely due to the fact that the radiators, of which a great number are required, are often quickly heated and as quickly cooled. This rapid expansion and contraction necessarily throws much strain upon all connections and when these are opened they are frequently hard to close. The boilers of course require expert care, especially where high pressures are used both to insure safety and to guard against deteriorations. Leaking flues and steam fittings require the services of expert mechanics and this is expensive service. But taking it all in all the best advice to give, especially in the colder climates of the country, is to install a low-pressure system of steam heating and to depend largely, if not entirely, upon direct radiation and a thoroughgoing system of thermostats to regulate the heat in each room. Of course the utmost care must be taken to proportion and apportion the radiators in the several rooms and to make certain that the disturbing noises or "water-hammerings" are eliminated as completely as possible.

It is essential that every board of education upon whom the duty of building schoolhouses rests should see to it that the best of expert advice be followed in installing heating plants. Otherwise one can not expect satisfactory results.

7. THERMOSTATS.

When the heating of schoolrooms is wholly or is part dependent upon indirect radiation and warmed air introduced into the classroom, it is a vital necessity to have an adequate system of thermostats to regulate the temperature of the air or rather to maintain a proper temperature inside the classroom.

Such devices depend in one way or another upon the principle of expansion by heat and contraction by cold. The practical difficulty to overcome has been that of hitting upon a medium sufficiently sensitive to respond and yet steady enough to prevent rapid fluctuations. Some use mercury as the medium, others sensitive metals of a more rigid form, and still others liquids of such a composition that they will vaporize at the temperature required. Generally, those using mercury depend on making and breaking an electric circuit in which an electromagnet acts upon the dampers to close or open the entrance for hot air, and vice versa to open or close the duct permitting the entrance of cold or tempered air. Those using liquids depend directly upon the force generated by the vapor to regulate the dampers, while those using metals of a rigid sort depend upon the management of compressed air to do the work required. These appliances have brought great relief to both the teachers and the children, for without them the teacher was compelled to keep watch on the thermometer to prevent the room from either becoming too cold or too hot. When thermostats are properly installed and the heating is of the indirect sort mentioned, the temperature of a schoolroom can be regulated, and, if the heat is always to be had, will keep the room at a temperature not varying more than 2° F. at any time. One of the most successful kind may be described briefly as follows: Somewhere in a convenient place in the basement is a tank containing compressed air, from which small pipes radiate to the various schoolrooms, where they connect with a thermostat properly located and carefully adjusted. One part of the apparatus visible in the schoolroom shows by means of a pointer whether the room is being cooled or warmed. A neat covering containing a thermometer shields the rest of the apparatus and at the same time furnishes a ready means for testing its accuracy. The thermometer has no organic connection with the thermostat. The air is supplied to the tank containing the compressed air by an air pump automatically regulated. The force applied to this pump is usually that of the water in the pipes of an ordinary city water supply. If this is not available, some other source of regular power must be used. If the temperature of the room is below that required, the opening in the end of this tube is kept closed by a tight-fitting valve or plug held in place by a spring. When the air reaches the temperature desired, a tongue of specially prepared metal expands, and, by means of the mechanism connected with it, opens the valve and permits the air to escape through another tube, at the end of which is a small air-tight chamber connected on one side with a diaphragm, or metal bellows. These are in the basement, where the changes in the diaphragm can be observed by the fireman. The pressure of the air within this cavity forces up this diaphragm, which acts on a lever connected with the dampers in the air ducts leading to the schoolroom, and thus cuts off a part or all of the warm air and at the same time opens the damper to the cold-air chamber, and thus through the pressure of the fan allows the cold or tempered air to be driven into the schoolroom until that temperature is reached which causes the metal tongue to contract. The spring will then cause the valve to close the tube leading to the compressed-air tank and at the same time permit the air in the diaphragm to escape back through the tube into the outer air. The diaphragm will then be compressed by a spring attached to it and the dampers will be reversed, allowing warm air again to enter the schoolroom. This plan will prove successful if carefully guarded, and the apparatus is so made that it will not be constantly changing and through too great a range of temperature.

There is this to be said about all thermostats with which I have had experience in school buildings: They are complicated bits of apparatus and must be guarded with care and will not prove successful unless the caretaker thoroughly understands their construction and knows how to adjust them. It is a waste of money and dangerous to the health and comfort of school children to install a system of thermostats and then to put them under the control and supervision of a janitor or a teacher who does not understand the principle used in their construction or the mechanism devised to utilize the principle involved. A janitor selected for political purposes or simply because he can sweep and build fires is never likely to handle them well. Here, then, let me repeat what is said elsewhere, the janitor of a modern and thoroughly equipped school building must have had a good deal of mechanical training and above all must be a man of high-grade intelligence.

The modern thermostat, in which a metal bellows takes the place of a rubber tambour, has eliminated much difficulty. They are or may be made as sensitive to changes as the older type and are entirely free from the necessity of constant attention and such fluctuations as would come with the loss of elasticity in rubber.

VIII. VENTILATION.

It would require the writing of a volume to discuss exhaustively the problems connected with ventilation, and even then lack of exact knowledge would be much in evidence, for there are still many unsolved problems in this field. It seems wise, then, to limit the discussion in this bulletin to those demands which must be considered and met during the process of the construction of school buildings and leave the others to more technical treatises on school hygiene and engineering. Let us then set ourselves the task of answering as best we can this question: What are the requirements in the way of equipment and construction necessary to secure adequate ventilation of a modern school building?

Theoretically there is no satisfactory system of ventilation for many-roomed school buildings which does not use some form of mechanical means to force air into the rooms or to withdraw it from the rooms, or both to drive in and withdraw it at the same time. A gravity system of ventilation (that is to say, one where the air is caused to move by reason of different temperatures) can be made fairly satisfactory in medium to cold weather when the differences in the temperature required in the room and that prevailing outside are from 40° to 50° F. Plainly in mild or warm weather there will be very little movement in the air unless a wind is blowing, and for this reason it is difficult to make changes in the atmosphere in the classroom depending entirely on window ventilation. The reason that this is true lies in the physical principle that all air motion necessary in gravity or natural ventilation is caused by the difference in weight of the same bulk of heated or cold air. When we warm air it expands and becomes lighter, and hence will rise when surrounded by cold air, for the same reason that a cork will rise to the surface if immersed in a bucket of water. Water is heavier than cork and will thus displace it until it finds a balance at the surface where a part of it will rise above the water. Cold air is heavier than warm air and will displace it if opportunity is given for the warm air to rise; so if the air outside the room is cold and the air inside is heated, either by direct or indirect radiation, there will be a pressure exerted from all sides and underneath the schoolroom by the heavy air to displace the warm air and drive it up, just as the cork is driven up from the pail of water. The cork does not come up of itself, neither does the warm air rise of its own accord. Neither would move were it not for the fact that each is displaced by heavier medium. This gives us the principle upon which all forms of natural or gravity systems of ventilation depend. If we remember that air when heated expands and bulk for bulk is lighter than cold air then we have a guide to the measurements of air currents in any gravity system of ventilation. Suppose, then, it is cold weather and we depend on heating the air about a furnace or steam coils in a basement and connect these heating boxes by means of a system of ducts with the various schoolrooms above. As the air is warmed it expands, becomes lighter, and is forced to rise by the greater weight of the same bulk of cold air which will rush into the duct leading from the outside to the heating surface, providing, of course, this entrance duct delivers the cold air underneath the heating surfaces and the ducts leading to the schoolrooms connect at or near the top of the heating chamber. Suppose the air outside is at a temperature of 20° F. and the fires warm the heating surfaces in the furnace so as to cause this cold air to take a temperature of 70° F. There will then be a strong upward movement of this heated air caused by the pressure of the cold air. This warm air will escape through the ducts arranged for the purpose into the schoolrooms. This warm air is pure air, if it comes from a good source and the heating surfaces are properly made, and hence the schoolrooms are being supplied with pure, warm air. But it is plain from what has been said that the amount of such fresh air delivered into the schoolrooms will depend on the size of the ducts and the rate of the movement of this fresh, warm air. Try another experiment with the cork by embedding in it some leaden pellets, such as shot, to see if the rate of its movement from the bottom of the bucket to the surface of the water will be increased or decreased. You know what the result will be before trying. The less the difference in weight between the cork so loaded and the same bulk of water the slower will be its upward movement. Exactly the same thing happens by reducing the difference in weight (that is, the amount of expansion) between the air ready to enter the schoolroom and that outside. Suppose, for example, the air outside is at a temperature of 50° F. To heat it to a temperature of 68° F. will cause less difference in expansion and therefor less difference in weight. Hence the rate of movement will be slower and less warm, fresh air will enter a room within a given time.

Thus the ventilation of that room will be less rapid and will supply the needs of fewer people.

Children of the primary grades, gathered in a schoolroom, need 2,000 cubic feet of fresh air per pupil each hour. Students of high-school age need 2,500 cubic feet. This does not mean that they will individually breathe so much, but that each will vitiate that amount. They will each breathe approximately 18 cubic feet per hour, but when a breath of air is exhaled it has lost so much of its oxygen and has taken up from the blood so much carbonic-acid gas that one exhaled breath will vitiate more than a hundred times as much fresh air to such a degree that none of it will be fit to breathe. This vitiation consists in reducing the normal amount of oxygen, but especially in increasing the normal amount of carbon dioxid and throwing into the air bad odors and possibly some sort of toxic agent produced through fatigue.

Since the first edition of this bulletin was prepared much investigation has been undertaken with reference to proper methods of ventilation. The most notable work done in this field is that of the New York Commission on Ventilation. After two or three years of experimental work, in which ample means and trained specialists were at command, the following conclusions represent in part the results of their labor:

1. The amount of carbon dioxide in ordinary classrooms, even under condition of poor ventilation, is of very little danger.

2. The depletion of oxygen in a badly ventilated classroom is insufficient to cause appreciable harm.

3. The chief difficulty lies in the interference with the normal escape of heat from the bodies of the children, due to the lack of the dissipation of the blanket of heated and moist air with which they are surrounded.

4. In order that these disadvantages may be obviated, it is necessary to keep the air in the classroom in motion, and to keep it from becoming too warm.

5. The outstanding result in the condition of those who are subjected to badly ventilated workrooms is loss of appetite.

This much-talked-of and fairly thoroughgoing investigation seems to make it clear that the chief problem is to keep the air in motion within the classroom, so that the bodies of the children will be kept at the proper temperature and the blanket of moisture gathering about the bodies be carried away. This looks as if it would be necessary, if the recommendations of the commission be carried out, to install within the room some mechanical device to keep the air in motion rather than to depend upon a central plan of fans to drive the air into the room. The fact is we are still in doubt as to the best methods of supplying, at a reasonable cost and without other disturbances, the best sort of mechanical schemes of ventilation. It is very plain that it is perfectly possible to install sufficient fan power in the basements of buildings and connect these up with properly placed ducts with the classrooms to furnish ample and thorough ventilation without the necessity of installing fans within the rooms. But the trouble comes in the expense of installation and in the running of such fans. There are thousands of fans installed in school buildings totally inadequate to do the work they are supposed to do. There are hundreds of others sufficiently powerful but are not operated because of the expense connected with their operation. The truth is (and boards of education should understand this thoroughly) it is a very expensive process to install fans of sufficient power to ventilate all schoolrooms properly and a much greater and a more constant expense in the long run to keep them running. It is disheartening, to say the least, to see how many school buildings are supplied with fans that never run. Literally there are millions of dollars' worth of ventilating devices rusting out in the large school buildings of this country. It stands to reason that one of two things ought to be done. Either fans must not be installed, or, if adequately installed, they must be kept running. Boards of education must be frankly told that mechanical systems of ventilation are very expensive, and unless they are willing to bear this expense constantly and regularly it is a serious blunder to introduce fans. The safest plan, at least temporarily, is to heat by direct radiation and ventilate through the windows. I am fully aware that this throws the responsibility wholly upon the teacher so far as maintaining ventilation is concerned, and that it also introduces the difficulty of ventilation in mild weather, when the air currents move very sluggishly. Possibly the next step will be the introduction into rooms of individual electric fans to help keep the air in motion, still depending upon the windows for intake and exit. The whole problem of ventilation is still far from being solved, and boards of education should be warned against any so-called mechanical system without the best of disinterested advice and the knowledge that they must pay heavily for the results obtained.

While it seems established that temperature and humidity are the chief factors to be considered in ventilation this does not mean that increase in carbon dioxide and decrease of oxygen content may be totally disregarded, and it is not at all proven that odorous substances given off from the body are not depressing and that toxic materials may not also be present in respired air.

The best thing to do is to keep the air in classrooms as near to that of the outside air as possible, when that outside air is at the proper temperature, in order to prevent undue accumulation of heat in the body. The big problem, of course, is to induct sufficient fresh air into the schoolrooms, distributing this equally and keeping it moving at such a rate as to dissipate the blanket of moisture gathering about the bodies of the children. The best possible way of doing this has not been demonstrated, but at present (knowing the tendency everywhere to neglect the use of fans in ventilating classrooms) the best results may be obtained by the use of properly adjusted windows, properly oriented, and handled by teachers who thoroughly appreciate what they are trying to do. (See Appendix on Orientation of Buildings in Southern States.)

IX. TOILETS.

The walls of toilet rooms should be made of white tile, glazed brick, or hard cement and finished with a hard waterproof white paint. All schoolmen know the difficulties encountered in keeping the walls of these rooms free from obscene writings and drawings. They also know that the neater and better the toilet rooms are prepared at the first, the less apt the walls are to be defaced. The walls of dark and dingy toilet rooms are the very ones, other things being equal, that suffer from such indiscretions. Young people respect and care for these rooms when decently made, flooded with light, and acceptably ventilated. And when we are arguing for this care in planning and construction we are doing so not only from the point of view of sanitation and convenience but also for the sake of moral values. Where glazed tiles or bricks can not be used, due to the expense, specially prepared hard cement plaster and hard waterproof paint may be used with a fair degree of satisfaction. In order to keep these rooms free from evil suggestion, then, flood them with light and *keep* the walls scrupulously *clean*.

Toilet rooms should be so constructed as to offer direct drainage through a trap with sewer connections. In the girls' room this should be on opposite sides from the seats or toward the front, so that the drainage may flow from the seats toward the outer wall. In toilet rooms designed for boys no special opening is necessary, for the drainage can be made through the urinals. While to some the foregoing directions may seem unnecessary, it has been found by extended observation that a great many blunders have been made in these details.

Elsewhere it has been suggested that the toilet seats should be set in a single row and not back to back as most frequently found. It is almost impossible to light stalls when set back to back, and then it is difficult to inspect such rooms quickly and see that all conditions are justifiable. Naturally this requires a little more space per pupil than if seats were set in double rows back to back. But this demand is legitimate and hygienically important.

The urinals in the boys' toilets should be constructed of white glazed enamel, and set so that the bottom will be slightly below the level of the floor and sloping toward the drain. They should be of small to medium size. The floor should slope very gently so that the pupils may stand close to the urinals without danger of slipping and thus prevent contamination as well as conserve decency. One urinal for each 30 boys is ample, especially if teachers and principals will so order recesses that there will be no congestion. Enough is necessary but too many bring trouble. In buildings given over entirely to children of primary grades, there should be one urinal for each 25 boys.

There is no reason why small children should be furnished with adult-sized toilet seats. Indeed, it is sinful to impose on them in this fashion. Juvenile-sized seats are on the market, cost no more, usually less, and when furnished, automatically segregate the smaller children in these rooms from the older pupils. This in itself is worth while; but it is positively insanitary and unjust to require little folks to use adult sizes. Care must be exercised in selecting the proper type of toilet fixtures. Those opening slightly in front and without top lids are to be preferred, for this not only assures better cleanliness but less danger. With the development of plumbing it is now possible to secure directly flushed seats so as to get rid of the flush tanks of the older variety. These tanks have been the sources of a great deal of trouble in schools because of the fact that they get out of repair so frequently. The automatic flush and hinged type of seat is not satisfactory for the lower grades and indeed not completely so for any grade of school. It is very difficult for small children to mount these seats and also troublesome for them to get off without soiling themselves. It is better to have the push button or lever type of direct flush and depend upon teaching children to flush the seats.

One seat for each 20 girls in the lower grades and for each 25 in high schools is sufficient. For the boys there should be one seat for every 25 pupils in the lower grades and one for each 30 in the high schools. These numbers are reductions from the writer's earlier estimates, but subsequent careful investigation has shown that when programs are planned so as to dismiss the various grades, with a few minutes interval between, that the foregoing number of seats will be entirely satisfactory. Of course this takes into account the necessity that all should be kept in repair and not, as frequently happens, a number of them allowed to remain out of repair for weeks at a time. It is essential to have enough, but it is unnecessarily expensive and hygienically troublesome to supply more than are necessary.

The width of stalls should not be over 32 inches and their depth, if the doors open out, not over 4 feet. These dimensions give ample room, conserve space, and thereby save expense. The top of the sides of the stalls should not be over 5 feet from the floor. This gives all the privacy needed, permits better lighting, better ventilation, and reduces expense both in installation and upkeep. Partitions made of slabs of expensive marble, 7 feet high, have been installed in some school buildings. This is not only a criminal waste of public funds but really a harmful thing to do from the hygienic point of view. The reason why the sides of toilet stalls have frequently been made so high is to raise the front cross bar between the stalls high enough to clear the head of a tall man. To be sure, these braces must be high enough to avoid bumps, to keep the stall sides rigid, and, also, in the boy's toilet, to prevent them from being used for gymnastic apparatus. This can be accomplished, however, without the necessity of boxing in the stalls with partitions as high as these cross braces. Steel pipes T'd off from the outer and upper corner of the sides of the stalls and fastened securely to them and the walls at each end of the toilet room furnish neat and rigid braces. Naturally, the bottoms of the stall partitions should be lifted at least 12 inches above the floor, and the bottom of the door high enough from the floor—say 14 inches—to permit the shoes of the children to be readily seen without opening the door. A door 3 feet high so set is high enough for all necessary privacy. I believe these doors are necessary and important for the stalls designed for the upper grades of the school. There is a delicacy suggested by them worthy of our consideration and should be a part of the regular school influence.

X. DISPOSAL OF SEWAGE.

Lavatory bowls should be set in these rooms as near the exit as possible and always in good light. These ought to afford a suggestion to each child as he leaves the room, "Wash your hands." This is an elemental, sanitary rule, which should be taught to all children. The number of these lavatory bowls need not be greater than one-third of the number of seats. They should be kept in good repair and scrupulously cleaned each day.

In specifying these demands for as good toilet equipment as can be made, there is no desire to be wasteful or unduly particular. The best is in the long run the most economical and certainly the most educational. A schoolhouse is not only a place where children are taught, but, in all its appliances and conveniences, it should be an educational and sanitary agent. As better sanitary fixtures are being installed in the homes, the number of such fixtures can be safely reduced in school buildings. Parents should teach their children (and do when conveniences are afforded) to use them before school hours and thus conserve health and the time at school.

What are we to do with toilets, baths, overflow from drinking fountains, and drainage in general from a schoolhouse, if the building is in a town not supplied with a sewer system, and especially in the country? This was formerly a difficult question to answer, but relief can now be satisfactorily afforded. Under such conditions the best method to use is some form of septic tank disposal. Since the first edition of this bulletin was written much progress has been made in this kind of sanitation. Perhaps the best known simple form of septic tank is one devised by the Kentucky State board of health for use in country homes and at country schools. The following cut and description will make this clear:

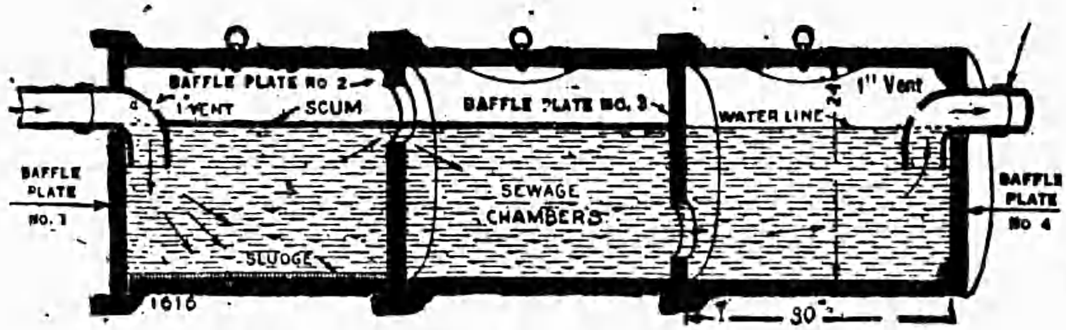


FIG. 5.—Septic tank made of glazed sewer tiles.

Naturally, one of the important factors making for success in this type of sewage disposal is the absorption field. This field must be ground of porous nature, so that the outflow from the tank may be quickly and readily absorbed, and all suggestion of overloading, which would cause disagreeable odors or keep the ground wet and soppy, must be avoided. The automatic siphon, which properly and wisely belongs to this form of waste disposal, tends to insure a better use of the absorption field, because by reason of an intermittent but rapid outflow it spreads the water throughout the whole field, and then, until the dosage tank is refilled, time is given for the absorption field to take care of the water and dry out and purify itself. Where the outflow is constant and comparatively slow there is a tendency for that part of the absorption field lying nearer the tank to be overworked, while other parts are insufficiently supplied. However, this siphon attachment requires more thoughtfulness and care in setting it than the simpler form, such as the Kentucky type, which, however, when properly devised and well placed, is a very important element in sewage sanitation.

Properly speaking, this short discussion belongs more properly in the bulletin entitled Rural Schoolhouses and Grounds which is to follow this publication. In this, further and completer discussion will be made.

XI. BATHS.

It is no longer an experiment to install in public-school buildings bathing facilities for school children. Naturally baths are most needed in large city schools, especially in those sections where foreigners and poverty-stricken families generally congregate. But what a glorious thing it would be if country and village high schools could all be supplied with baths, for all who know country conditions generally know that country children rarely have access to proper bathing facilities. Country boys bathe in summer in streams and "mudholes," chiefly for the fun of it. Even this questionable method of ablution is generally denied the girls.

It is safe to say that not one country child of school age in a hundred has even regular weekly sanitary tub or shower baths throughout the year. With modern windmills, driven wells, storage tanks, air-pressure tanks, and gasoline engines, country schools and country homes are no longer of necessity compelled to handle a water supply at a great disadvantage. One part of the social mission of the schools consists in introducing into the homes better facilities for plain hygienic living, appliances which will bring surcease from much useless drudgery, and those modern conveniences which save so much time and conserve health. Every consolidated country school should, therefore, be supplied not only with pure, wholesome drinking water but an ample supply for baths, lavatories, and toilets.

From the point of view of cleanliness, and especially from that of economy, shower baths are much to be preferred in school buildings over either tub baths or swimming pools. In arranging a building for shower baths, very little extra cost for plumbing is necessary. The only item of serious expense is that for providing hot water. Some form of heater or boiler is necessary, unless some method of sun heating is adopted, such as is used in many parts of California. There, by means of a series of lenses focused on a water tank, all the hot water needed is readily supplied. But, of course, such a method is only practicable where the climate is very mild, and where days with a high sun are very common. Where gas is accessible, it is not difficult to install heaters, and these are now manufactured in many styles and sizes, and are so constructed that they need little care, are very compact, and can be used at a minimum expense for fuel. It is never advisable to use water from a steam boiler for bathing purposes, because of the impossibility of preventing the water in such boiler from becoming increasingly dirty and oily. However, there are good oil stoves now on the market which might be easily arranged to heat water for baths. Besides, there are coal stoves designed for this purpose and may be installed wherever flue connections and a water supply are available.

It is easy to see that shower baths in schools are superior to tubs and swimming tanks, for the former require less water, and this is constantly pure; there is less danger in them of the spread from one pupil to another of any contagious skin disease; they take much less time, require less space, and on the whole are more effective.

But it may be asked, how could bathing facilities be installed in a village or country school building where there is no public water supply that could be piped into the building? This can be easily accomplished now by the use of a windmill or gasoline engine in connection with an air-pressure tank in the basement or elsewhere out of the danger of cold and storms. By this method water can be forced through a building to laboratories, toilet rooms, faucets, drinking fountains, bathrooms, wash rooms, lavatories—in fact, wherever it is needed. Such a provision for water supply will also lower the rate of insurance and render the building safer for children to occupy, for in case of fire it offers immediate help.

The matter of soap and towels can be left to local communities to settle. Where public opinion warrants the expenditure, it is best for the school to furnish these, for then the washing and sterilization can be done thoroughly. However, there is no decisive reason why each pupil should not be free to furnish his own towels and soap. In general, it is better to begin in this way and thus prevent some criticism.

The position of the baths and dressing rooms in a school basement will be determined in part by the size of the basement and the number of pupils to accommodate; but they ought to be placed where waste water can be carried away most readily. It is never hygienically permissible to allow waste water from any part of a school building, save that passing through the urinals and toilet vaults, to pass directly into sewers. Somewhere outside of the building the ordinary waste-water pipes should be trapped into the sewer so effectively as to make it impossible for sewer gas or odors to come into basements.

XII. SWIMMING POOLS.

Naturally, swimming pools are for healthful recreation and not for bathing purposes. No one should ~~enter a~~ swimming pool who has not been thoroughly cleansed in a shower bath, and who is not free from any contagious skin disease. There has been a rapid increase in the last 10 years in the number of swimming pools throughout the country, in connection with high schools, Christian associations, churches, municipality undertakings, and many fraternal orders. The committee on sanitation of swimming pools of the American Public Health Association reported in New Orleans, in 1919, that data had been received relative to 1,254 pools of 47 States. Probably it will not be far from the truth to say that at present there are between 1,500 and 2,000 swimming pools in various parts of the country. It is interesting to note that according to population the Western States are better supplied in this regard than the Eastern. California has practically twice as many as any other State in the Union.

Keeping these pools in sanitary condition and seeing that they are used properly are not easy tasks. In most States, as the report of the foregoing committee shows, very little has been done in the way of legislation to control sanitary conditions in swimming pools. A committee of the American Public Health Association also sent out a questionnaire on bathing places. Seventy per cent of the replies received were to the effect that bathing places were an important factor in the transmission if diseases. Bathing places in this report include beaches and other open pools in addition to swimming pools. Naturally, there would be a good deal of difference between these two types of bathing places. In open water, such as beaches and rivers, there is more opportunity for contamination from a distance; that is, the water is likely to be far more impure than in properly cared for bathing pools. On the other hand, the danger of transmission of diseases from person to person is doubtless more likely in swimming pools. The problems of the swimming pools are not only concerned with the purity of the water but with the cleanliness of towels and the condition of the bodies of those who enter the pools. The report of the above-mentioned committee may be fairly well represented by the following quotation:

> The most significant and important data obtained from our replies were reports of epidemics of various diseases, which, from the information supplied by the reporting physicians, may be considered reasonably authentic. Seven different physicians reported epidemics of conjunctivitis, and six others, epidemics of skin diseases, four of these being epidemics of furunculosis, two of impetigo contagiosa, two of molluscum contagiosum, and one of eczema. Two physicians reported epidemics of middle-ear infection, which, from the history submitted, were undoubtedly caused by infection of the water at the bathing places. Two other physicians reported epidemics of tonsillitis and pharyngitis, and one reported an epidemic of nasal sinus infection in which all the evidence pointed to bathing water as the origin. One of the members of the committee also reported an epidemic of typhoid fever in a camp for boys, which was unquestionably caused by bathing in polluted water.

It is very seldom that fatal cases of any disease, outside of typhoid, perhaps, have been attributed to bathing place infection. One physician, however, reported a fatal case of mastoid infection and four other physicians reported a number of fatal cases of meningitis following infection of the nose or ear passages.[1]

It is plain from the result of this investigation, and others of a similar nature, that those who plan to construct swimming pools in high-school buildings or other public-school buildings may have clearly in mind that while they are offering a fine opportunity for healthful sport they are also affording opportunity for the spread of infectious diseases unless they make thorough sanitary provisions to prevent such dangers. Eye, ear, nose, and throat specialists have frequently told me that infections have multiplied perceptibly and in certain cases strikingly whenever swimming pools have been opened to the general public. To be sure, it will be much easier to guard from infections in swimming pools for schools than those in general public use, but even here a definite and serious problem must be frankly met.

All water in swimming pools should be thoroughly filtered each day, and this can be accomplished by any good form of pressure filtration. The water should be tested at regular intervals, both chemically and biologically, but probably more important than all, no one should be allowed to use the swimming pool who is infected with eye trouble, nose or throat trouble, or any form of contagious skin disease. This calls for a constant examination of children's bodies and would certainly require more time and more expense than the average high school is able or willing to undertake at present. All swimming pools should be sterilized daily by the use of chemicals, or, preferably, ultra-violet rays of light, for this is not harmful to eyes or ears.

From what has been said above there is no reason to infer any opposition to swimming pools in connection with high schools if the community is willing to pay for their installation and proper sanitary oversight. All who have seen the delight and help children get in learning to swim will agree in saying that it is a splendid recreational agency. I am anxious, however, to make plain the dangers connected therewith so that those who construct swimming pools will know the problems they must plan to meet and the dangers they must combat.

XIII. GYMNASIUMS.

During the past 10 years there has been a remarkable growth in the demand for gymnasiums in public-school buildings and especially so in medium-sized high schools. The problem of health development, greatly emphasized by the World War, has caused boards of

[1] American Journal of Public Health, February, 1922, pp. 121-128.

education and the people in general to demand gymnasiums and equipment for school buildings much more persistently than was formerly the case. No one can conscientiously deny that this is a good thing, but it often happens that people make demands inconsistent with conditions as they actually exist. Gymnasiums are important, no doubt, but so are open-air sports and outdoor exercises. In the northern part of our country it is too cold and disagreeable in winter to get much regular exercise outdoors, and hence in such climates gymnasiums are far more important than in the warmer sections where, during at least four-fifths of the winter, children can play out of doors, to the advantage of all concerned. Some architects, notably Mr. Ittner, have made the gymnasium serve the purpose of a theater and assembly room. This is illustrated in the Grover Cleveland High School in St. Louis and the new Phillips High School in Birmingham, Ala. Others have made assembly rooms serve as gymnasiums.

The size and relative dimensions of gymnasiums should be worked out to suit the special conditions and needs of the school, but it should be high enough, wide enough, and long enough to accommodate a regulation basket-ball court, for this is rapidly becoming a very important game in American high schools and colleges and is worthy of encouragement.

It is to be hoped that more attention will be given by schoolmen to open-air gymnasiums than thus far has been given. By an open-air gymnasium is meant a covered structure large enough and high enough for all gymnastic exercises, but inclosed on the sides with wire only, so as to allow the free movement of the outside air and complete exposure of the floor to sunshine some parts of the day. The most successful of such structures are usually made of a light but firmly united steel frame and trussed roof. In most of the Southern States such gymnasiums can be used nearly every day of the winter and, of course, offer children a chance to exercise in the open air without exposure to inclement weather. But in sections where snows drift and the temperature is too low for free play out of doors they are not especially valuable.

A combination of gymnasium and auditorium will be discussed under the heading "Assembly room."

XIV. PLAYGROUNDS.

The apparent tendency of boards of education to limit the amount of ground for school buildings and at the same time to demand expensive gymnasiums should be protested against. The popular call for gymnasiums, in which spectacular basket-ball games may be played, should be resisted. It would be better to spend the money

on larger and better school grounds, with hard surface tennis courts which may be used for outdoor sports of many kinds, including basket ball, volley ball, etc.

Educational authorities and officers should give more time to the general recreation and health of all the children instead of devoting money, time, and attention to opportunities for athletic contests, for a few only. These contests are not harmful if managed sanely and honestly, but they are far less valuable than the quiet, unpretentious but thoroughgoing upbuilding of the health of all the pupils. It often happens that those who need general outdoor exercise and general upbuilding are the ones who are left out when some "team" is to be developed. Year after year this problem arises when grounds are selected and buildings planned. Principals of schools are partly to blame for this, because very few are able to resist the advertisement that comes from a winning team.

By all means build gymnasiums, if the community is willing, but first get plenty of ground for play purposes and prepare this for all sorts of sports and expect the children to use it. When this attitude toward relative values becomes more marked, fewer gymnasiums will be necessary.

XV. LABORATORIES.

The time has passed in the history of education when it was thought sufficient in a course in physics or chemistry for the teacher to set lessons in textbooks and do the experimenting himself in the presence of the class. There is yet definite need for textbooks and good models of experimentation, but we have learned that unless the pupils take hold of apparatus and, under specific direction and wise guidance, perform experiments themselves, we can not hope for any lasting interest or thorough understanding of these subjects.

It becomes necessary, therefore, to plan to give each student who is studying either or both of these sciences, and for that matter all sciences, room and opportunity for individual work. Furthermore, as a laboratory equipped with tables, gas pipes, water basins, microscopes, balances, etc., can not be used conveniently as a lecture room, where the class may meet to see experiments of a special sort, to discuss them and to compare their own results with certain principles enunciated in the textbooks, a science lecture room is almost a necessity. Hence, at least, five rooms are needed for these two sciences: A laboratory for physics, one for chemistry, a common lecture room, and two smaller rooms for storing apparatus and chemicals until needed. In a high school where one teacher is expected to teach both of these sciences one supply or apparatus room of ample dimensions and of proper construction can be made to suffice. This is true only on the condition that some isolated part of it be set apart for those chemicals which might by their presence in the same room be deleterious to certain pieces of physical apparatus. But it is always better to have a separate room for the chemicals, where they may be carefully and systematically placed and rendered less dangerous to both apparatus and the building as a whole.

Suppose two supply or apparatus rooms can be provided, how shall these, the laboratories, and the lecture room be best arranged with reference to each other? In the first place, the question must be asked: Where shall these rooms be placed, on the first floor or on the second, if a two-story building is planned? There are advantages and disadvantages with either location. When a chemical laboratory is placed on the first floor there is danger that the fumes and odors from the chemicals used in experiments may escape into hallways and adjoining rooms, rendering it difficult to keep the air fresh and pure. Then, too, it is better, as far as possible, to use the space on the first floor for recitation rooms, and in this way make it unnecessary for most of the students to climb the stairs so often, for it must be remembered that at least three-fourths of the recitations of a high-school course are held in ordinary classrooms. In the next place, it is far more difficult to ventilate properly a chemical laboratory on the ground floor than it is one located on the second floor next to the roof, presuming, of course, that the building is two stories in height. In fact, no schoolhouse should be built higher than two stories; all those going beyond this limit introduce many difficulties and dangers merely for the sake of economy. No chemical laboratory can be safely used unless adequate precaution is taken to carry off the fumes and gases generated during experimental work. And these ventilators must extend to the outer air above the building. When the laboratory is on the ground floor these ventilators have to be placed in the walls, and this either makes it necessary to do the work close to the walls or to make sharp angles in the ventilating ducts so that they can overhang the experiment tables in the center of the room. If the ventilating ducts are placed in the walls and the experimental tables arranged next to the walls, it is almost impossible to arrange sufficient work room with satisfactory light without undue expense. If these ducts are bent or elbowed so as to open above the central parts of the room, where the tables should be placed, they are thereby rendered far less effective on account of the great retardation of the movement of the air due to the friction in the crooked and longer ducts. On the other hand, it is much easier and less expensive to supply proper and safe plumbing for a chemical laboratory situated on the ground floor. Gas pipes and water pipes can be easily carried into the walls to the second floor and be brought through the floor at the proper places, but it is more difficult to place the waste pipes and render them safe and hygienic. But aside from these difficulties of plumbing (and they can be overcome) and the greater instability of the upper story of a building, there is no reason why the second floor should not be preferred for the physical laboratory. The light is usually better, and the opportunity for many disturbances is reduced. In delicate experiments where jarring or shaking movements are troublesome and disturbing there is a real difficulty. But, generally speaking, there is little or no real need for such experiments in a high-school course in physics, and, judging by the growing tendency to eliminate them, they will shortly be left to the college course, where they belong.

All things considered, physical and chemical laboratories are better placed on the second or top floor than on the first. Doubtless this will not hold good for all conditions, but in the majority of cases it has proved wise to arrange them in this way.

If it were possible to have a separate building of one story devoted to the sciences, then, of course, what has been said would not apply. It would be an ideal arrangement, as far as laboratories go, to separate them from the main building; but usually, on account of lack of space and because of the increased cost of such rooms, they are made to occupy a part of the main structure. This arrangement reduces the expense of heating, ventilation, and plumbing, as well as initial cost in the room provided.

So far it has been assumed that it is best to have the physical and chemical laboratories on the same floor, and if possible in the same part of the building, in order to make the lecture room serve for both, and not to be far removed from the apparatus or supply rooms. At the present time there seems to be a tendency, especially in small or medium sized high schools, to eliminate the science lecture room as a separate room and use one end of the laboratory for this purpose. There are some advantages and some disadvantages in this plan. For example, it will eliminate to a certain extent some duplication in furniture and give the teacher an opportunity at any moment during the laboratory period, if it seems necessary, to call the students together for a demonstration or general directions. In a way, it will seem less formal than if the students were taken to a separate room. In this manner possibly better reactions, or at least more natural ones, can be secured. However, if the laboratory room is made sufficiently large to use one end of it for lecture purposes very little, if anything, is saved in the way of space and hence expense in construction. There will also be no chance to use this space for other purposes as satisfactorily as can be done with a lecture room.

Furthermore, a lecture room can be much more readily and easily arranged for lanterns or any type of visual work than can be done in the laboratory proper. Then, again, this lecture room can be used for all the sciences and in this way bring them closer in touch with each other and enhance daily the value of cooperation. One space, therefore, in the form of a lecture room will avoid duplication of space in several laboratories.

The following cut illustrates what seems to be one of the best arrangements thus far worked out:

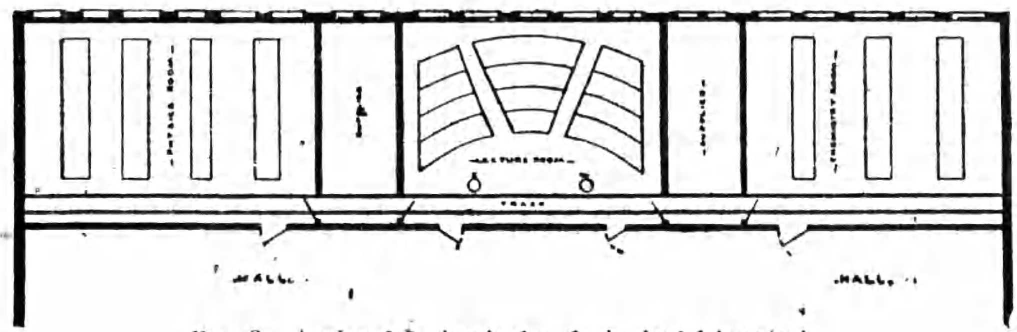


FIG. 6. A plan for chemical and physical laboratories.

This shows these laboratories occupying the same wing of a building with windows looking toward the east. They are supposed to be on the top floor, and are adjusted with reference to the apparatus rooms and a common lecture room. It will be understood that the lecture room can be built with an inclined floor sloping away from the window side down to the teacher's table. This plan is somewhat objectionable on account of the necessity of the teacher facing the light, and also on account of the pupils having to write somewhat in their own shadows, i. e., with the light behind them, but it insures good light on the apparatus toward which both pupils' and teacher's eyes will in the main be directed. The students will have comparatively little writing to do in this room, for in proper work the time will be, in the main, given to observation and discussion, and what writing they will have to do will be limited to a few notes and drawings.

As to the teacher's position toward the light, it may be said that his table can be adjusted on the track designated, so as to give him a position to one side of the front of the room and in this way relieve him from the necessity of facing the light directly. Then, too, if he wishes to spend a greater part or all of the hour in lecturing he can stand to one side still further.

But most of the disadvantages resulting from this method of lighting can be readily obviated by introducing a skylight into the lecture room. This method seems to be growing in popularity since heavy wired and ribbed glass have been manufactured. A skylight is direct and does not disturb either the lecturer or students, and at the same time offers the least difficulty with shadows. However, it is somewhat more difficult to darken the room for lantern work, and it also introduces difficulties in obtaining proper architectural effects and efficient ventilation where mechanical means of ventilation are not provided. But these objections can be overcome, and skylighting for a science lecture room seems on the whole to be the best.

The track mentioned above and indicated in the cut is of light rails laid flush with the floor so that the teacher's tables, properly equipped with wheels, can be run from the apparatus rooms into the lecture room with the apparatus all in place, and at the close of the lecture, can be run back into the apparatus rooms to discharge the apparatus not further needed. This arrangement will save a great deal of the teacher's time and make it possible for the room to be used immediately for another lecture or for any other purpose. It will enable the teacher to prepare for an experiment the day before without appropriating the lecture room. It will save not a little breakage, insure better order in the supply rooms, and better care of the apparatus in the laboratories. Furthermore, this arrangement will save time in transporting the apparatus and thus make it easier to prepare for lectures and demonstrations.

This arrangement of science rooms is an adaptation of one I saw in the Reform Gymnasium in Berlin and which was recommended highly by the science master.

It will be noticed that the track extends entirely through the whole series of rooms and can be utilized for collecting and replacing apparatus in the laboratories and transporting such to and from the storerooms. This, again, will save much time, especially in supplying the demands of the workers in the physical laboratory. If the track is laid flush with the floor and the side grooves made only deep enough and wide enough to admit the flanges of the wheels, the rails will not interfere with the use of that part of the room and will be in no way objectionable.

But if for given reasons it seems best not to extend the track through the laboratories, it can, of course, stop at the outer doors of the supply rooms and be used only for carrying apparatus to or from the lecture room. It seems wise, however, to lay it in the physical laboratory, on account of the frequent changes in the apparatus needed in a course of experimental physics.

A window from each supply room to its corresponding laboratory has been indicated to further aid the teacher in distributing apparatus and materials to the laboratories. The shelving and cases in these rooms can be arranged to suit the equipment, and ought to be specified by the science teacher or the principal of the school. It is better that no doors should open into the halls from these supply rooms. This will aid in safeguarding the apparatus from meddlers and prevent the entrance of much dust. If sliding doors could always be relied on, it would be better to use this form of door between the lecture room, supply rooms, and laboratories, but since they are usually troublesome, wide swinging doors are indicated, to be set to open away from the apparatus.

In the lecture room there should be a switchboard and water connections, as indicated in the figure by "W" and "E." These could be placed next to the wall or in the wall were it not for the fact that when connected up with the apparatus on the table the wires or water connections would be in the way of the teacher while at work at the table. It seems best, therefore, to make a permanent basin with all necessary plumbing at one end of the table when it is in place and a switchboard at the other end. These, as shown in the cut, ought to be in front and just clear of the edge of the table when moved along the track. These permanent fixtures can be boxed in and made to be covered so as not to present any danger or untidy appearance when the room is used for lectures in any other subjects. In fact, they can be easily finished so as to be transformed into stands from which a lecturer may read, or upon which books can safely rest. With this arrangement they will be out of the way when not needed and ready for immediate use when required.

The wall space between the doors into the hall can be used for a blackboard. It is best to set it 4 feet above the floor and make it at least 3½ feet wide. It should be of slate of a good grade and set as near flush with the wall surface as possible, in order that a white curtain may be pulled down from a roller fastened against the wall close to the ceiling. The purpose of this curtain is to furnish a surface upon which lantern projections may be thrown. The stereopticon or projectiscope can be used to advantage not only in the sciences but in history, literature, and art. To this end a small, level platform ought to be constructed near the side of the room next the windows, from which lanterns or like apparatus can be used. This suggests proper electric wiring for light and provision for thoroughly darkening the room. And just here let it be said that a little forethought and definite planning will save time and often much trouble. For example, instead of depending on a loose wire down the hallway to the teacher's table, a signal wire can be run under the floor and emerge at the right places with practically no expense. This will always be ready and save much annoyance. The seats in this room should be of the opera type, with two aisles in the central part and one on each side. There should be two doors opening from this room into the hall, as indicated. This will prevent crowding, save time, and make it possible for the room to be used for other classes even while the laboratories are in use.

If the windows, in case lateral lighting is used, are placed 4 feet above the main-floor level, the rear of the inclined floor will not seriously obstruct the light, for 3 feet rise will be ample to insure to each student a chance for unobstructed observation. It is needless to say that the location of the electric or other lights, permitting the use of the room at night, is a matter of importance but must be left to the architect and the principal to work out.

FLOORS.

The laboratory floors, especially on the chemistry side, are matters of rather serious concern. Cement is heavy, expensive, and both hard and cold. But it is safer than wood. It can be scrubbed without harm and can be replaced when worn. Perhaps the best floor that can be constructed for a chemical laboratory is that made by laying hard-baked glazed tiles in cement. These tiles when of good quality are nonporous, nonabsorbent, acid proof, and are easily cleaned. They are durable, and when planned with due respect to artistic effect give to the laboratory a clean, neat, and wholesome appearance. A laboratory in which this material is used for the floor is rendered still more artistic and aseptic by using the same material for wainscoting. This material is rather expensive when considering the initial cost. Consequently it will be used sparingly save in fireproof construction and in those wealthier communities which can afford the best. In the long run such a floor is economical, for it is easily cleaned and lasts indefinitely when properly set.

Another form of floor covering consisting of cement and broken bits of marble mixed evenly and then polished to a level surface has been used, but this is subject to injury by acids, and is both hard and cold. Some builders have used a good quality of cement, and with due precaution such floors have proved fairly satisfactory. They are, however, porous, will in time stain and discolor, and will also suffer from acids.

When any of the fireproof floors are used it is well to surround the work tables with some form of linoleum to protect the feet of the students from the cold floor and to lessen the fatigue incident to long standing on a hard surface.

If wooden floors are used in a chemical laboratory, they should be protected by wax, paraffin, or some such material. Wherever finances will permit, and especially in a brick, stone, or concrete building, the use of tile floors is strongly recommended.

Floors made of asphaltum are recommended by Professor Gill. "But," as he remarks, "there is danger that heavy tables, chairs, etc., will sink into the asphaltum and thus render them of unstable balance and out of level." This, he suggests, may be partly overcome by making wide foot rests for such tables. Naturally this sort of floor must be laid on the top of a close-fitting underfloor and separated from it by tarred paper, asbestos board, or some form of steel lath. In every case where a laboratory is on the second floor all possible leakage from water pipes or basins must be prevented, and this is best done by taking care in construction.

The late Doctor Baskerville, formerly of the College of the City of New York (Science n. s. 28. p. 665 f.), said:

> In my opinion, the best material for floors which has been put forward is that which is known as lithoplast, devised by Dr. W. L. Dudley, of Vanderbilt University. It is essentially a paraffined sawdust-sand floor, with a magnesia cement. This flooring may be laid in any length and in one piece and offers many desirable qualities. The baseboard may be made as a part of this floor. There are no cracks. The presence of the sawdust allows of its expansion and contraction with changes of temperature and the coating of paraffin over it prevents its rotting or napping, which are objections put forward in opposition to sawdust. It may be tinted, polished, washed, or scrubbed. It can be repaired without having cracked points, and, furthermore, it allows nails and screws to be driven into it in much the same way as wood does.

When it comes to a consideration of the material to be used for the tops of the laboratory tables, a more difficult problem must be confronted. It is without doubt true that all, or nearly all, of the older tables used for this purpose had wooden tops, and as a result of habit in the making of other tables oak or some more expensive material was used and finished with much care for appearance sake. But, as all who have worked in a chemical laboratory know, it is only a matter of weeks until such tables are blistered, stained, or discolored until they are unsightly, and it seems unnecessary to use expensive lumber and go to the trouble of polishing and varnishing it, as is done with furniture in general. Good, clear pine, free from pitch, is about as serviceable as oak. Naturally, there is some danger in the use of wood, but it causes less breakage of test tubes and beakers than almost any other material used. It is not so cold as glass, tile, or slate, and hence does not endanger glass apparatus as much.

Theoretically, plate glass is the most satisfactory material for table tops, for it does not stain, is easily kept clean, is nonabsorbent, is not affected by acids in ordinary use, and from the standpoint of wear is durable. The only objections of serious importance that can be offered against the use of glass for this purpose are that it is cold and hard and is liable to crack from the heat reflected from the bottom of vessels heated during experimental work. This latter is such a serious objection that it seems wise to caution against its use.

Professor Gill says:

> For the tops of laboratory desks or tables the following woods have been found to give good satisfaction: Northern pine, whitewood, cedar, and California redwood. These may be finished with equal parts of linseed oil and turpentine, or better, filled with aniline black made in the pores of the wood.

It may be added here that sugar pine is an ideal wood for table tops for laboratories, for this wood does not readily warp. It can be had in boards wide enough for a full top, and so will leave no cracks. It does not splinter, can be planed easily, readily takes the stain and filling noted above, and is not heavy. Unfortunately, the great trees from which such lumber is made are rapidly disappearing, and therefore the lumber is comparatively expensive.

Mr. Lincoln, of the Technical High School of Springfield, Mass., says that he prefers wood as material for table tops for beginners in chemistry on account of the danger of increased breakage with the use of harder surfaces, but personally prefers white glazed tiles if they can be laid so that they will not buckle. When wood is used, he prefers soft pine treated in the following way (which is the same as that recommended by Professor Gill):

Recipe for treating tops of laboratory tables.

Solution 1:

- 100 grams aniline hydrochloride,
- 40 grams ammonium chloride,
- 650 grams water.

Solution 2:

- 100 grams copper sulphate,
- 50 grams potassium chlorate,
- 615 grams water.

Apply solution 1, let it dry, then apply solution 2 and let it dry. Do this three times.

During this process the color changes from green to black. The table top is then washed with hot soap solution, allowed to dry, then rubbed down with vaseline. After this last the color of the table top is a soft deep black.

The tables treated as above have given very good service. They are wiped with a damp cloth each day after the laboratory work is over.

WALLS.

In a chemical laboratory it is important that the walls be so constructed that the material composing them will neither discolor nor disintegrate as a result of the fumes liberated in experimental work. The ordinary plastered walls are very unsatisfactory, for this disintegration begins quickly, and not only litters the floor but causes the room to appear untidy as a result of the rough and stringy appearance of the plaster. In laboratories where any quantitive work is done this falling material will vitiate results and cause much trouble. In sections of the country where earthquakes occur the plastering so affected is likely to fall and is therefore dangerous. The same is true in the event of fire. The use of cement instead of ordinary plaster is followed by similar troubles.

Hard-glazed tiles are clean, durable, neat, and acid proof, and when carefully selected and well set are easily cleaned and are also attractive in appearance. Glazed white brick is still more to be desired, but is expensive, and for inner walls adds considerably to the strength necessary in the building. Unglazed bricks may be used, but need to be covered with an acid-proof white or cream-colored paint. Professor Gill recommends for such purpose a paint made of "sublimed lead ($PbSO_4$), barytes, or zinc white, or preferably a mixture of these in about equal proportions."

On the whole, despite the added danger due to the inflammable material, a ceiling made of well-seasoned pine or maple, carefully tongued and grooved with the boards not more than 3 inches wide, blind nailed and then treated with acid-proof paint, seems best adapted to a chemical laboratory for high schools. This is, in its initial cost, more expensive than plaster, but in the end it is cheaper and much more satisfactory.

Where plaster must be used "white plaster, which has been given three coats of acid sulphur-proof paint, a combination of lithopone and zinc oxide, has proved satisfactory. Paints which contain lead oxide should be avoided. All metal ware which is likely to be exposed to any fumes whatever in the laboratory should be painted with an acid-proof paint."

In the plan presented to indicate the proper arrangement of the science rooms, it will be noticed that the main aisle is along the wall away from the windows, and along the track laid in the floor. The tables in the laboratories ought to be placed at right angles to the main aisle, with individual work spaces and plumbing on each side. This will insure good light and better classification of the workers. The secondary aisles between tables can be made as wide as space will permit; but they should be at least 5 feet.

Further discussion of the arrangement of science rooms seems unnecessary, for equipment and plumbing are matters which school authorities must settle for each individual case. This further point, however, ought to be emphasized: It is a serious menace to the health of the students to work in a chemical laboratory which is not provided with adequate means for carrying off the fumes and keeping the air pure and clean. Therefore, directly above the tables upon which the experiments are performed ducts should be placed to carry off the gases liberated in the experimental work. In small laboratories gas jets kept burning within the main part of the duct will create a fairly good draft and in this way help to keep the air pure. But in a larger room where many students are engaged and the system of ducts rather complicated, it is best to place in the pipes between the roof and the ceiling a small exhaust fan with an electric motor attachment to be run during the laboratory periods. This fan must be firmly bedded so as not to jar or buzz while running, and the branching ducts must be as free as possible from sharp angles, and air-tight between the openings above the tables and the outer air above the roof.

XVI. ASSEMBLY ROOMS.

The assembly room, or aula, as it is called, is the center of school life for a German gymnasium. It is the place of all places in the school where artistic and even lavish decoration is the rule. It is the historic remnant of the days when churches and chapels were used as gathering places for students, and it has retained some of the religious atmosphere of those bygone days. They gather here for music, for worship, for lectures, for counsel, or for some celebration. Stained glass windows, beautiful mural paintings, tasteful pieces of statuary, and very frequently a pipe organ attest the fact that this room is designed to be used for important educational purposes.

We have made rapid progress in supplying assembly rooms for both high schools and grammar schools since the earlier edition of this bulletin was printed. The illustrations of assembly rooms herewith presented should arouse our pride, for they are as beautiful and commodious as many of our best theaters. But for our smaller and medium-sized high schools we are not yet demanding what we should in this regard. It is earnestly hoped that the illustrations here reproduced will serve to stimulate to further efforts to secure for all schools this much needed and very helpful agency.

There is no desire to overestimate the need of assembly rooms in the American public high school, but I believe there is no country in the world where the need of social unification, artistic refinement, and cooperation is more pressing than in our country, under our form of government. Loyalty to athletic prowess is a good thing, but there is need for a deeper, more fundamental loyalty to school, to scholarly ideals, and to the community; and an artistic assembly room will greatly contribute to these ends. Every high-school building, then, ought to be built to meet this need. In addition to the uses above suggested it will be a great stimulus to boys and girls in the grades if they also can occasionally share in the use of these rooms. Wise supervision of city schools demands closer contact between the children of the grades, especially the upper grades, and those of the high school. It would be a powerful stimulus to many boys to endeavor to enter the high school if now and then they could get a peep into the laboratories and assembly rooms of which they sometimes hear but which they rarely or never see. Moreover, around the school, as has been suggested, are gathering many organizations for social service looking to immediate help in practical citizenship. An assembly room, properly and tenaciously guarded against those who have selfish ends to serve, can become the rallying point for the general educational movements in the community. Such use of a school building will not desecrate it, and can, if wisely directed, be of great service in connecting school work with the real and vital problems of the community.

Having said so much in general—and these arguments are often needed to convince those in authority of the importance of supplying an assembly room—let us now turn to the actual demands of construction.

The first question to consider is its location in the building. The prevailing practice in the older buildings was to put it on the second floor, but this is passing away, for surely the first floor is a better place. This location saves much wear on the building, in that it enables large audiences to gather without threading hallways or climbing stairs. It makes it easier to start the day's work with an assembly, and in this way gives opportunities for announcements by the principal, for the inspiration of song, readings, or short addresses. It is safer in case of fire; permits of easy entrance from the second floor to the gallery, if one is introduced; and allows ample height for the stage and for the ceiling above the gallery without interfering with a uniform scheme for roofing. It also insures a safer and stronger building for large audiences and gives a better opportunity to heat and ventilate it properly. By thus using the height of two stories, the floor of the main room as well as that of the gallery can be inclined without interfering with any other part of the structure, and extra exits can be arranged with little expense and without marring the architectural effect of the building as a whole. This position will also have the advantage of the wider hallways, and exits below and will thus avoid crowding in the halls and on the stairways. If situated in the central axis of the building and opposite the main entrance, it will give a unity and dignity to the interior not possible when on the second floor. The floor plans and cuts herewith presented illustrate the arrangement of assembly rooms for large buildings and also for smaller buildings.

An assembly room should be provided with a stage of ample proportions. Upon this stage the young people will gather on graduation day to receive their diplomas; upon it they will give their plays, choruses, and recitals; from it they can hear lectures and concerts by visiting talent; and in many ways there will be need for a roomy and safely built stage. There should be dressing or retiring rooms at both ends of the stage and on the same level with it.

Some interesting plans, especially those designed by William B. Ittner, of St. Louis, show an enlarged stage equipped as a gymnasium. With means of a temporary partition or drop curtain this may be reduced to the ordinary sized stage or opened up to the audience as a gymnasium. In this connection the following from Bulletin (1922) No. 23 of the United States Bureau of Education says:

> Experience has proved that it is altogether feasible to expand the stage to the size of a standard gymnasium and by this method to increase the seating capacity of the auditorium whenever desired. The combination stage-gymnasium also has other advantages. It gives opportunity to view physial educational exhibitions from the auditorium and makes provision for large choruses, symphony concerts, and community activities for which an ordinary stage is always inadequate.[4]

All assembly rooms call for ample light, and the stage should have windows, but placed so high that they can not be seen by the audience. (In large schools there should be a gallery so constructed as to require as few supports from the main floor as possible, and built with due care for the demands of acoustics.) The lighting of an assembly hall is an important feature in its usefulness and should be given careful consideration. If, as has been suggested, this room is placed on the central axis of the building and on the ground floor, light can be had from both sides, above and below the gallery.

In village and country high schools there is as much or more need, comparatively speaking, for assembly halls as in cities with more pretentious buildings, and yet under the stress of financial conditions they are often eliminated from the plans for the smaller schools. The accompanying floor plans for a small building (fig. 7) were drawn with this difficulty in mind, and the hallway has been widened so as to serve both for a passageway and an assembly room. It will be observed that the hall is shorter than the wings of the building and ends in a raised platform or stage, which can be cut off by folding or sliding doors and used as a library, principal's office, and a

[4] High-school buildings and grounds. A report of the commission on the reorganization of secondary education appointed by the National Education Association. U. S. Bureau of Education Bulletin (1922) No. 23.

stage. An open fire in the center will make it attractive from within the office, and also from the assembly hall. It will be noticed that cloakrooms are connected with each room so as to keep the hall clear. Movable chairs can be used and quickly arranged when needed and crowded together when a wider passageway is required along the sides or across the hall to facilitate the movement of the students between recitations. Provision can easily be made in the event that this room is desired for a study room. The ceiling of the assembly room is high, is finished to show the timbers, and is lighted from above. I am indebted to Mr. Bernard Maybeck, architect, Berkeley, Calif., for the drawings. This building can be built of wood, plastered on the outside or shingled, or of brick or stone. It does not readily lend itself to a painted clapboard construction. It

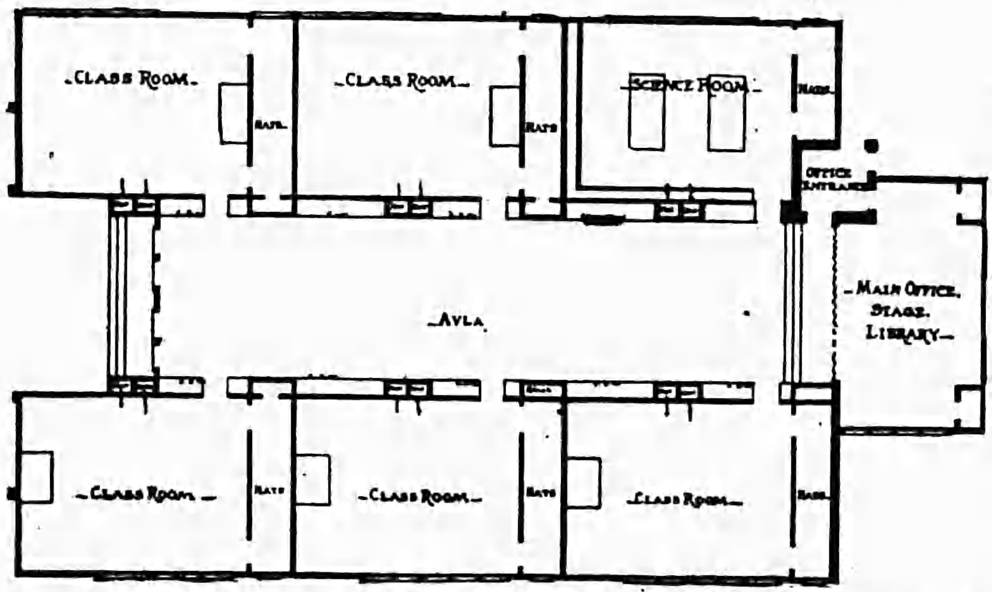


FIG. 7.—Plan for a village high school, so arranged that the hall may serve as an assembly room, with the main office as the stage.

should be made to blend with the landscape, and when covered with vines will make a charming village high school for the accommodation of 75 to 100 students. The only serious difficulties to contend with are the long valleys in the roofs at each side of the assembly room, and, in the hotter parts of the country, the lack of a cross breeze in the lower part of the assembly room.

It is characteristic of an American community to expect of the architect more school accomodations than the money allowed him will buy. Amost invariably the demand comes for an assembly room and very frequently for a gymnasium, and yet not more than half enough money is voted or set aside for the construction of the building desired. It has therefore become necessary to sacrifice some features of the building demanded or to insist on waiting until sufficient funds are in hand to do what the community wishes.

All schools in city or country need some sort of an assembly room where the school children may congregate or where the whole community may join in entertainments or more serious educational undertakings. But a room built only for an assembly, with a sloping floor and fixed chairs is used too infrequently in small to medium-sized schools to warrant this heavy outlay. So it has become necessary to plan an assembly room with a level floor, without fixed seats and with a sufficiently high ceiling, that it may be used for a gymnasium as well as for mere assembly purposes. One of the chief difficulties with this has been the trouble of handling chairs. To get them out of the way for gymnasium exercises and to replace them again for assembly purposes has been a serious problem. Much relief, however, has come by building a stage a little higher than ordinary, so framing it that stalls can be made under it facing the assembly floor, and small trucks, the width of a folding chair and the length of the depth of the stage, constructed with counter-sunk casters, upon which to place the chairs and run them under the stage when not needed. These little trucks or cars are not expensive to make, they require only a groove on either side under the stage upon which to run the casters, and posts at each end to prevent the chairs from sliding off. One of these will hold sometimes as many as a hundred chairs and thus practically all of the chairs can be cared for by using a few trucks. When chairs are to be removed from the floor, the trucks are run out into the room; the chairs are picked up and placed on the trucks in an orderly way, and then pushed under the stage. Vice versa when chairs are needed the trucks can be pulled out onto the floor and the chairs placed quickly as required. Naturally double doors are set in front of the stalls to close them when the chairs are removed or returned. This device has been used for a number of years. It has made an assembly room serve assembly, gymnasium, and social purposes, to say nothing of exhibitions or fairs. Thus the value of this room and the income from the investment have been multiplied many fold.

XVII. SCHOOL ARCHITECTURE AND SCHOOL IMPROVEMENT.

This is the age of schools and schoolhouses as characteristically as the latter part of the Middle Ages was the period of churches and great church buildings. In each case the faith and fervor of the people can be read and fairly understood through a critical study of these objective results and the ideals for which they stand. It will not miss the mark very far to say that our ideals and feelings associated with the notion of popular education are becoming suffused with a glow and zeal heretofore only found associated directly or indirectly with religious faith and religious propaganda. And something of the same spirit that once wrought to build a tabernacle or a cathedral worthy of a dwelling place of the Most High is seeking expression in furnishing to the youth of our land nobler temples in which their hearts, minds, and bodies may better adjust themselves to the demands of a practical civic brotherhood. Whoever, then, undertakes to build a schoolhouse to meet and foster these ideals ought to approach his task with holy hands and a consciousness of the devotion which it is to typify.

The problem, then, of building a schoolhouse to-day is in no small sense complicated by the growing tendency to use schoolhouses for all sorts of attempts at social betterment. Schoolhouses, especially in the large cities, have come to be used night and day, summer and winter. Vacation schools have been established, in which unusual programs of work and play have been introduced, and for their successful consummation such programs often demand equipment and accommodations not needed in the regular day schools. Lecture courses have been introduced not primarily for school children but for those who have quit school and gone to work, for those adults who have a desire to keep up their intellectual interests, and for those also who have sufficient spiritual pride to begin even late in life. But such buildings demand special equipment in the way of lighting, stereopticons, photographic rooms, assembly halls readily accessible, chairs, platforms, moving-picture machines, etc.

Manual and technical training courses have been introduced, demanding power plants not heretofore needed, or at least not thought desirable. Playgrounds are in greater demand, not only for the regular school children, but for those who for various reasons are denied school privileges through the day. Such children may come in the evening, after school hours, or on holidays. This demand for greater space and better adjustment led to roof playgrounds on school buildings. But no sooner had they been built than it was discovered that such favored and well-ventilated areas could be utilized as social gathering places, where good music could be heard, where the young people could meet and enjoy social dances under wholesome and safe environments, and where society could institute rational competition with the cheap vulgar shows and dangerous dance halls rampant on the streets below.

There are social movements in almost every community in our country to-day looking toward educational betterment, and such movements should be fostered, guided, and rationalized. Whenever these are for any worthy reason disconnected from church organizations, either the public-library building, some building designed especially for social workers, or the public-school buildings ought to be available as a center for such workers.

The school building has many advantages, for it is the citadel of a democracy, and there has developed about it a sentiment of dignity and decorum, influential in all movements undertaken within its precincts. Furthermore, the use of these buildings for worthy social work of all kinds is bringing school work into more vital touch with the real life of the world; vice versa, it is bringing the American community into a more vital relation with the teachers and those who are responsible for schools and school organization.

In planning even a country schoolhouse or village high-school building, one must therefore think out into the possible needs of the community and enlarge his usual notions of the scope and purpose of public-school education.

Some day in the near future more pains will be taken to make schoolhouses beautiful in external appearance as well as commodious and healthful within. Thus far the architects of the large majority of our smaller school buildings have clung tenaciously to the "schoolhouse type," and have given us, in the main, buildings devoid of any attempt at niceties of proportion or unity of design. In many cases attempts at cheap ornamentation have been made at the expense of real beauty of form and hygienic considerations.

It seems strange, on first thought, that our schoolhouses have been the last of public buildings through which public taste has sought to express itself. But when one recalls that this tardy recognition of children's rights has exhibited itself in all lines of endeavor wherein the education and care of children were concerned, a fundamental phase of human nature is brought into light. Adults have regularly thought and planned first for the satisfaction of their own needs rather than those of the children. If the reader is inclined to doubt this, let him make a study of the Sunday-school rooms of our churches and compare them with the rooms of the same buildings set apart in the main for the use of adults. Let him examine the homes and contrast the provisions made for adults with those for the children, and he will understand more clearly what I mean. Even children's clothing is designed not so much for personal comfort, joy, and approval of children as for the satisfaction of older people. Precisely for the same reason that the education of children at public expense has been, in the main, the last phase in the development of our educational systems, we may expect that schoolhouses for the little children will not receive so careful attention from the general public in our generation as those designed for college students or students of our secondary schools. But a protest should be entered against this selfishness and, at the same time, a plea made for the æsthetic education of the children and through them the development of an enlightened conscience and artistic sense in the public at large. The school buildings in which our children spend a great part of their working hours during their early years deserve serious attention and artistic treatment. Art leagues desiring to promote civic improvement should offer artistic and well-adapted plans of country schoolhouses for the consideration of those who have charge of the construction of such buildings.

Such plans should be simple and easily followed. They should call for materials within the reach of local markets or conditions. Country schoolhouses are, in the main, built by "hatchet-and-saw" carpenters who can not read complicated drawings or follow readily the usual forms of specifications. Proportion in such buildings is almost everything, and to secure this end plans ought to be drawn and specifications devised so explicitly that no mistake can be made. No amount of interior decoration will offset the bad effect of exterior ugliness.

If country people are inclined to be careless about the appearance of their schoolhouses and school grounds, and we all know that this is often the case, it becomes a double duty for those who have better taste to exert themselves to place before them better models. Real beauty is not expensive. The best things are in reach of us all. Log cabins can be built as satisfying to the artistic sense as palaces, indeed frequently more so. The planning of a one-story, one-room country schoolhouse ought to demand, and will demand from any capable and conscientious architect, as painstaking consideration as a large city school. In fact, the opportunity for the development and dissemination of taste in this, the central agency for social and æsthetic improvement in the country, ought to appeal with especial interest to all concerned.

Here is an account of the influence of one teacher "who organized a community" (World's Work, vol. 5, p. 9601):

In September, 1904, Miss Mabel Carney, a young Irish girl just out of normal school, began teaching in a country school in Putnam County, Ill. Her pupils were few, the building dilapidated and poorly equipped, the site unattractive, but she was a teacher of practical ideas. Two neighboring schools were in a condition equally bad, and Miss Carney went to work on a plan of consolidation. She talked consolidation of these three inefficient country schools until she had won hearers enough to put the question to a vote in the spring of 1905. The electors voted down the proposition that year, but the young teacher's consolidation plan was adopted at the election in 1906. Here are some of the concrete results: Mr. John Swaney, a public-spirited citizen, gave 24 acres for a campus—a campus for a country school! The people of the three districts voted $18,000 to make the building one of the best schoolhouses in Illinois. Wagons carry the children who are too remote from the building to walk. The principal of this country school is paid $1,000 a year. On the campus is an agricultural experiment plot of 6 acres, conducted in cooperation with the school of agriculture of the State university, and a large tract of natural forest. A four-year high-school course is offered, with a liberal election of studies. Country boys and girls may here study agriculture, animal husbandry, horticulture, domestic science, and all phases of work vitally related to the fundamental means of a people living in the country. Culture subjects are not neglected, but the real basic interests of culture among an agricultural people are given due emphasis. An enlarged country neighborhood has been bound into a co-operative social unity, whose possibilities for higher culture are not inferior to those of cities of 10,000 people. These are the products of two years' work of a young girl with the right ideals.

Equal or more striking results have been achieved in all parts of the country since Miss Carney's efforts. There has been a truly wonderful growth, especially in the rural districts, in the consolidation of schools and the use of the school building as an educational center for the whole community. Permit me to sketch very briefly and inadequately what has happened in one county in Alabama. Five years ago the author was called to advise with County Superintendent Feagin, of Montgomery County, Ala., to see what might be done in the way of consolidation in that county, especially looking toward the greater social unification of the white people in the rural communities. At that time the small village of Pike Roads had a miserable makeshift of a school building with two teachers in charge. The children were badly handicapped, and the teachers were so badly situated that they were unable to do satisfactory work. The conditions were deplorable. Fortunately, there was a desire in the community for better things. Through the proper presentation of the needs of the school the people were induced to purchase a small farm of 35 acres adjoining the town. The county bonded itself to construct a modern school building and to consolidate at this place a great many districts. Automobile trucks were purchased, good teachers employed, and the children of a large area of the county were gathered in at this place.

The change in the educational interest of the people and the progress of the children in this community, as well as the county at large, during the past few years are almost unbelievable. Bonds have now been voted to construct buildings of this type for all the white children of the county. In a few buildings the school children of a whole county will meet together. The spirit of educational progress has already called for a rural high-school edifice of a distinctive and fine type, where the children of the county can get such preparation for advanced work as before was impossible. The effects of this socializing influence are radiating throughout the whole State.

It has been the custom in many places in our country to build schoolhouses according to ready-made plans furnished by so-called architects and builders. These plans are rarely sufficiently accurate and complete to give any definite idea of what will result as the finished product. Their specifications are indefinite and not infrequently in error, and trouble and extra expense result from attempting to follow them. The sane and economical thing to do, even if only a one-story school building is to be erected, is to engage the services of a reliable, tasteful architect, and with him work out every detail before the plan is finally accepted. School boards of towns and cities should give their teachers, or at least a committee from the teaching force, a large share in helping to plan their schoolhouses. It seems more than strange that members of a board of education who rarely have any intimate acquaintance with the demands and necessities of modern school buildings should, when called upon to erect new buildings, neglect to avail themselves of the services of the experts they have selected to do the school work. Boards of education often come together to consider plans which have been placed in competition without so much as inviting a principal or superintendent to aid them. One by one the architects are called before the board to extol their products and point out the superiority of their respective plans to all other possible plans. In general, the most plausible talker, with the gaudiest elevation and the greatest number of impossible carriages passing the proposed building, generally gets the vote. If the floor plans are studied at all, they receive a mere glance, and generally from eyes unable to read them intelligently. The fact is the planning and building of schoolhouses is a highly specialized business and can not be safely left in the hands of men who know nothing about it. In every system of city schools, whether a regularly employed architect is available or not, the superintendent of schools should insist that a committee from the teaching staff should with him be empowered by the board to study plans and advise architects on all matters pertaining to arrangements most suitable for practical school work. This committee ought to be a standing committee, and should be in every way encouraged to study in detail schoolhouses from the educational point of view. It is certainly very poor economy to neglect to utilize the teachers' intimate knowledge of what is needed. The same sort of a policy ought to be encouraged in villages and in country districts. County superintendents ought to be given power to pass on all plans for school buildings; or, better still, they ought to have at command data from which architects can work , and then through advice and direction guide to better plans.

In a large city system of schools where an architect is employed to make plans for all the schoolhouses to be built, and gives his whole time to this specialty, there is less waste and better results. And yet even these specialists can often profit from the suggestions teachers are able to give. But in the great majority of places there is no architect regularly employed, and few who know much about the special problems of school buildings. Under such conditions a custom has sprung up of advertising for competitive plans, and then is enacted the farce described above. Indeed, several States have made it compulsory for school boards to select plans in this way. There can be no question that this in general is a clumsy and ineffective method. The safe and businesslike thing to do is to engage an architect and let him work up a plan under guidance, so that when it is done it will be understood. The best architects rarely submit plans in competition. It is too expensive for them to prepare worthy plans on a mere chance. But school boards have a difficult political problem to meet when they select an architect, and the competition system has furnished them a means of forestalling criticism, and often of compelling the acceptance of unsuitable plans. Not one business block in a thousand is built after plans secured through competition, and the very men who serve on school boards would never manage their own business in this way.

One of the most difficult problems, as elsewhere suggested, rises out of the fact that people think that a successful school building, designed for a particular place and orientated in a specific way, can be copied exactly, used on a different lot with a different orientation, and be as successful in the latter as the former position. This is a very great blunder. Each school building is a problem in itself. It has a definite lot upon which it is to be located; it must face in a given direction to meet the demands of this lot; and it must be designed to meet the educational needs of the peculiar and specific community. To be sure, one can get many suggestions and frequently specific helps in the study of successful architecture wherever found, but, in the last analysis, each school building should be designed practically to meet its environment both physical and educational. The sane, safe, and economical thing to do when a school building is to be erected on a specific lot is to employ an architect, demand a careful study of the location and the needs of the school, and then gradually and slowly work this out into sketches until all demands are approximately met. An honest, conscientious architect, capable of preparing plans and specifications for a school building, will easily save enough to pay for his services and at the same time get a better building than could otherwise be expected. School architecture is a highly specialized line of work; and the planning and construction of schoolhouses demand the combined knowledge and skill of architects, superintendents, and teachers. Members of school boards rarely have time to study the needs of schools in detail and are rarely competent to select plans. They should depend on specialized knowledge and skill where so much is at stake, both financially and educationally. Fortunately this tendency is growing and in a large measure accounts for the growing excellence of American schoolhouses.

APPENDIX.

ORIENTATION OF BUILDINGS IN SOUTHERN STATES.

For a number of years past there has been rather constant demands in various Southern States that windows of classrooms be opened toward the south, for school officials in these States have generally insisted that the prevailing breezes in the warmer part of the school year blow from the south. Naturally it was a legitimate demand to make as much provision as possible for alleviating the temperature in schoolrooms in the hot months but, at the same time, we were likely to introduce more difficulty with the necessity of having to pull down the shades to cut out the south sun than we should get relief from this orientation.

In order to ascertain the truth of the matter, Mr. Roscoe Nunn, meteorologist in charge of the Nashville station of the Weather Bureau, was appealed to. He was kind enough to undertake this rather arduous task and sent questionnaires to all the bureau stations of the 10 Southern States to get information as to the direction of the prevailing winds at each station for the hours of 8 a. m. to 4 p. m. during the months of April, May, June, September, and October. These months cover the warm weather for most of the school year, and probably little change would occur in July and August. Through a study of these returns he worked out the following table:

U. S. Department of Agriculture, Weather Bureau.

[From Weather Bureau Office, Nashville, Tenn., Apr. 24, 1923.]

Data, prevailing winds (8 a. m. to 4 p. m.), for the months given.

Stations.	April.	May.	June.	September.	October.	Period.
Alabama:						
Anniston	NW.	NW.	N.	SE.	SE.	SE. and NW.
Birmingham	S.	S.	S.	S.	SE.	S.
Montgomery[1]	SE.	SW.	SW.	E.	E.	SW. and E.
Arkansas:						
Bentonville	S.	S.	S.	S.	S.	S.
Fort Smith	E.	E.	E.	E.	E.	E.
Little Rock	S.	S.	S.	NE.	S.	S.
Florida:						
Jacksonville	SW.	SW.	SW.	NE.	NE.	SW.
Pensacola	SE.	S.	S.	S.	SE.	S.
Tampa	NE.	SW.	SW.	NE.	NE.	NE.
Georgia:						
Atlanta	NW.	NW.	W.	E.	E.	NW. and E.
Augusta	NW.	NW.	SW.	NE.	NE.	NE. and NW.
Macon	NW.	NE.	SW.	NE.	NE.	NE.
Savannah	SW.	SW.	W.	NE.	NE.	NE. and SW.
Thomasville	SW.	SW.	SW.	NE.	NE.	SW.
Louisiana:						
New Orleans	SE.	SE.	SE.	NE.	NE.	SE.
Shreveport[1]	S.	SE.	S.	SE.	SE.	SE.
Mississippi:						
Vicksburg	SW.	SW.	SW.	NW.	NW.	SW.

[1] Hourly data not available; therefore use the monthly prevailing direction.

U. S. Department of Agriculture, Weather Bureau—Continued.

Station.	April.	May.	June.	September.	October.	Period.
North Carolina:						
Asheville [1]	NW.	NW.	NW.	NW.	NW.	NW.
Charlotte	SW.	SW.	SW.	NE.	NE.	SW.
Raleigh	SW.	SW.	SW.	NE.	NE	SW.
Wilmington	SW.	SW.	SW.	NE.	NE.	SW.
Oklahoma:						
Oklahoma	S.	S.	S.	S.	S.	S.
South Carolina:						
Charleston	S.	S.	S.	NE.	N.	S.
Greeneville	SW.	SW.	W.	NE.	E.	SW.
Tennessee:						
Chattanooga [1]	S.	SW.	SW.	NE.	NE.	SW. and NE.
Knoxville [1]	SW.	SW.	SW.	NE.	NE.	SW.
Memphis	SW.	SW.	SW	SW.	SW.	SW.
Nashville	NW.	SW.	SW.	NW.	NW.	NW.
Texas:						
Abilene	SW.	SW.	SE.	SW.	SW.	SW.
Amarillo	SW.	S.	S.	S.	S.	S.
Dallas	S.	S.	S.	S.	SE.	S.
Fort Worth	S.	S.	S.	S.	S.	S.
Galveston	SE.	SE.	SE.	SE.	SE.	SE.
Houston	SE.	SE.	S.	SE.	SE.	SE.
San Antonio	SE.	SE.	SE.	SE.	SE.	SE.
Virginia:						
Lynchburg	NW.	SW.	SW.	NW.	NW.	NW. and SW.
Norfolk	NW.	NE.	NE.	NE.	NE.	NE.
Richmond	SW.	SW.	NE.	NE.	SW.	SW.
Wytheville	W.	W.	W.	E.	W.	W.

[1] Hourly data not available; therefore use the monthly prevailing direction.

The general conclusions Mr. Nunn has reached, in addition to the data given in the foregoing table, may be represented by the following quotations:

The records show a rather mixed distribution of air movement over the Southern States, due principally to local topography and the varied conditions of exposure of wind vanes. But there are also regional characteristics of wind direction, due to geographical differences, the paths of general storms, and the distribution of mean temperature and mean atmospheric pressure.

Topographical effect is shown clearly at Fort Smith, Ark., where the wind rarely blows for any length of time from any direction other than east, due to the trend of the valley in which the wind vane is located. This is the most conspicuous case of the kind among Weather Bureau stations in the Southern States, but doubtless other similar situations exist. In the highland and mountain districts of Tennessee, Georgia, the Carolinas, and Virginia, the wind directions are evidently affected to some extent by the broken character of the land surface, ridges, and valleys; otherwise, it is difficult to account for some of the characteristics of the records at the several stations. The westerly component is prominent at Nashville, Knoxville, Atlanta, Asheville, Wytheville, and Lynchburg.

The suggested regional distribution may be grouped as (1) the States of Arkansas, Oklahoma, Texas, Louisiana, southern Mississippi, and western Alabama, where southerly winds, especially south and southeast, predominate decidedly throughout the period; (2) the eastern half (roughly) of the States of Virginia, North Carolina, South Carolina, Georgia, southern Alabama, and all of Florida, where the prevailing winds in spring and early summer are from the southwest and in September and October from the northeast; (3) the remaining portions of the Southern States, embracing Tennessee and the highlands and mountainous portions of Georgia, the Carolinas, and Virginia, where the westerly component (southwest, west, and northwest) predominates.

Means or averages of the data in the table, covering the whole area, are probably of little value. It is difficult to compute a correct mean from these data, as the sections of the area are disproportionately represented. However, it may be stated that, considering all the data in the table, we find that southwest is the most frequent direction recorded. This is followed by south, which is considerably less frequent; then by northwest, northeast, and southeast, of equal frequency but considerably less than south.

If we take the States east of the Mississippi River we find southwest winds distinctly predominating, followed by northeast and northwest. Taking Arkansas, Oklahoma, and Texas, we find south strongly prevailing, with southeast next, and but little from any other direction.

By months, considering the whole area, we find that southwest winds prevail in April, May, and June, and northeast in September and October; but south is a pretty strong second.

But these groupings and averages are considered of no great value for guidance in the orientation of a schoolhouse in any particular locality. They do indicate that there is no strong prevalence of south winds except in Arkansas, Oklahoma, Texas, and Louisiana. Emphasis should be placed upon the advisability of making as thorough investigation as practicable of conditions in each locality in the preliminary plans for school buildings, and this generally can be done through near-by Weather Bureau stations.

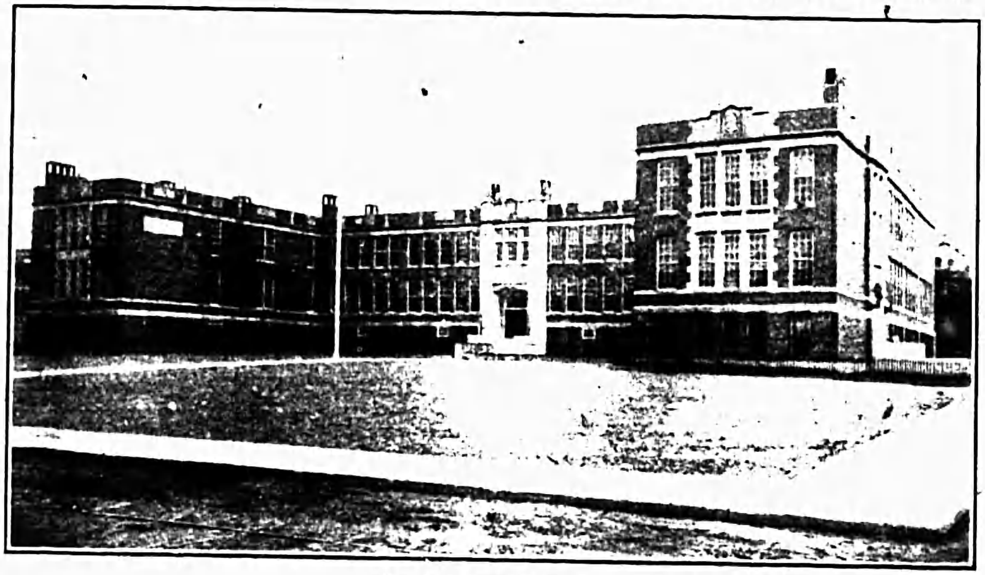
It is obvious that south windows would catch the breezes from the southeast, south, and southwest; west windows would catch them from the southwest, west and northwest. But west windows, it seems, are decidedly preferable from the standpoints of light and sanitation. Therefore, where the prevalence of south winds is very strong, as in the Southern States west of the Mississippi River, a choice of west or south windows may be difficult to make; but in the States east of the Mississippi River, generally speaking, it would seem that any sacrifice of other features to secure south breezes would be a mistake.

INDEX.

American Public Health Association, report on sanitation of swimming pools, 72-73.
Apparatus rooms, 76, 79.
Assembly rooms, 85-89; use of gymnasium, 74.
Basements, 9-11.
Baskerville, *Doctor*, on best material for floors, 82.
Baths, 70-71.
Blackboards, 32-36.
Blinds, sliding slat, use of condemned, 50.
California, lighting of schoolrooms, 41.
Carney, Mabel, influence as teacher, 92-93.
Ceiling line, curved, 47-48.
Children of primary grades, amount of cubic air required in schoolrooms, 64.
Classrooms, dimensions, 11-14; furniture and equipment, 40; height of ceiling, 16-18; length of room, 14-16; width of room, 16.
Cloakrooms, 21-23.
Construction and equipment of school buildings, 24-40.
Dampness, protection, 5-9.
Doors, 36-38.
Drainage, 5-9.
Dressing rooms, 71.
Dustless oil floor dressing, 29-30.
Fireplaces, 52.
Floor oils, 29-30.
Floors, 24-30, 81-83.
Foster, *Prof.*, on illumination of schoolrooms, 42.
Foundations, 5.
Furnaces, hot-air, 54-57. *See also* Stoves.
Furniture, 40.
Gill, *Prof.*, on best tops for laboratory tables; walls for chemical laboratories, 84.
Grover Cleveland High School, St. Louis, Mo., gymnasium, 74.
Gymnasiums, 73-74; used as theatre and assembly room, 74.
Halls, 18-20.
Heating, 51-61.
Hot-water heating, 57-58.
Illinois, consolidation of schools in Putnam County, 92-93.
Illumination. *See* Lighting.
Laboratories, 75-81.
Laboratory tables, best tops, 83; recipe for treating tops, 83.
Lighting, 41-49.
Lincoln, *Prof.*, recipe for treating tops of laboratory tables.
Location, 1-4.
Lockers, 19-20.
Maybeck, Bernard, architectural plan for village high school, 88.
Nashville, Tenn., high-school building improperly oriented, 3.
New York City, report to school board on color of walls, 49.

New York Commission on Ventilation, on heating problem, 51; ventilation of classrooms, 64–65.
Noises, avoidance of disturbing, 2–3.
Orientation of school buildings, 3, 43–47, 96–98.
Philipps High School, Birmingham, Ala., 74.
Planning, 9–24.
Platforms, 39–40; teachers', 39–40.
Playgrounds, 74–75.
Polish for hardwood floors, 29.
Prismatic or ribbed glass, use, 50.
Pupils, proper seating, 48.
San Francisco, windows and screens, 38.
School architecture and school improvement, 89–95.
Screens and windows, 38–40.
Sewage, disposal, 68–70.
Shades, roller, 48–49; proper color, 50–51.
Sites. *See* Location.
Soil and drainage, 5.
Southerland, Robert H., on proper orientation of classrooms, 43.
Stairways, 20, 31–32.
Steam heating, 58–60.
Stoves, box, 53; jacketed, 53–54. *See also* Furnaces.
Swimming pools, 71–73.
Tables, laboratory. *See* Laboratory tables.
Tanks, septic. *See* Sewage.
Theater, use of gymnasium, 74.
Thermostats, use of, 60–62.
Toilet rooms, 23–24, 66–68.
Track for transporting apparatus in chemical laboratory, 79–80.
Ventilation, 62–66.
Walls, best color for, 49; chemical laboratories, 83–85.
Weather Bureau, U. S. Department of Agriculture, data regarding prevailing winds in Southern States, 96–98.
Windows and screens, 38–40.
Winds, prevailing in Southern States, 96–98.

O

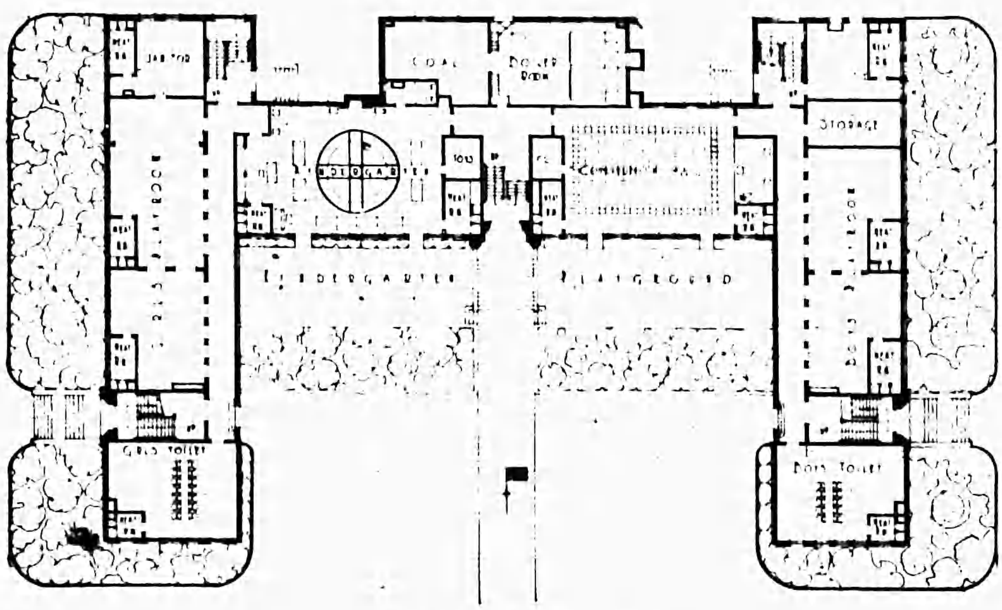


A. PERSPECTIVE

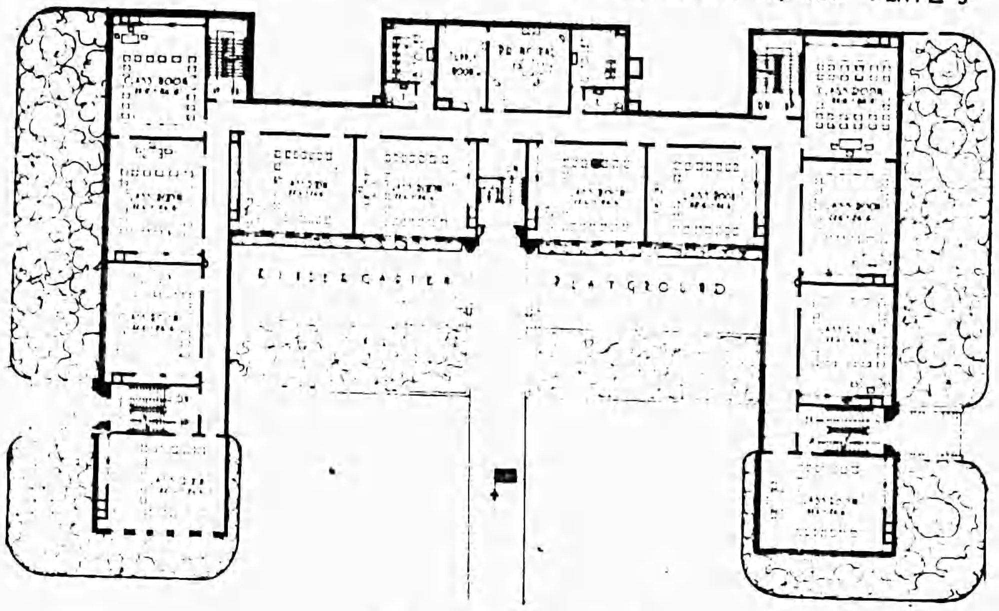
B. CLINIC

ELEMENTARY SCHOOL, LAWRENCE, MASS. JAMES E. ALLEN, ARCHITECT

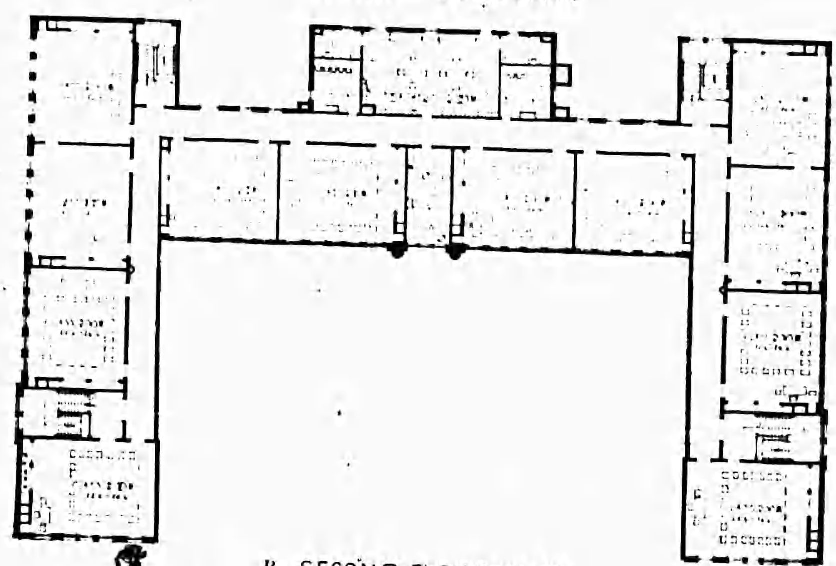
A. KINDERGARTEN



B. GROUND-FLOOR PLAN
ELEMENTARY SCHOOL, LAWRENCE, MASS.



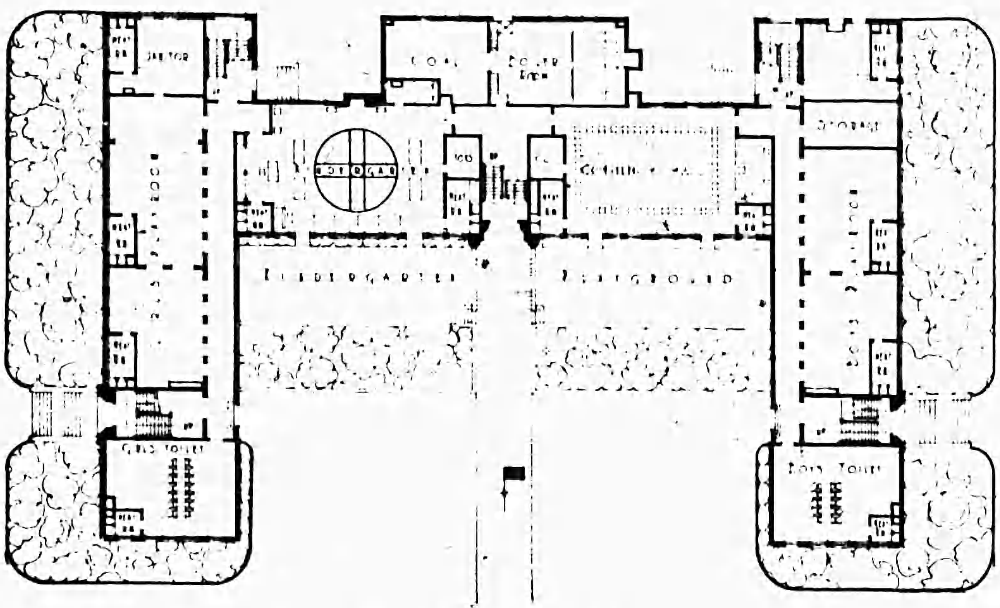
A. FIRST-FLOOR PLAN



B. SECOND-FLOOR PLAN

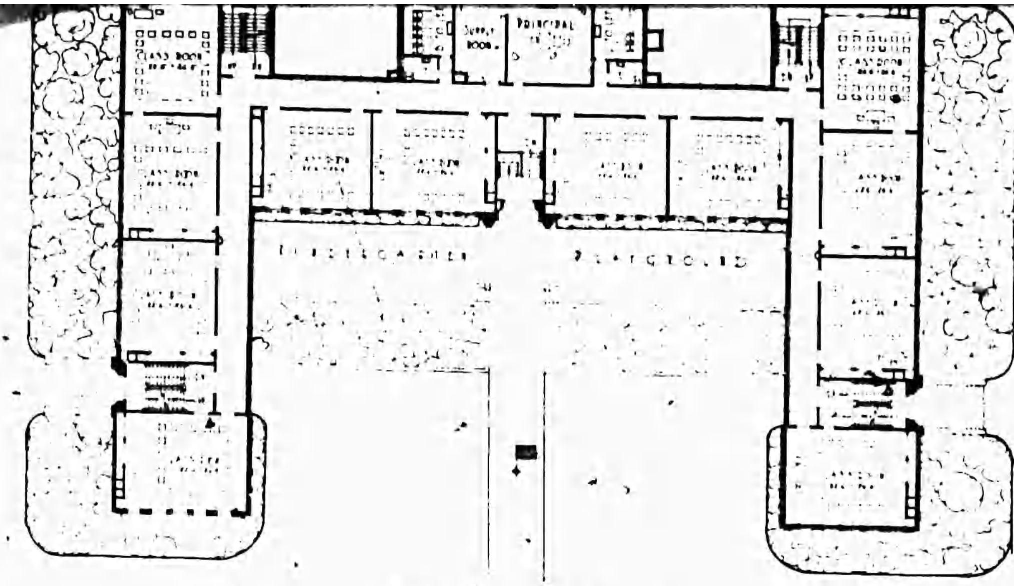
ELEMENTARY SCHOOL, LAWRENCE, MASS.

A. KINDERGARTEN

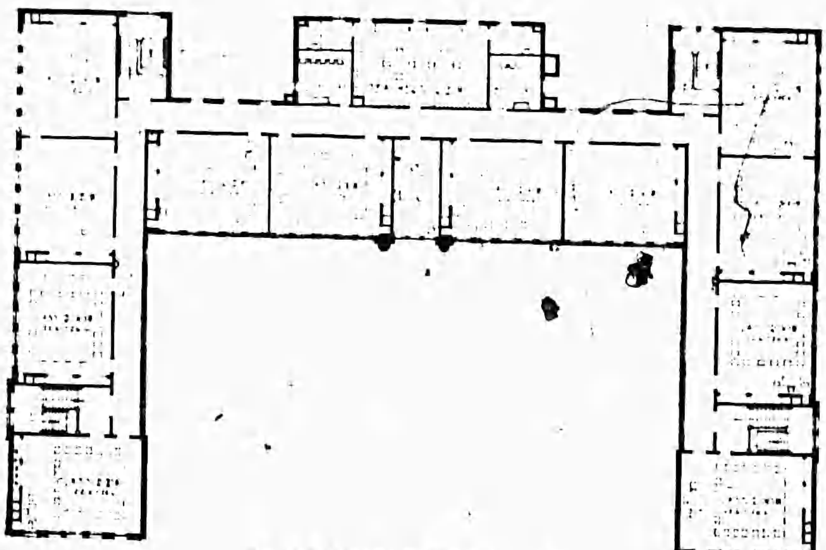


B. GROUND-FLOOR PLAN

ELEMENTARY SCHOOL, LAWRENCE, MASS.



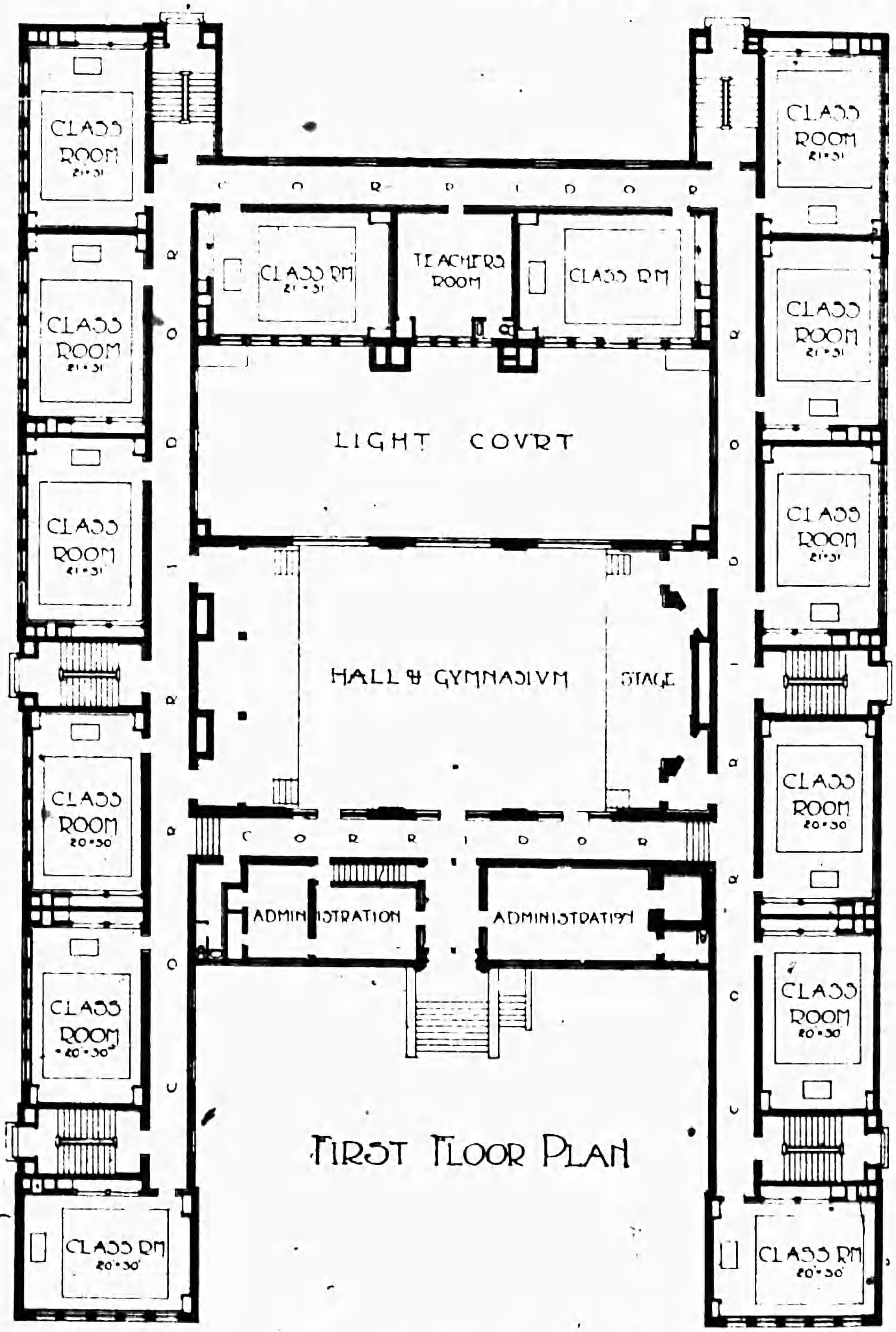
A. FIRST-FLOOR PLAN



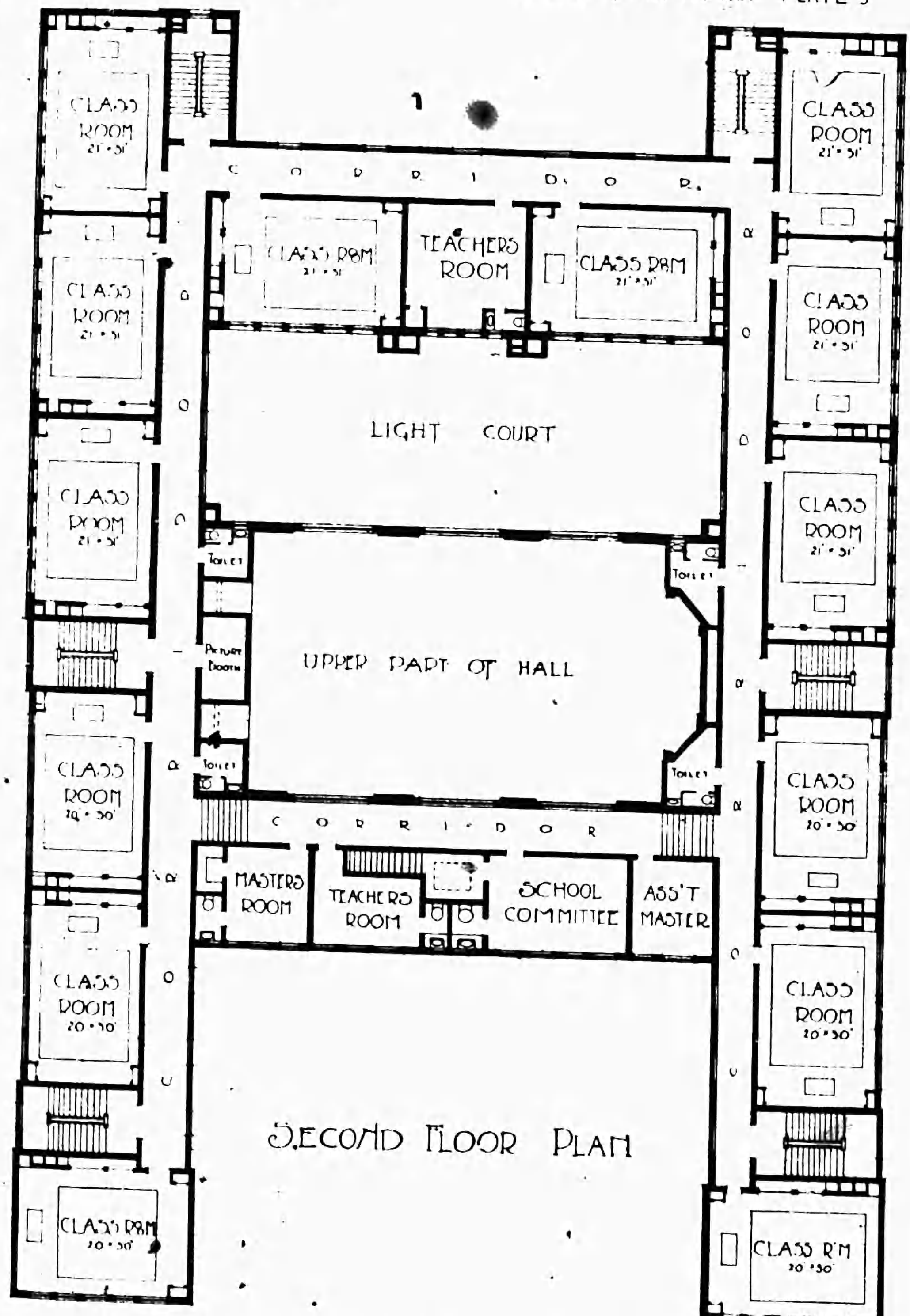
B. SECOND-FLOOR PLAN

ELEMENTARY SCHOOL, LAWRENCE MASS.

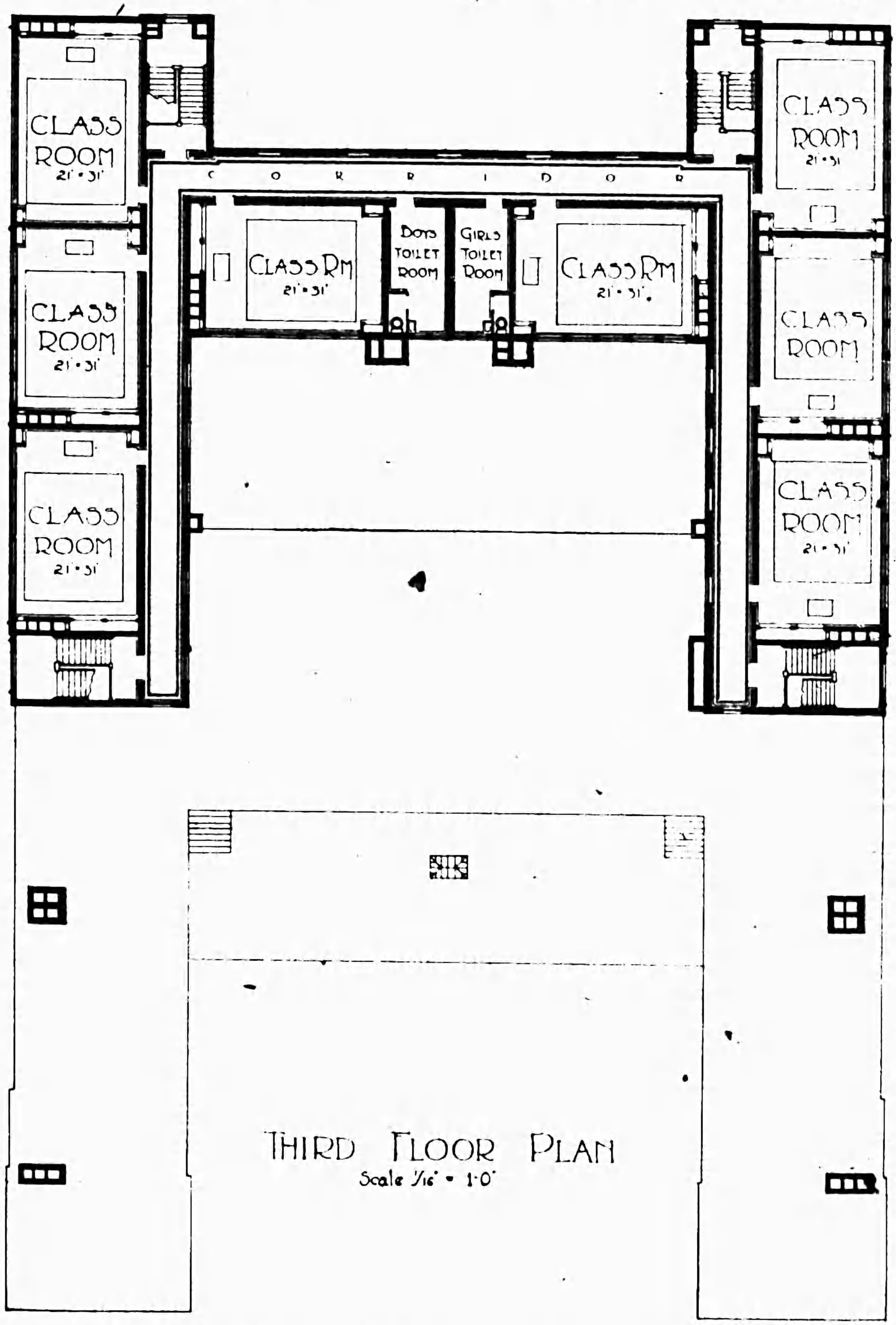
OLIVER SCHOOL, LAWRENCE, MASS. JAMES E. ALLEN, ARCHITECT



OLIVER SCHOOL, LAWRENCE, MASS. (FIRST-FLOOR PLAN)

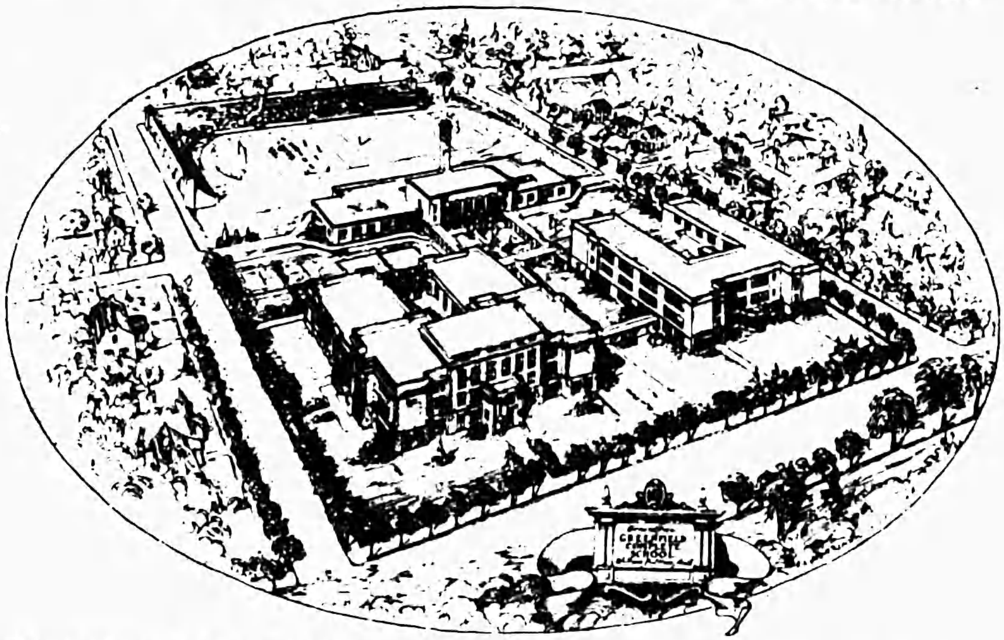


OLIVER SCHOOL, LAWRENCE, MASS. (SECOND-FLOOR PLAN)

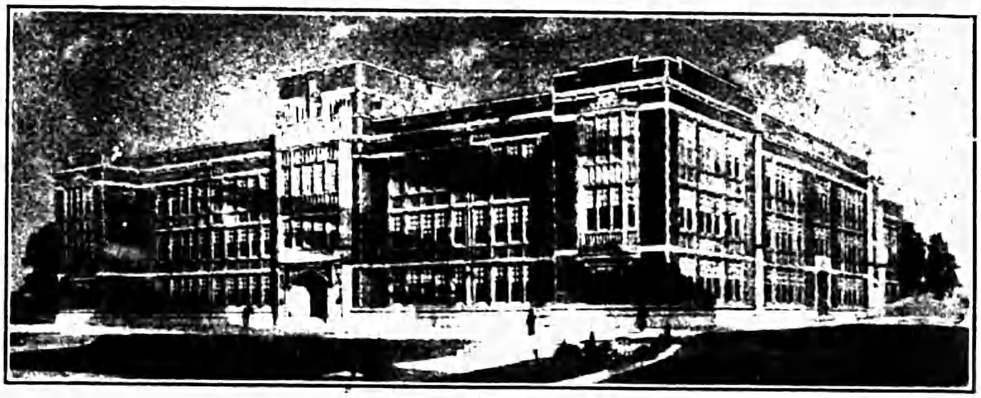


OLIVER SCHOOL, LAWRENCE, MASS. (THIRD-FLOOR PLAN)

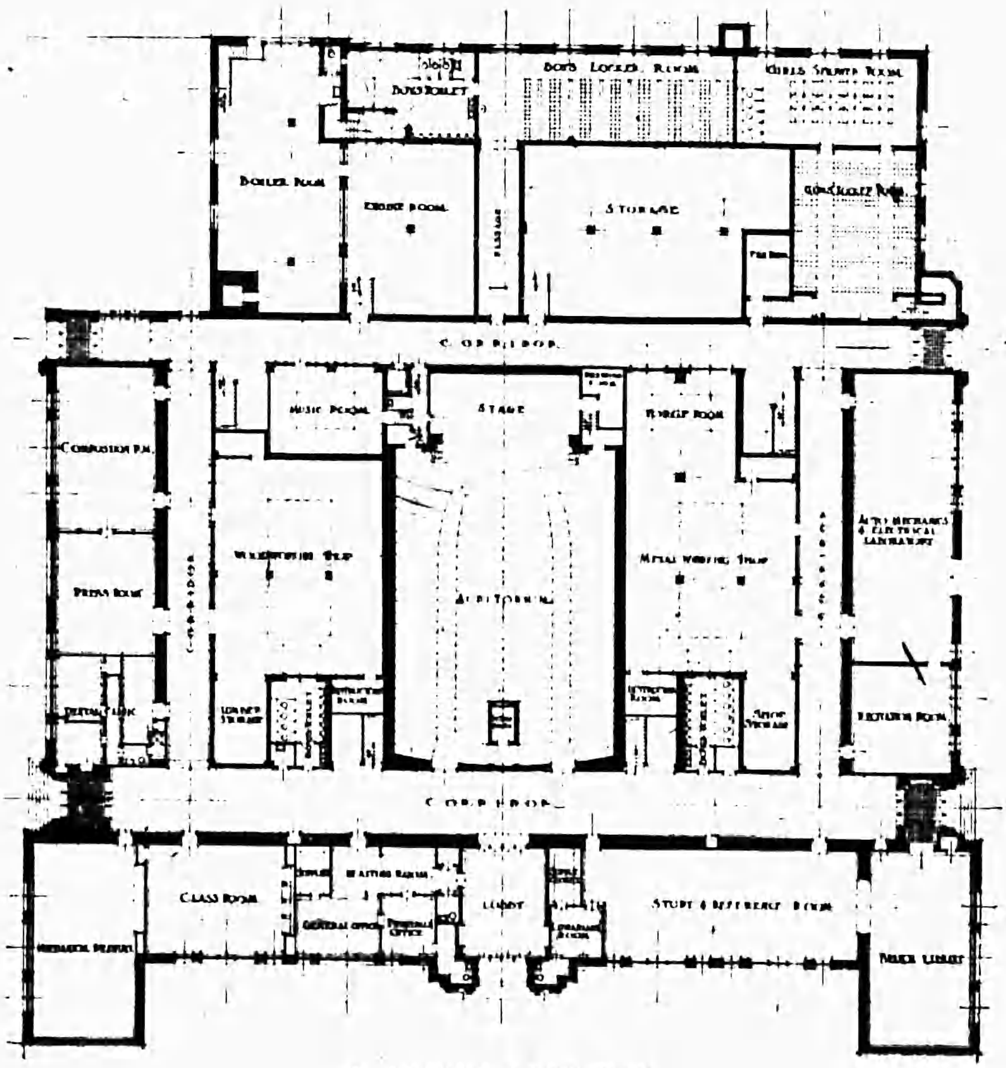
BUREAU OF EDUCATION BULLETIN NO. 17, 1924 PLATE 7



GENERAL VIEW, GREENFIELD (OHIO) COMPLETE SCHOOL. WILLIAM B. ITTNER, ARCHITECT

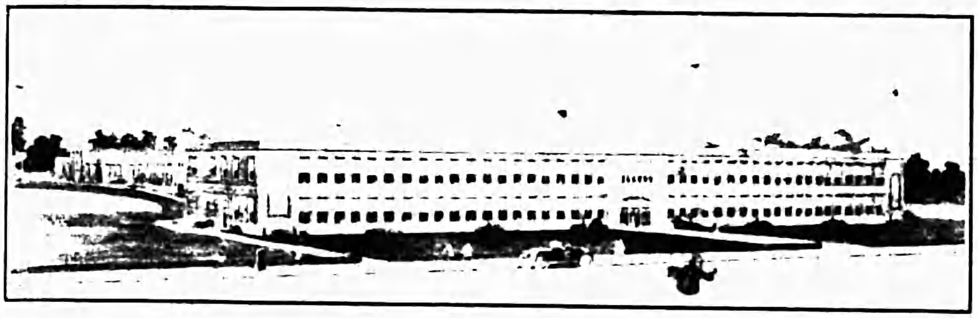


A. PERSPECTIVE

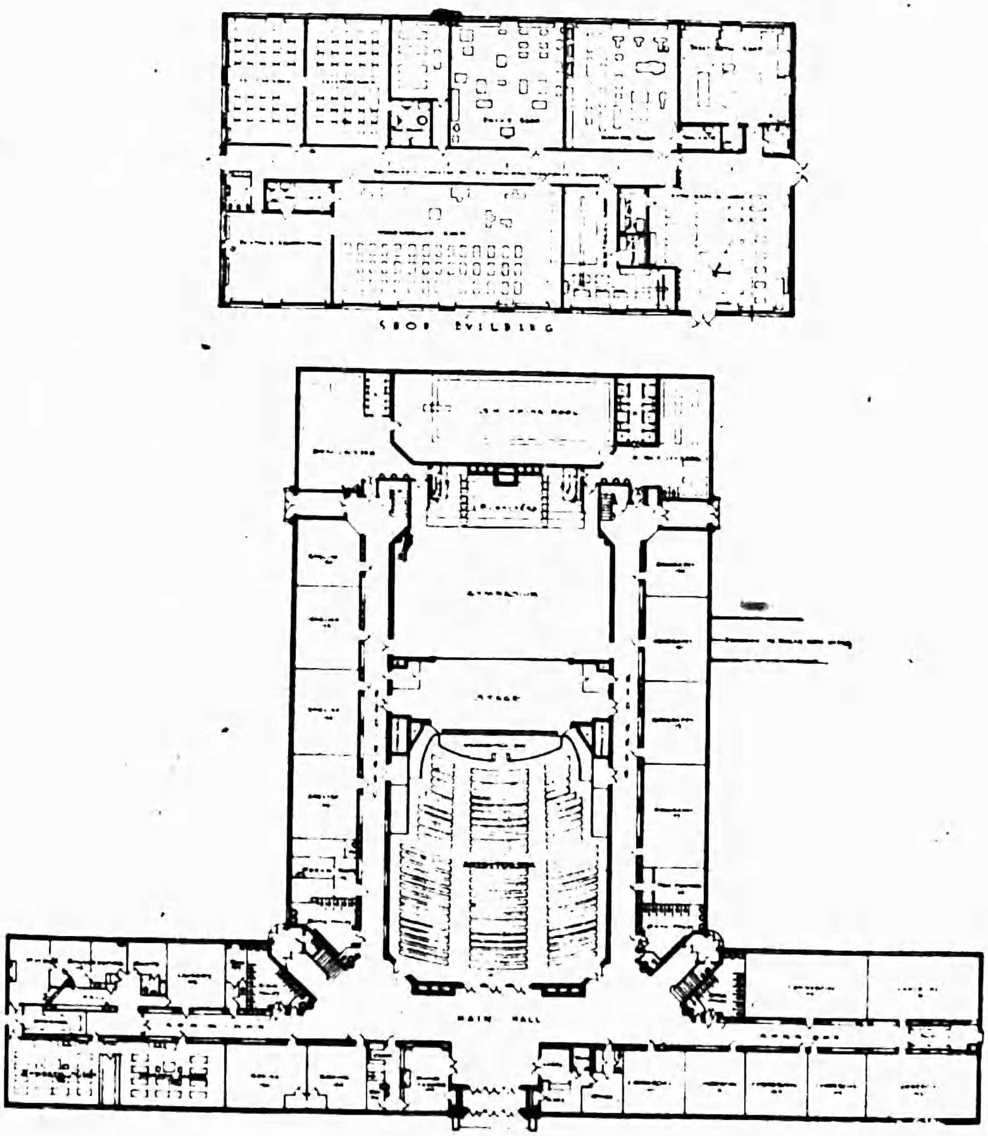


B. GROUND-FLOOR PLAN

CRESTON JUNIOR HIGH SCHOOL, GRAND RAPIDS, MICH. HENRY H. TURNER, ARCHITECT; V. E. THEBAUD, ASSOCIATE

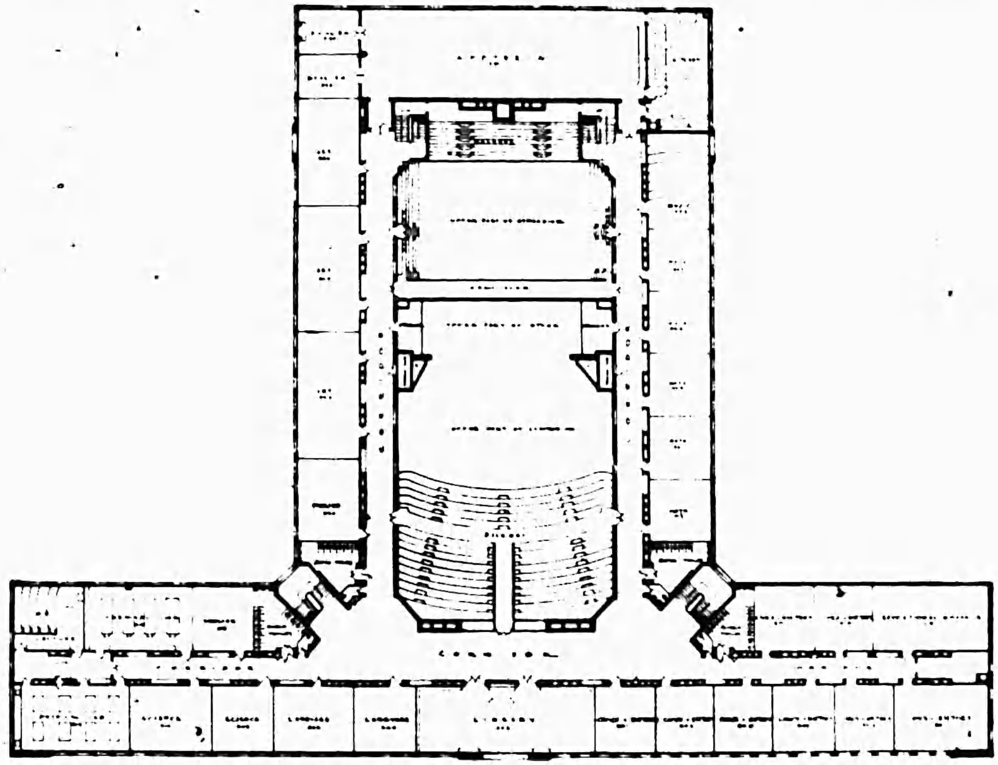


A. PERSPECTIVE

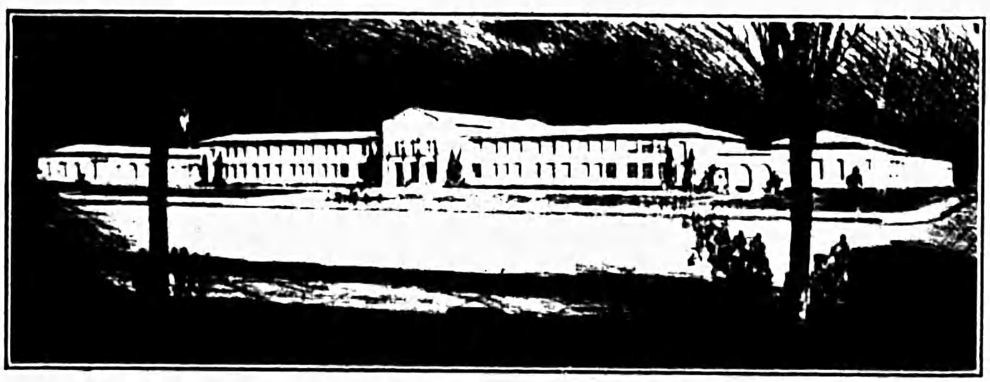


B. FIRST-FLOOR PLAN

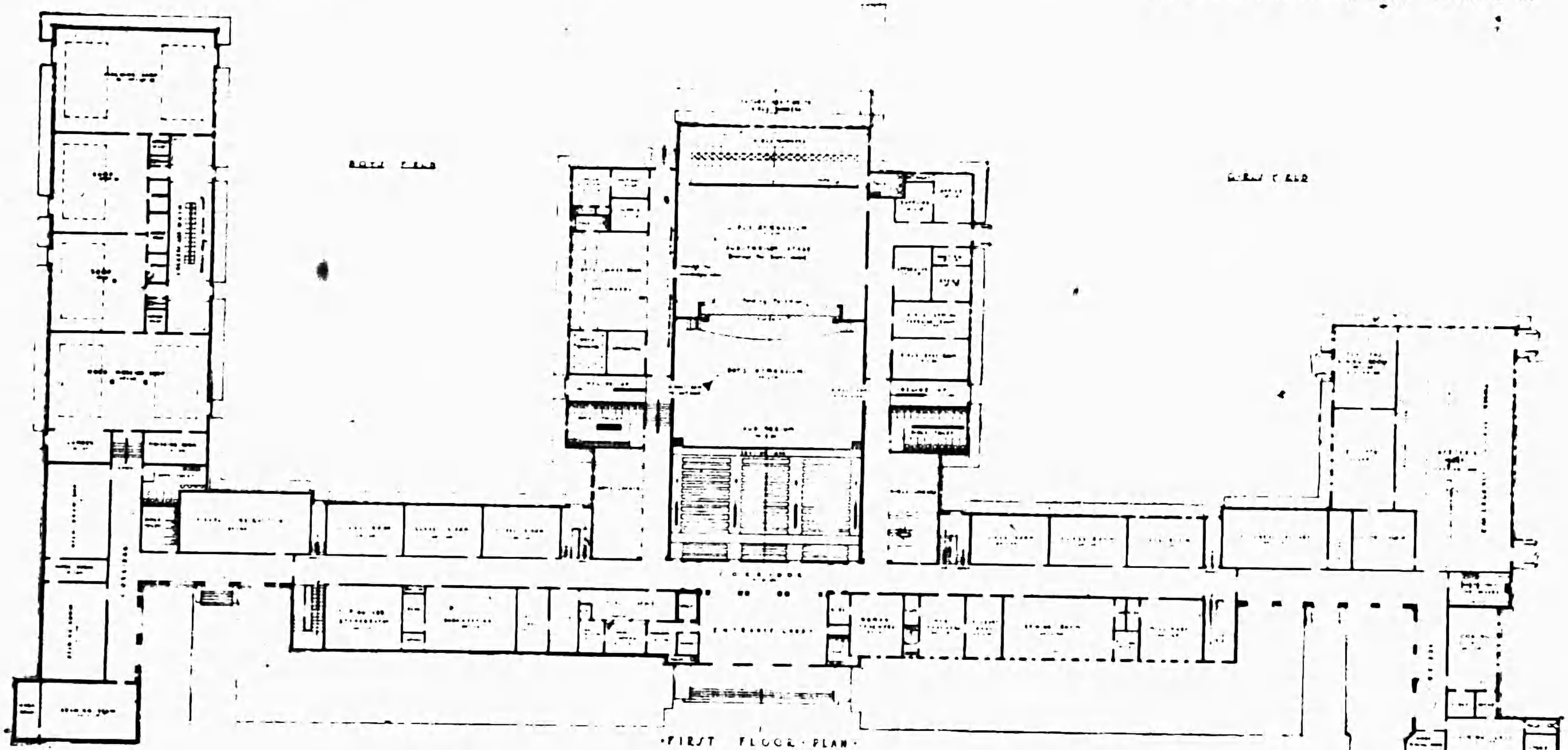
BENJAMIN FRANKLIN JUNIOR HIGH SCHOOL, NEWCASTLE, PA. W. G. ECKLES, ARCHITECT



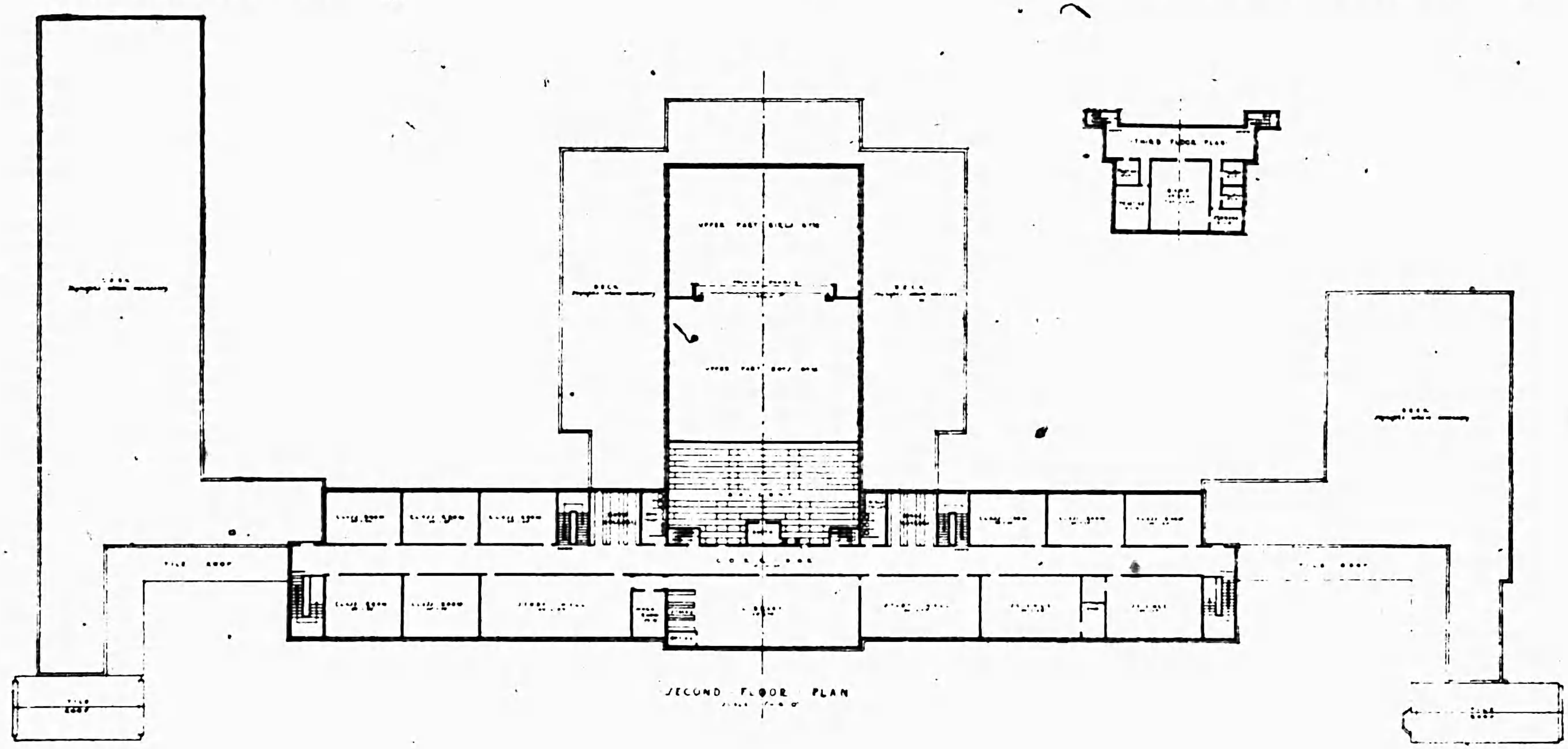
A. BENJAMIN FRANKLIN JUNIOR HIGH SCHOOL, NEWCASTLE, PA. (SECOND-FLOOR PLAN)



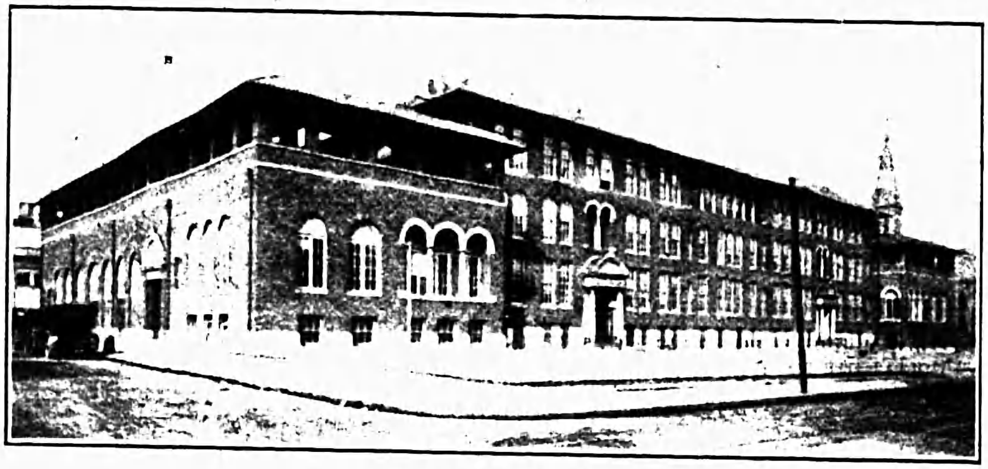
B. ELMHURST JUNIOR HIGH SCHOOL, OAKLAND, CALIF. C. W. DICKEY, ARCHITECT



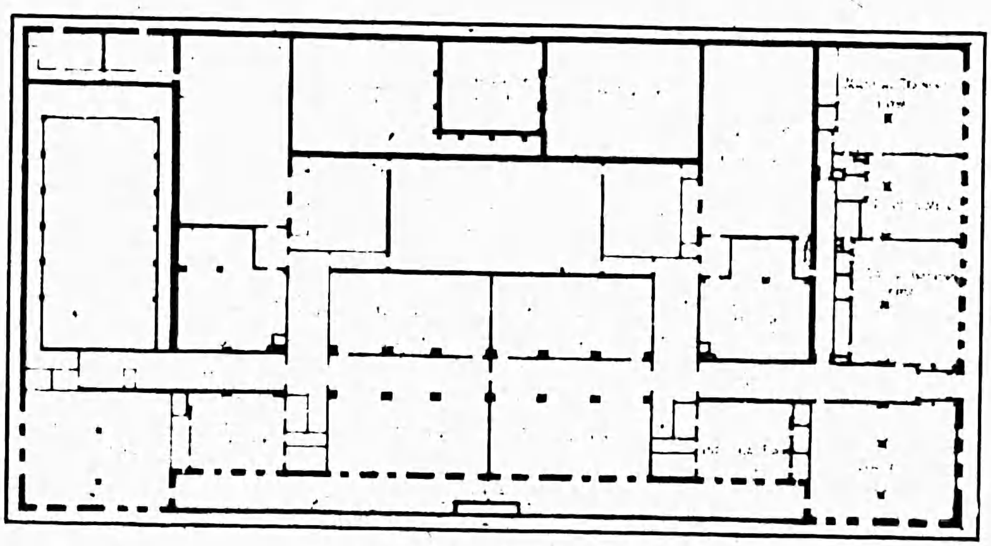
ELMHURST JUNIOR HIGH SCHOOL, OAKLAND, CALIF. (FIRST-FLOOR PLAN)



ELMHURST JUNIOR HIGH SCHOOL, OAKLAND, CALIF. (SECOND-FLOOR PLAN)

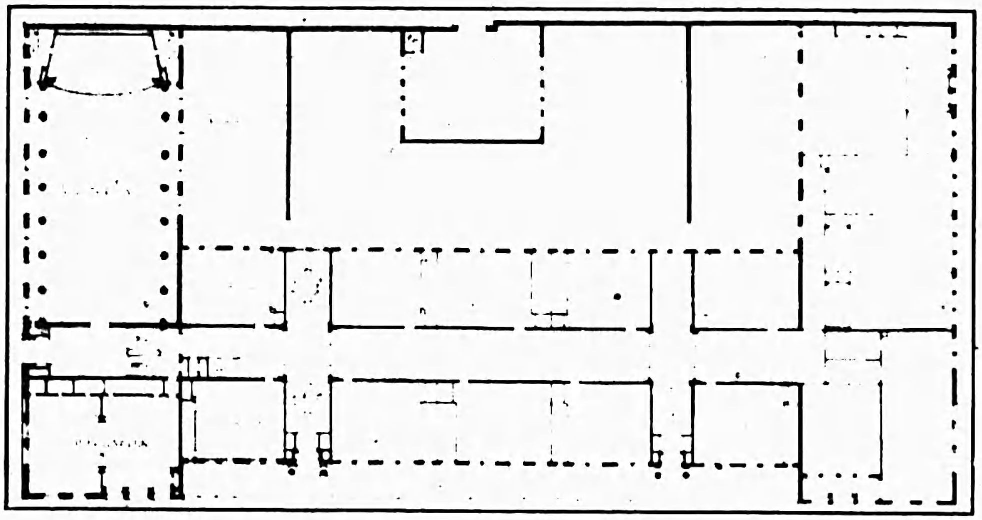


A. PERSPECTIVE

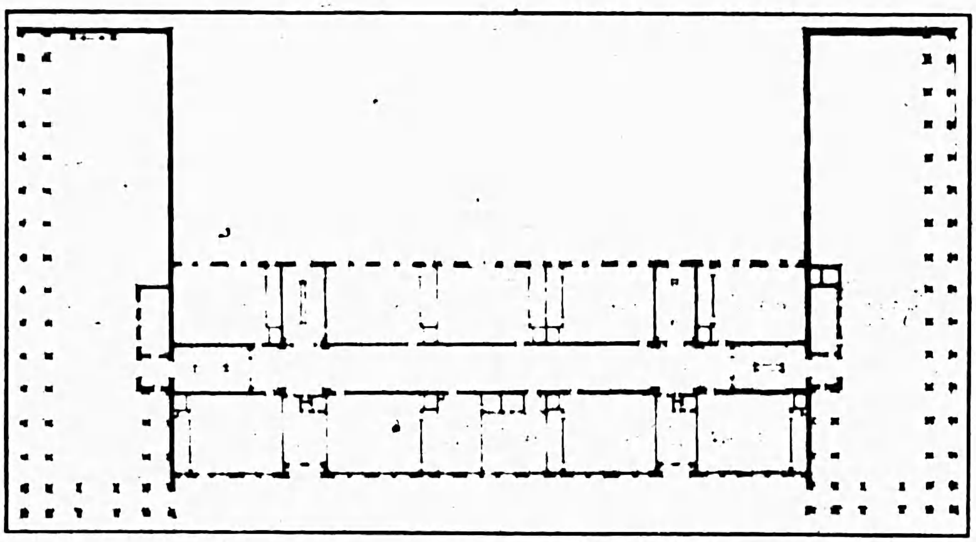


B. BASEMENT PLAN

LAFAYETTE BLOOM JUNIOR HIGH SCHOOL, CINCINNATI, OHIO. GARBER & WOODWARD, ARCHITECTS

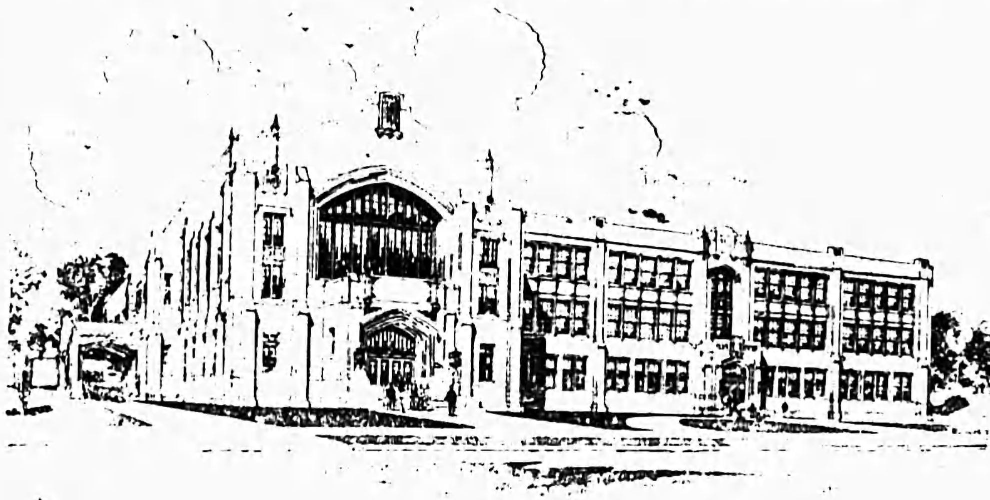


A. FIRST-FLOOR PLAN

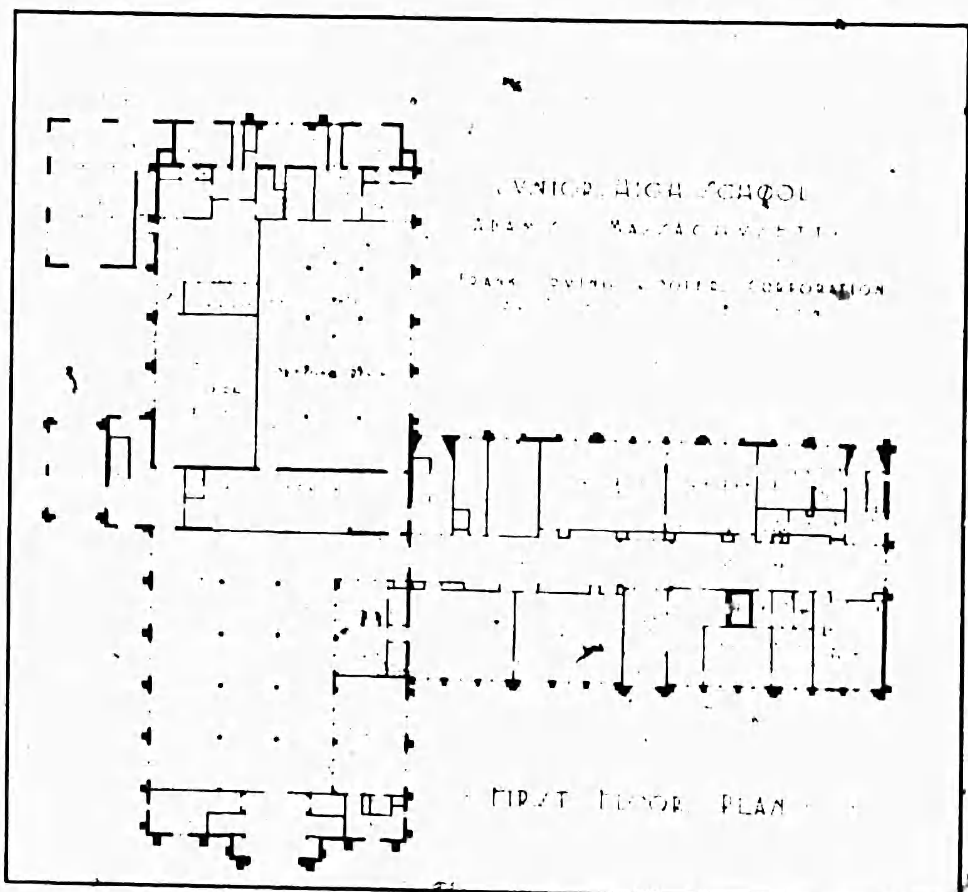


B. SECOND-FLOOR PLAN

LAFAYETTE BLOOM JUNIOR HIGH SCHOOL, CINCINNATI, OHIO

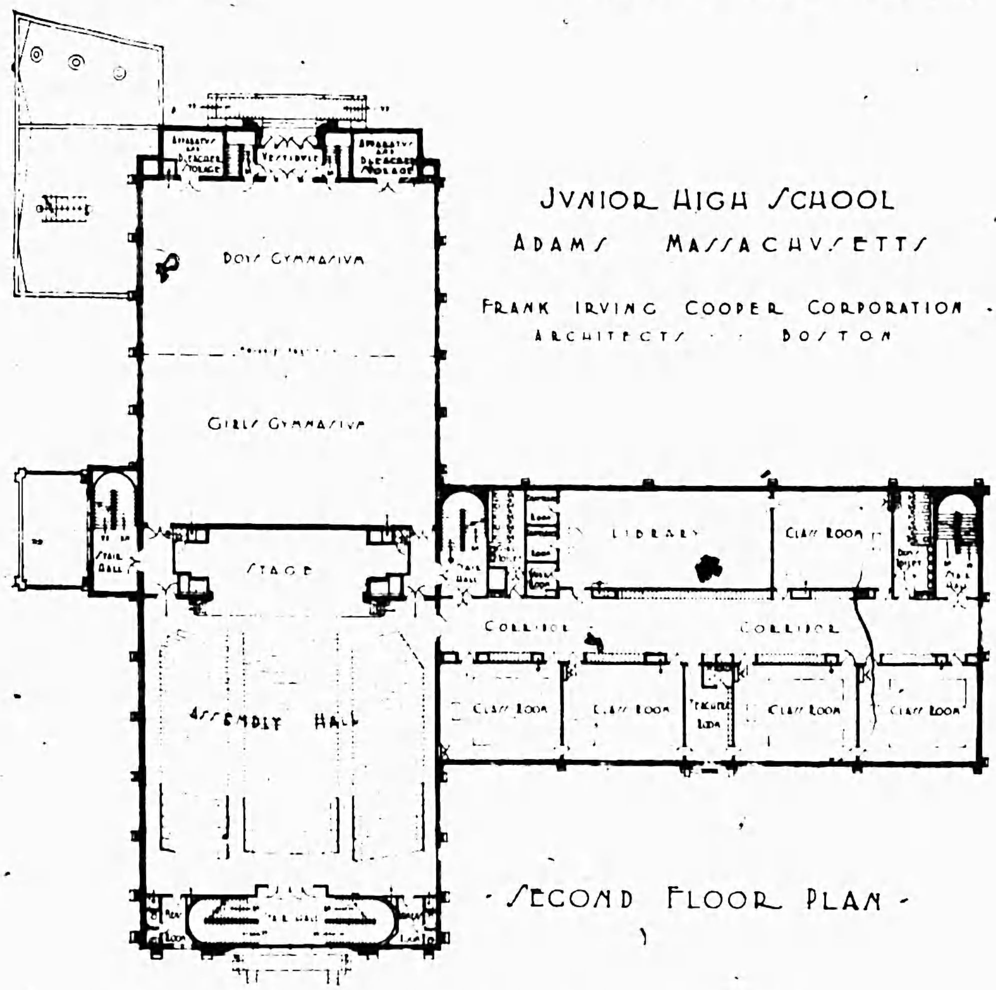


A. PERSPECTIVE

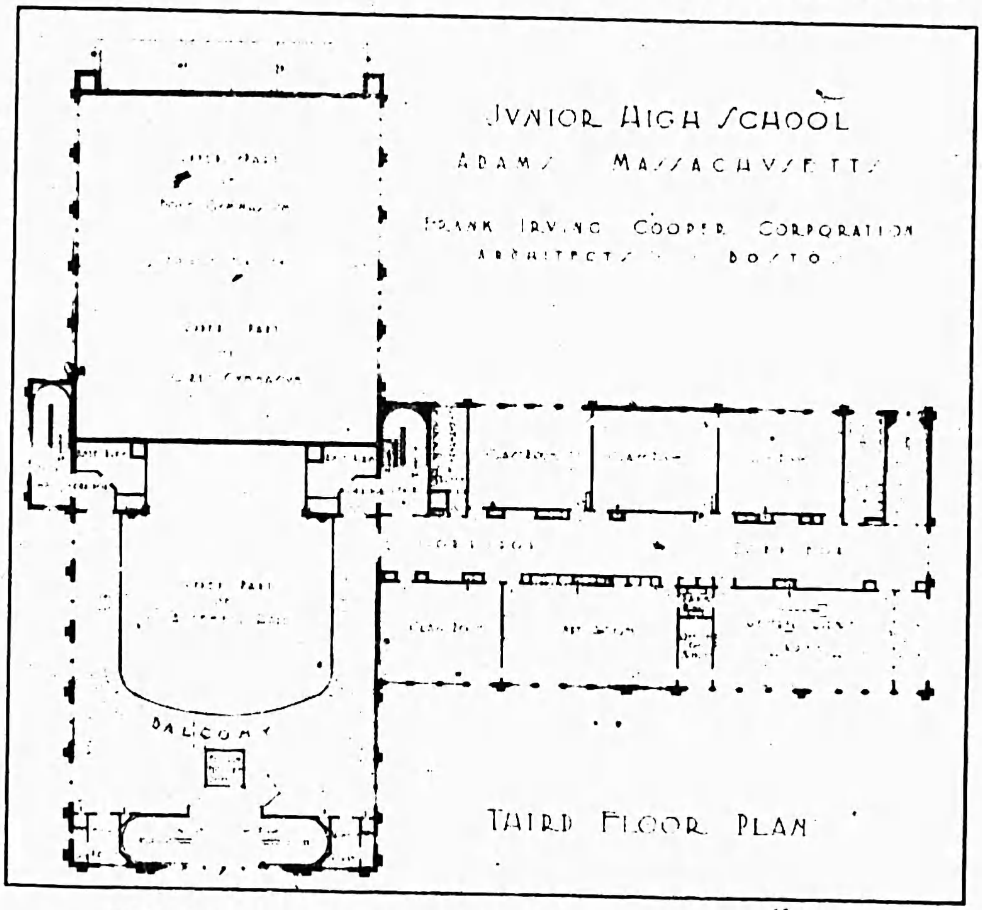


B. FIRST-FLOOR PLAN

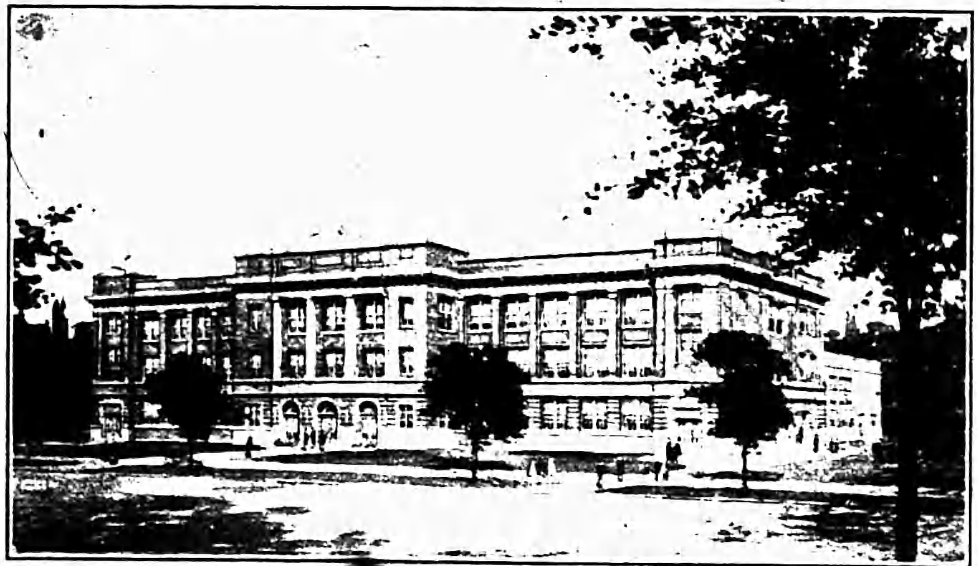
JUNIOR HIGH SCHOOL ADAMS, MASS. FRANK IRVING COOPER CORP., ARCHITECTS



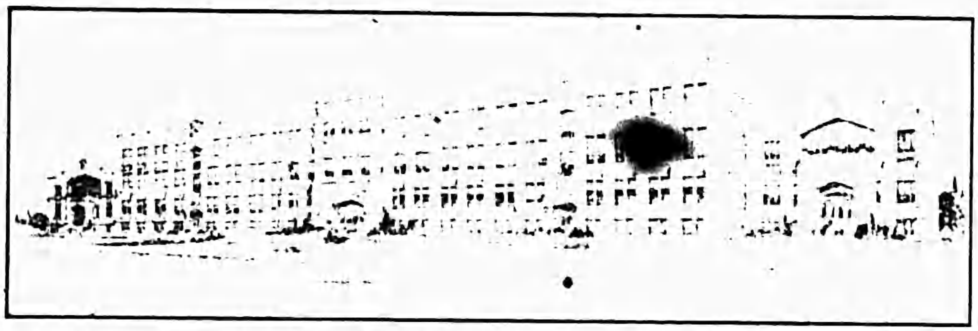
JUNIOR HIGH SCHOOL, ADAMS, MASS. (SECOND-FLOOR PLAN)



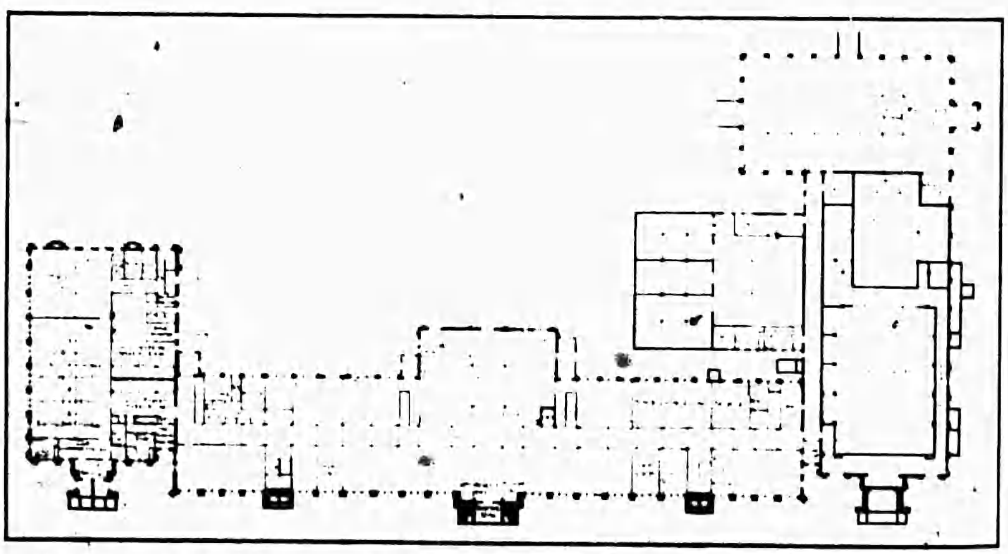
JUNIOR HIGH SCHOOL, ADAMS, MASS. (THIRD-FLOOR PLAN)



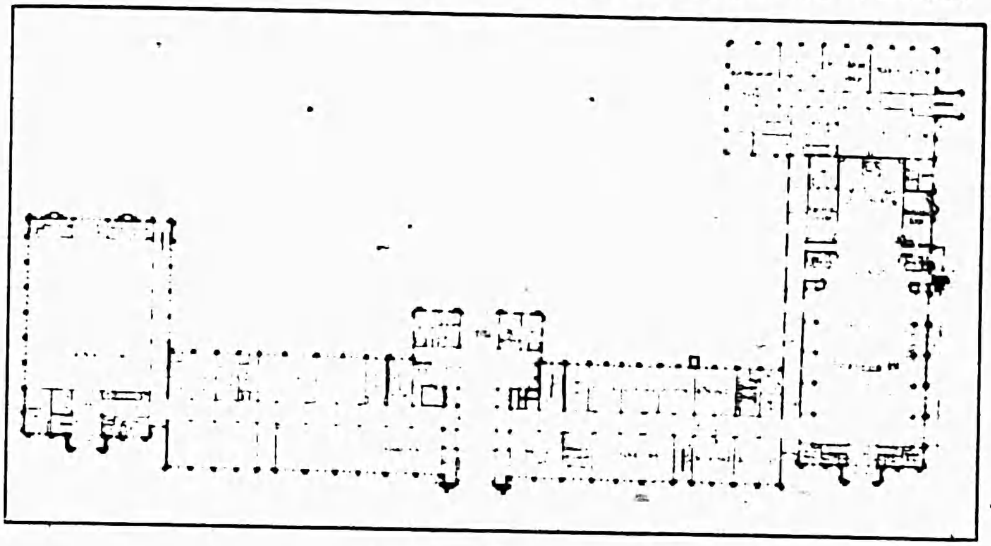
A. OWENSBORO HIGH SCHOOL, OWENSBORO, KY. A. F. HUSSANDER, ARCHITECT



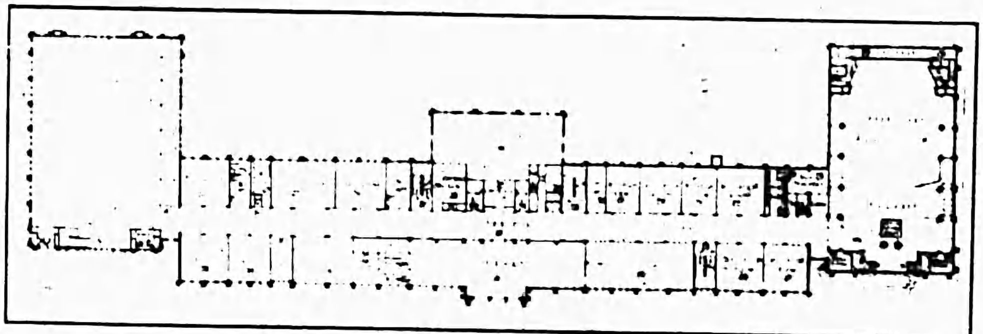
B. THOMAS SNELL WEAVER MEMORIAL HIGH SCHOOL, HARTFORD, CONN. (PERSPECTIVE.) FRANK IRVING COOPER CORP., ARCHITECTS



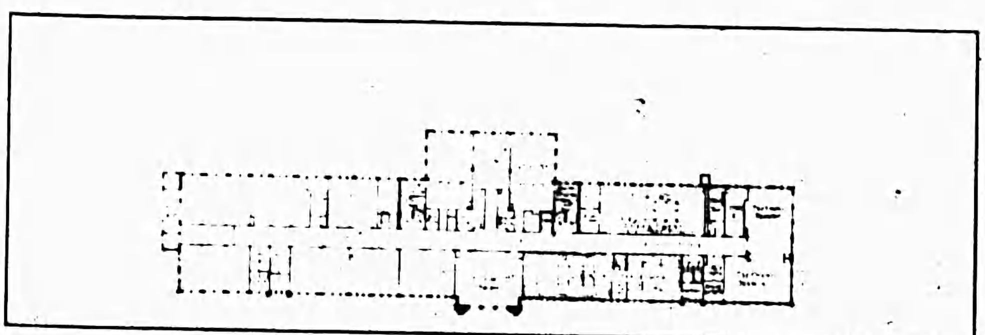
C. THOMAS SNELL WEAVER MEMORIAL HIGH SCHOOL, HARTFORD, CONN. (GROUND-FLOOR PLAN)



A. FIRST-FLOOR PLAN

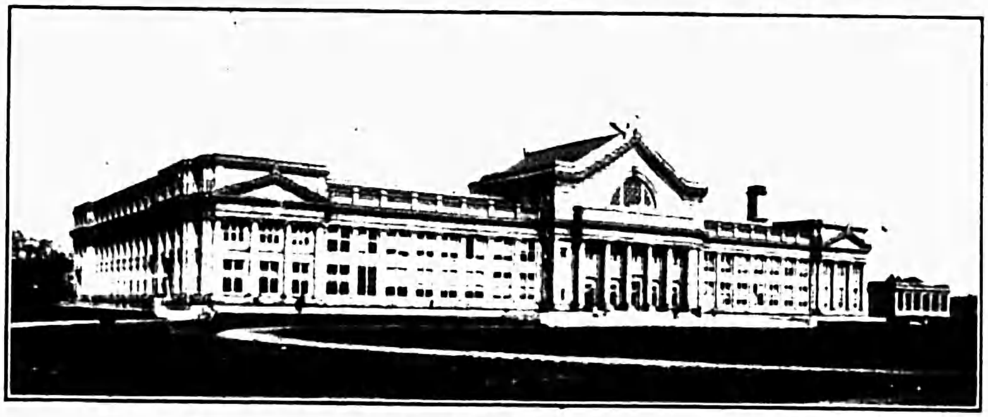


B. SECOND-FLOOR PLAN

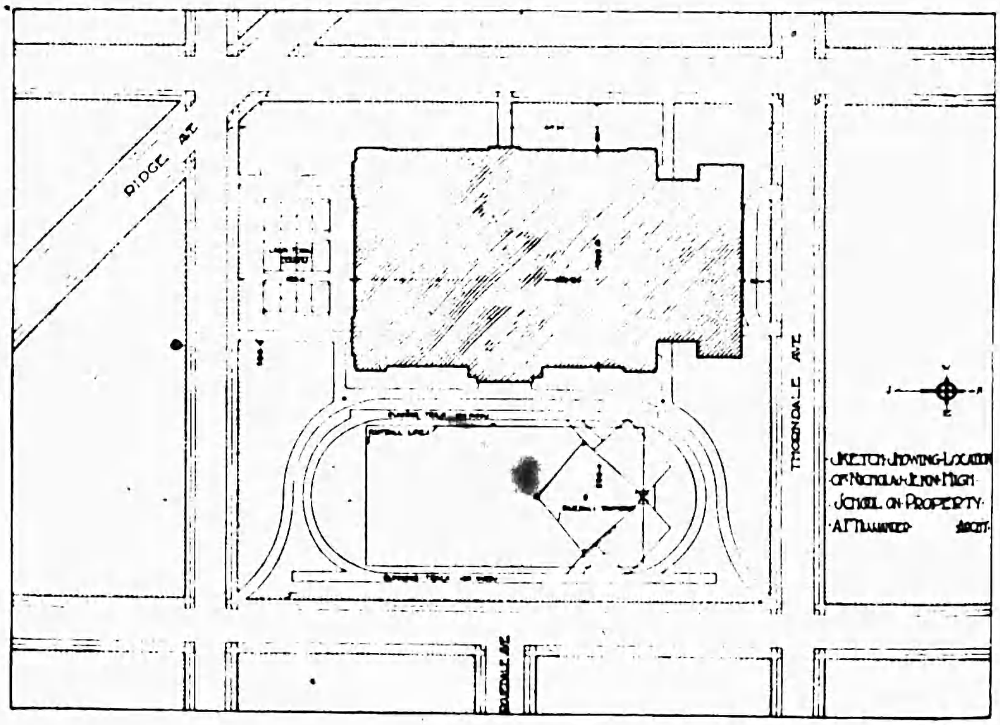


C. THIRD-FLOOR PLAN

THOMAS SNELL WEAVER MEMORIAL HIGH SCHOOL, HARTFORD, CONN.
FRANK IRVING COOPER CORP., ARCHITECTS

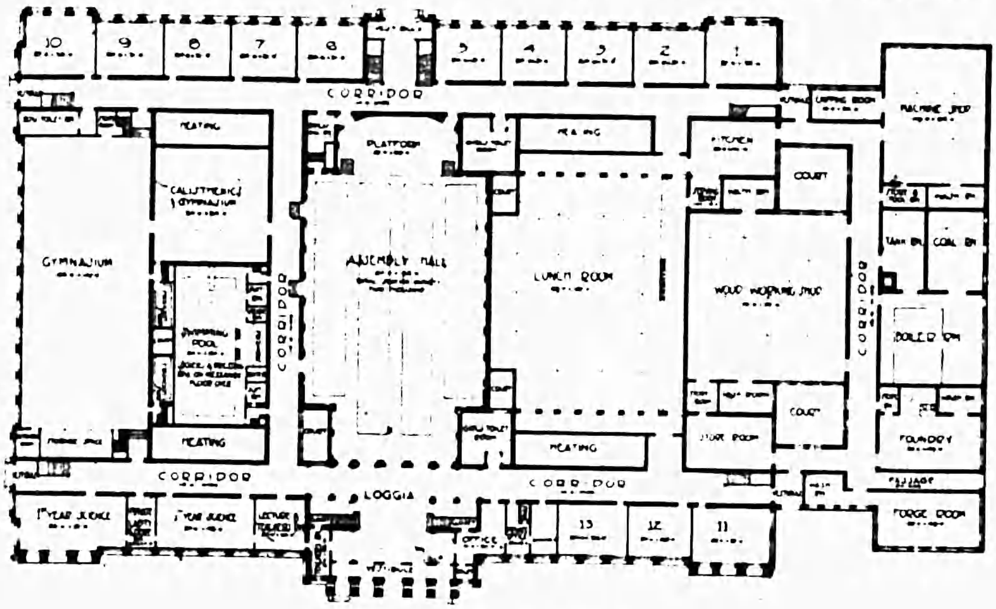


A. PERSPECTIVE

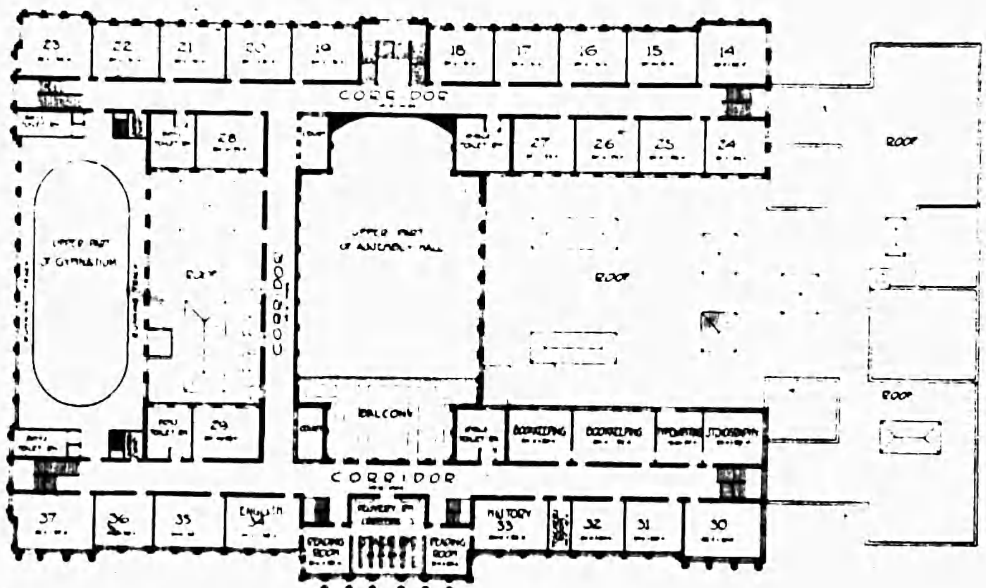


B. GROUNDS

NICHOLAS SENN HIGH SCHOOL, CHICAGO, ILL. A. F. HUSSANDER, ARCHITECT

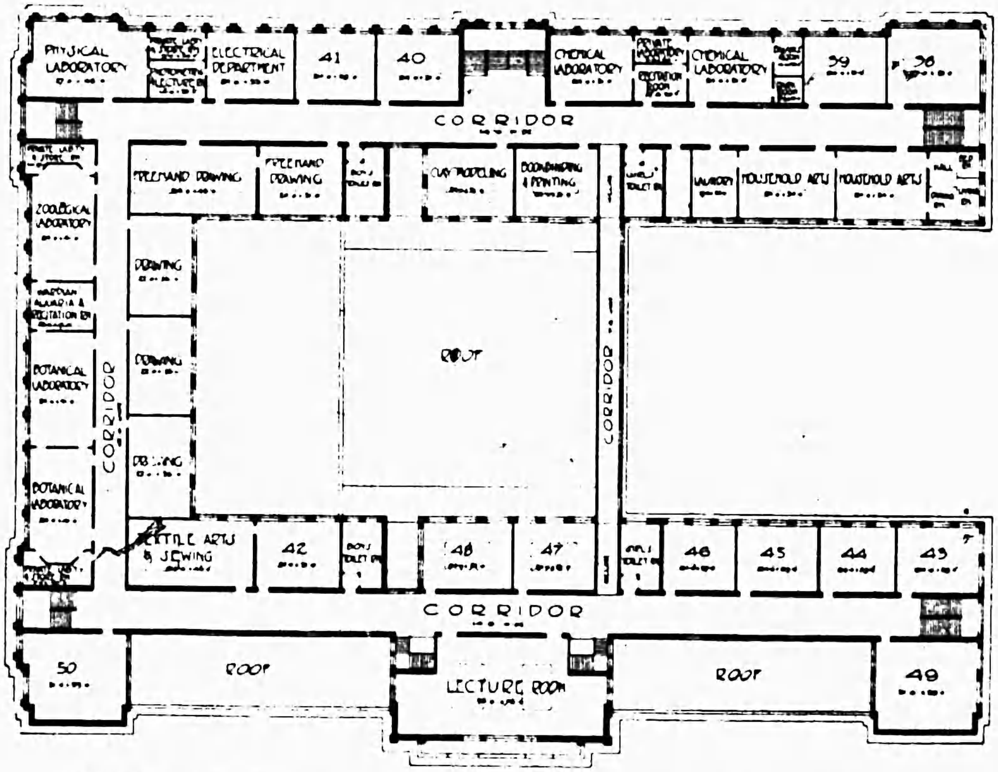


A. FIRST FLOOR PLAN

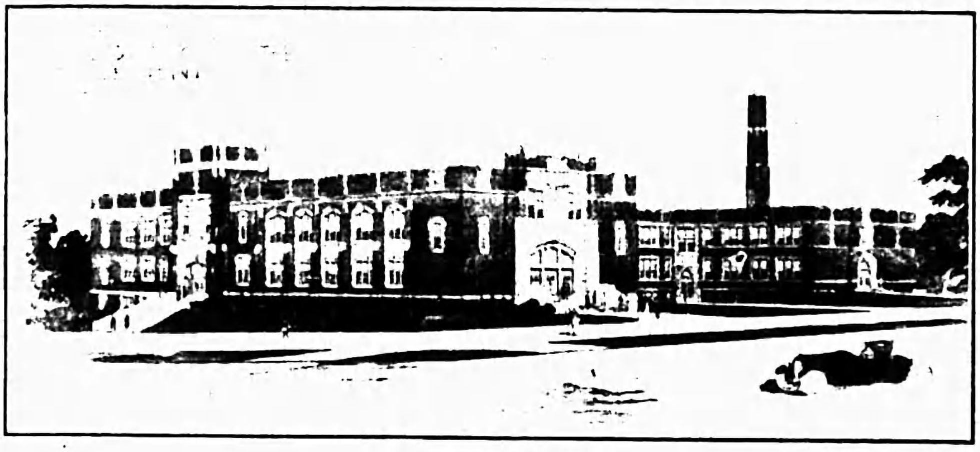


B. SECOND-FLOOR PLAN

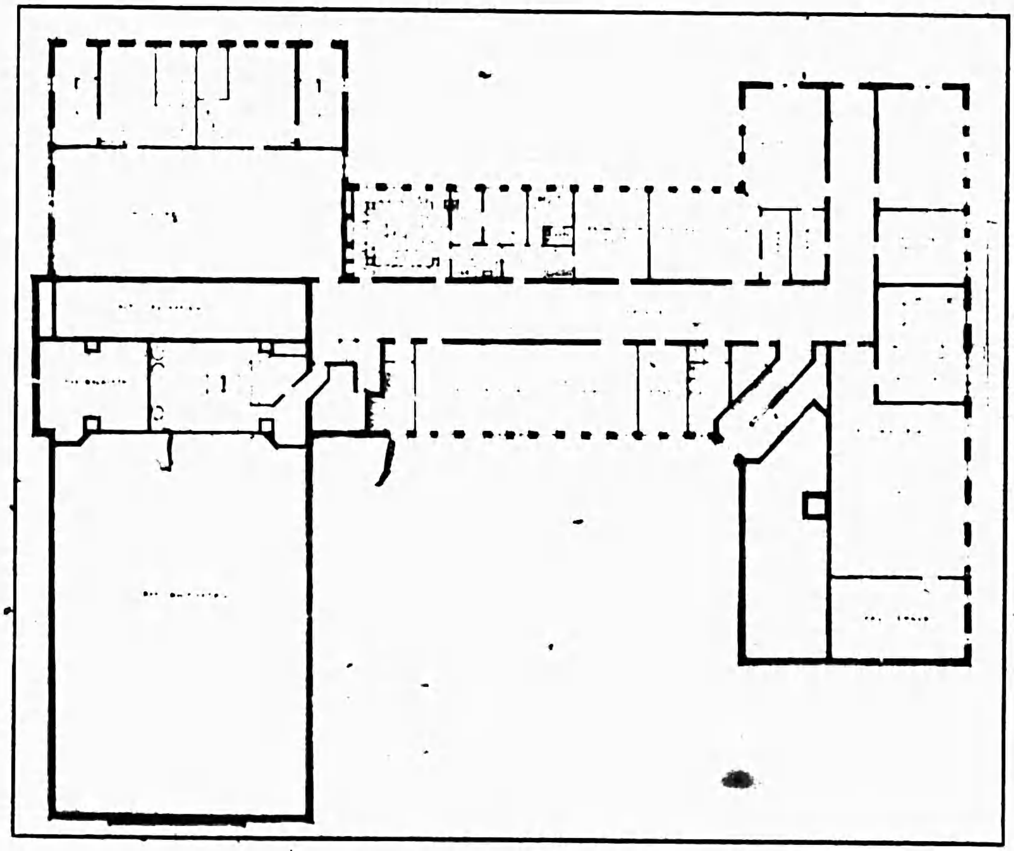
NICHOLAS SENN HIGH SCHOOL, CHICAGO, ILL.



NICHOLAS SENN HIGH SCHOOL, CHICAGO, ILL. (THIRD-FLOOR PLAN)

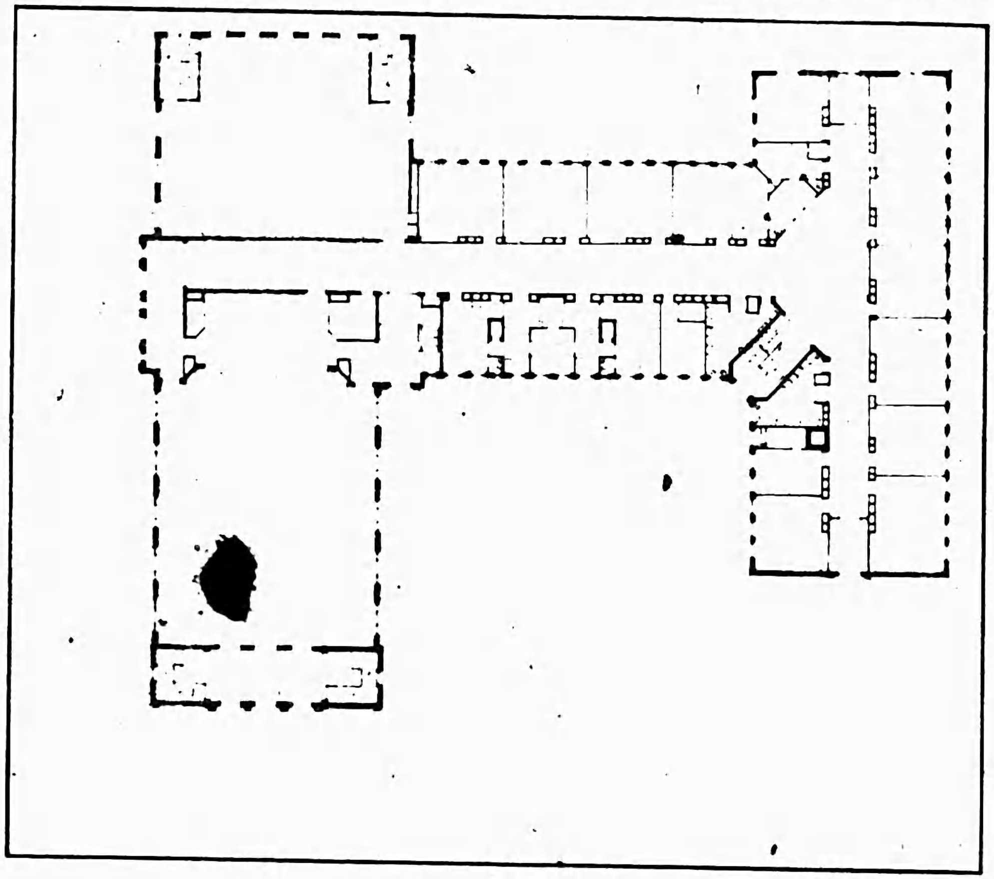


A. PERSPECTIVE

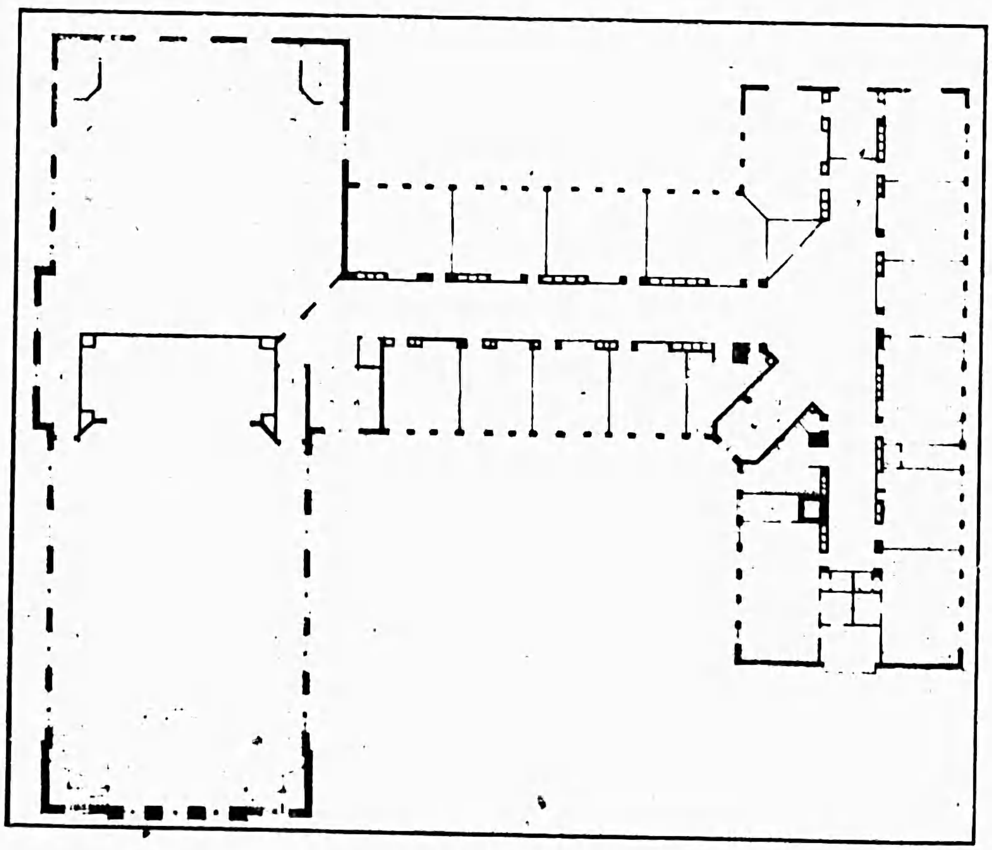


B. GROUND-FLOOR PLAN

HIGH SCHOOL, MEADVILLE, PA. W. G. ECKLES, ARCHITECT

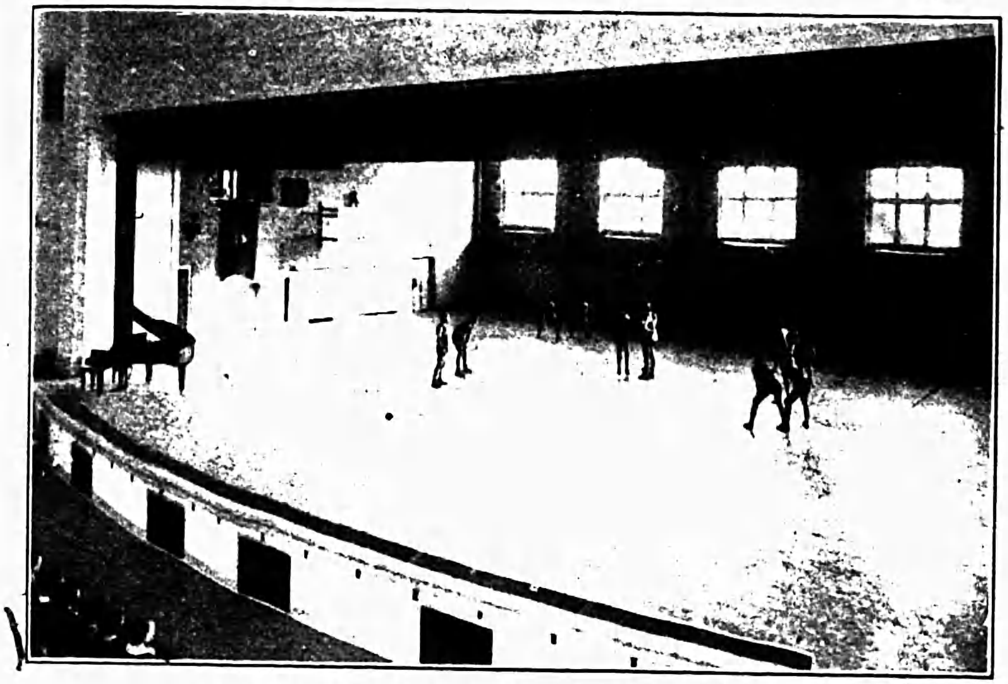


A. FIRST-FLOOR PLAN

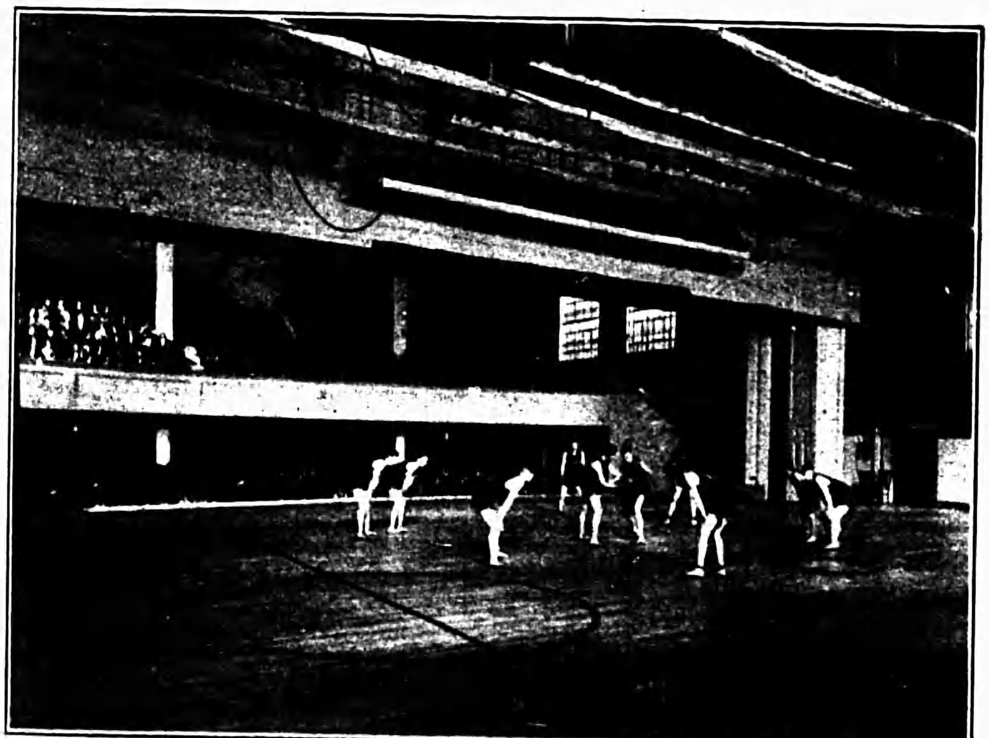


B. SECOND-FLOOR PLAN

HIGH SCHOOL, MEADVILLE, PA.

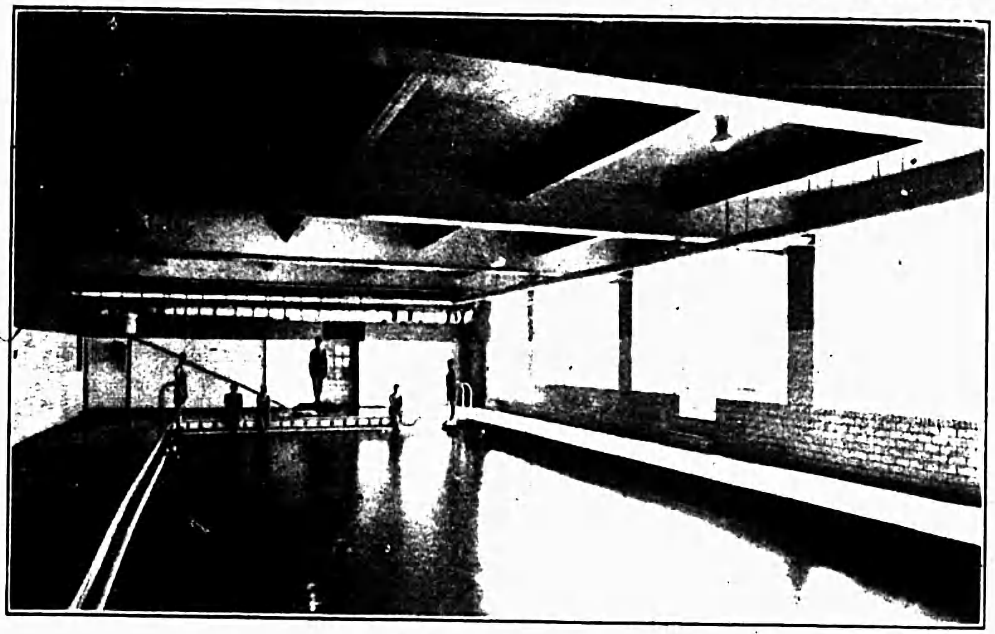


A. GYMNASIUM. (VIEW OF STAGE FROM AUDITORIUM)

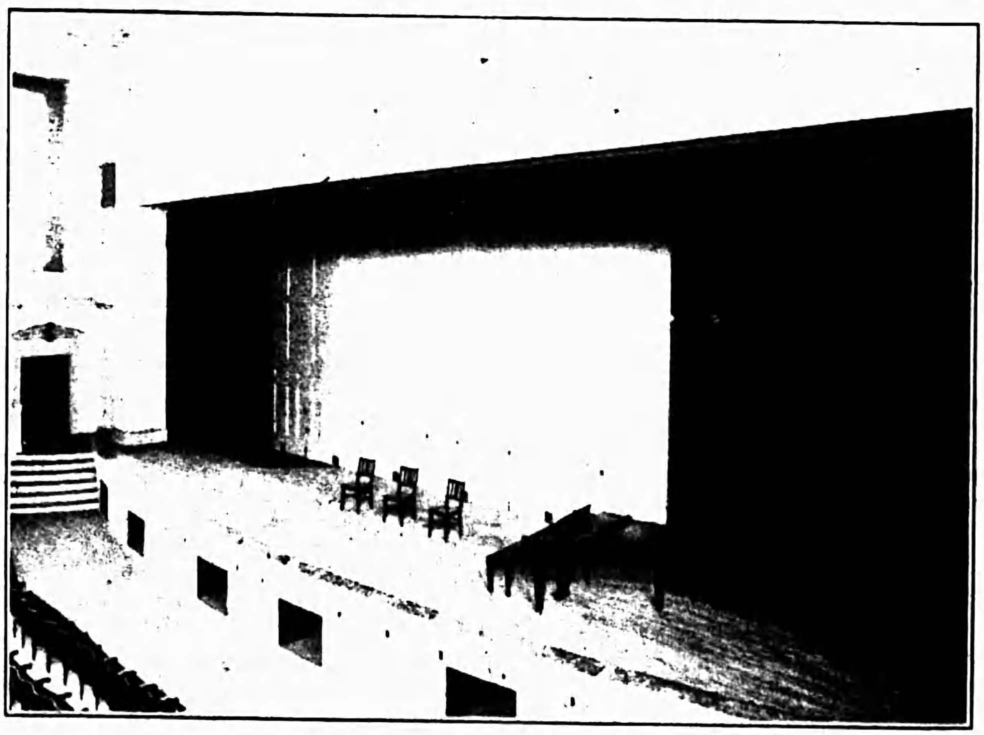


B. GYMNASIUM. (VIEW OF AUDITORIUM FROM STAGE)

HIGH SCHOOL, WATERLOO, IOWA. WILLIAM B. ITTNER, ARCHITECT



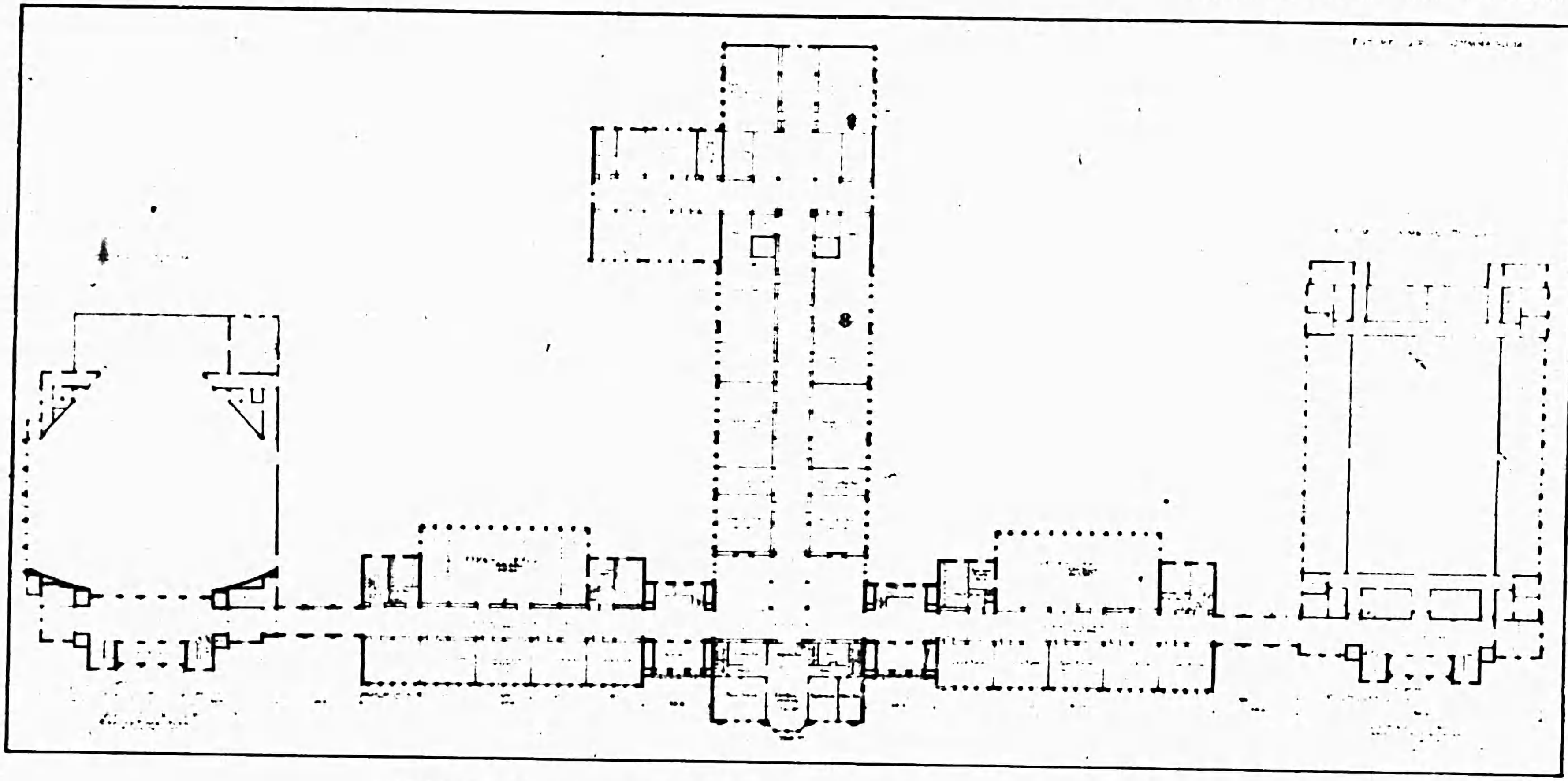
A. SWIMMING POOL



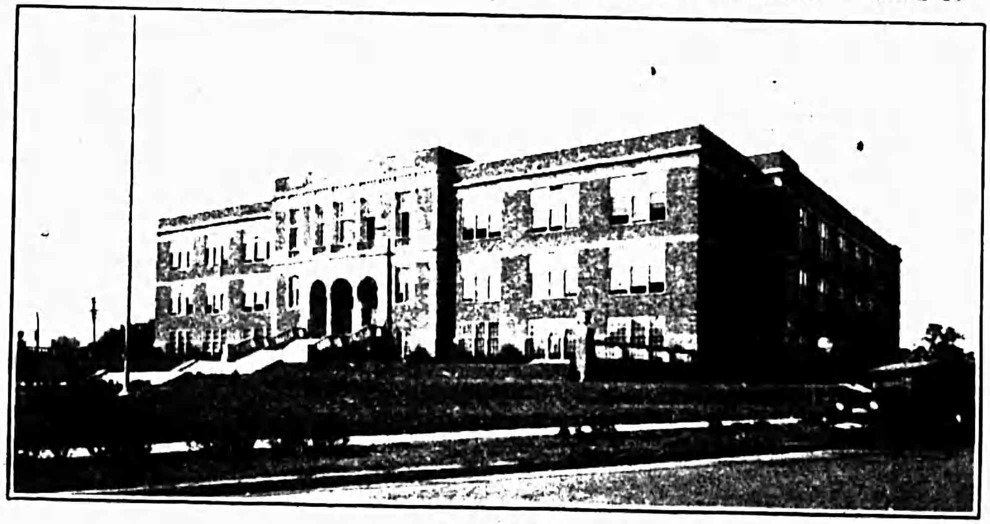
B. VIEW OF PROSCENIUM OPENING

HIGH SCHOOL, WATERLOO, IOWA. WILLIAM B. ITTNER, ARCHITECT

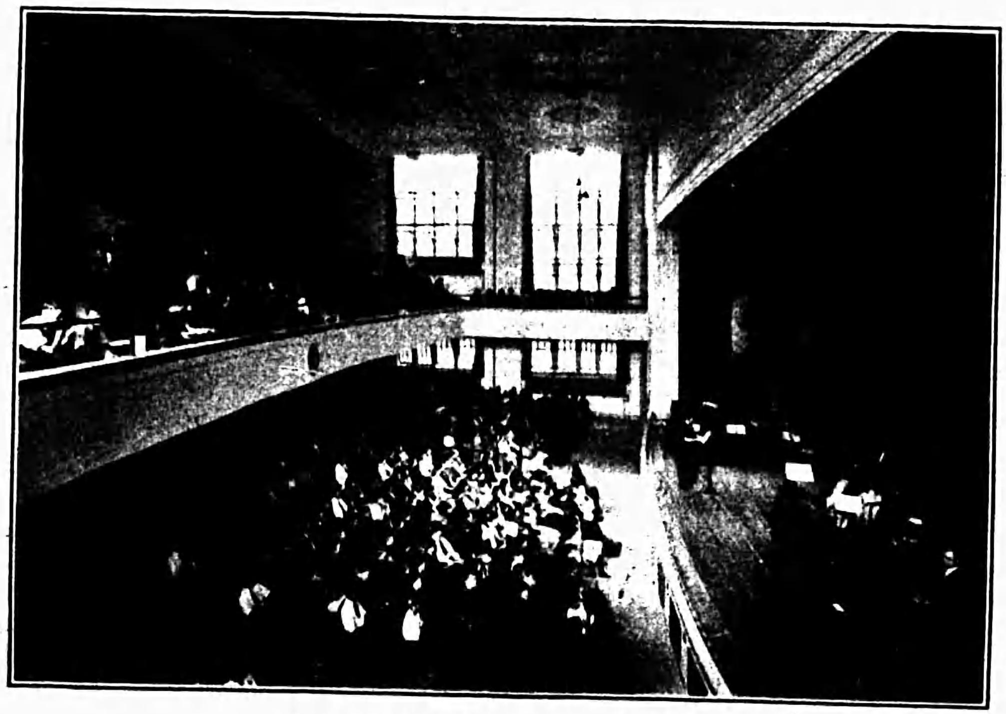
EVANSTON TOWNSHIP HIGH SCHOOL, EVANSTON, ILL., PERKINS, FELLOWS & HAMILTON, ARCHITECTS



EVANSTON TOWNSHIP HIGH SCHOOL, EVANSTON, ILL (GENERAL PLAN)



A. PERSPECTIVE



B. AUDITORIUM WITH SPECTATORS

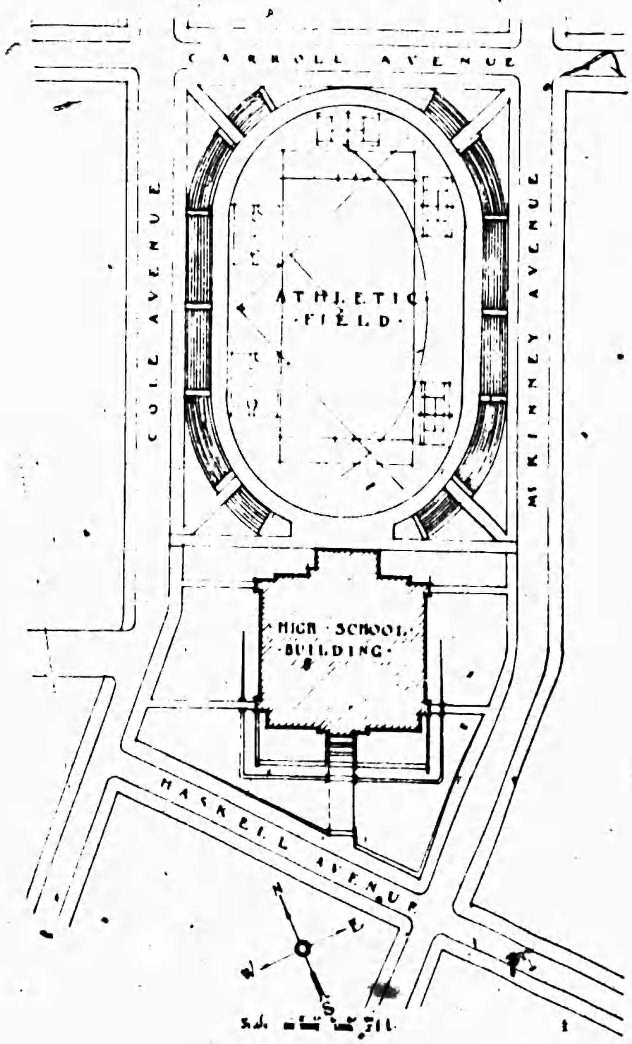
NORTH DALLAS HIGH SCHOOL, TEX. W. B. ITTNER, ARCHITECT

A. COOKING ROOM

B. CHEMISTRY LABORATORY

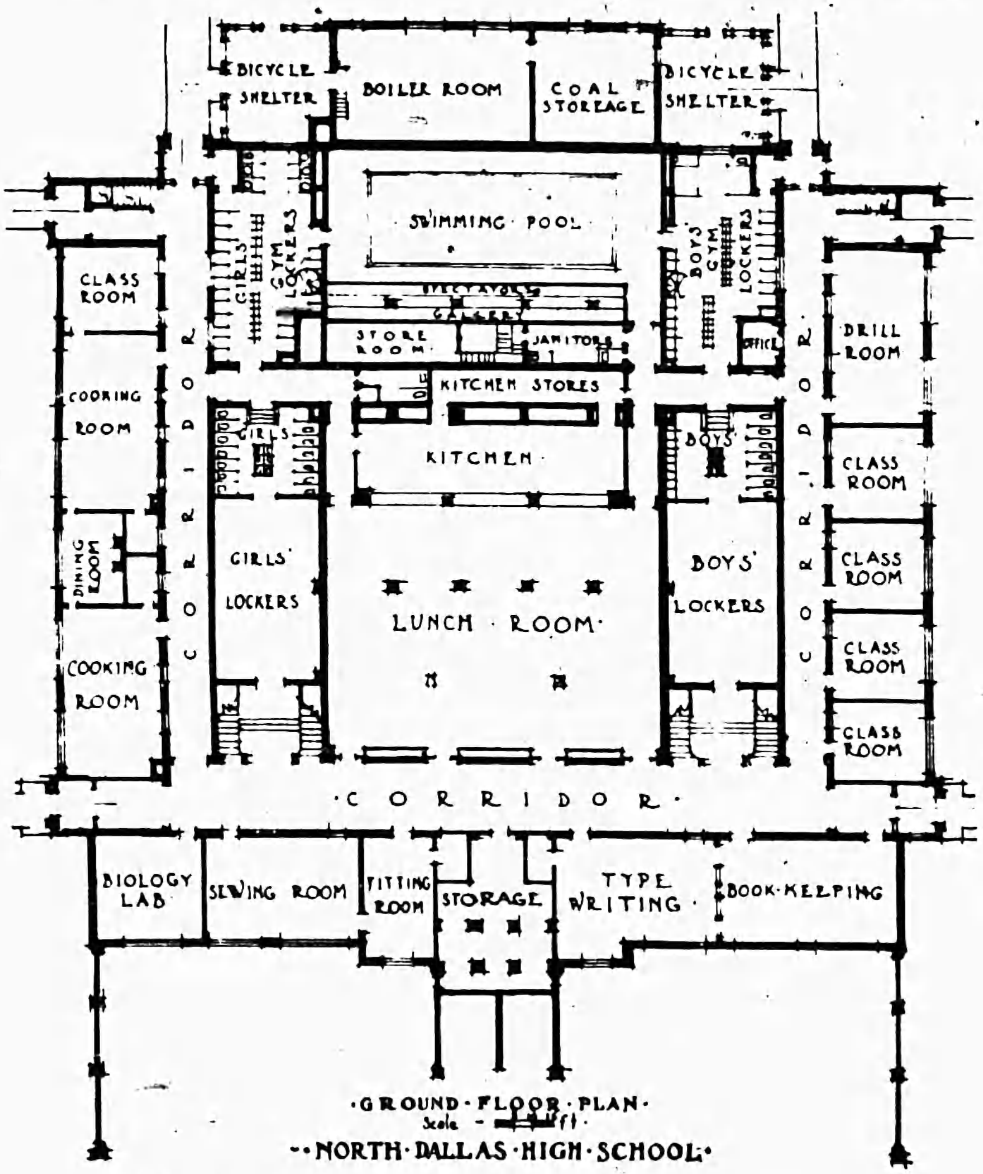
NORTH DALLAS HIGH SCHOOL, TEX.

A. BOYS' LOCKER ROOM

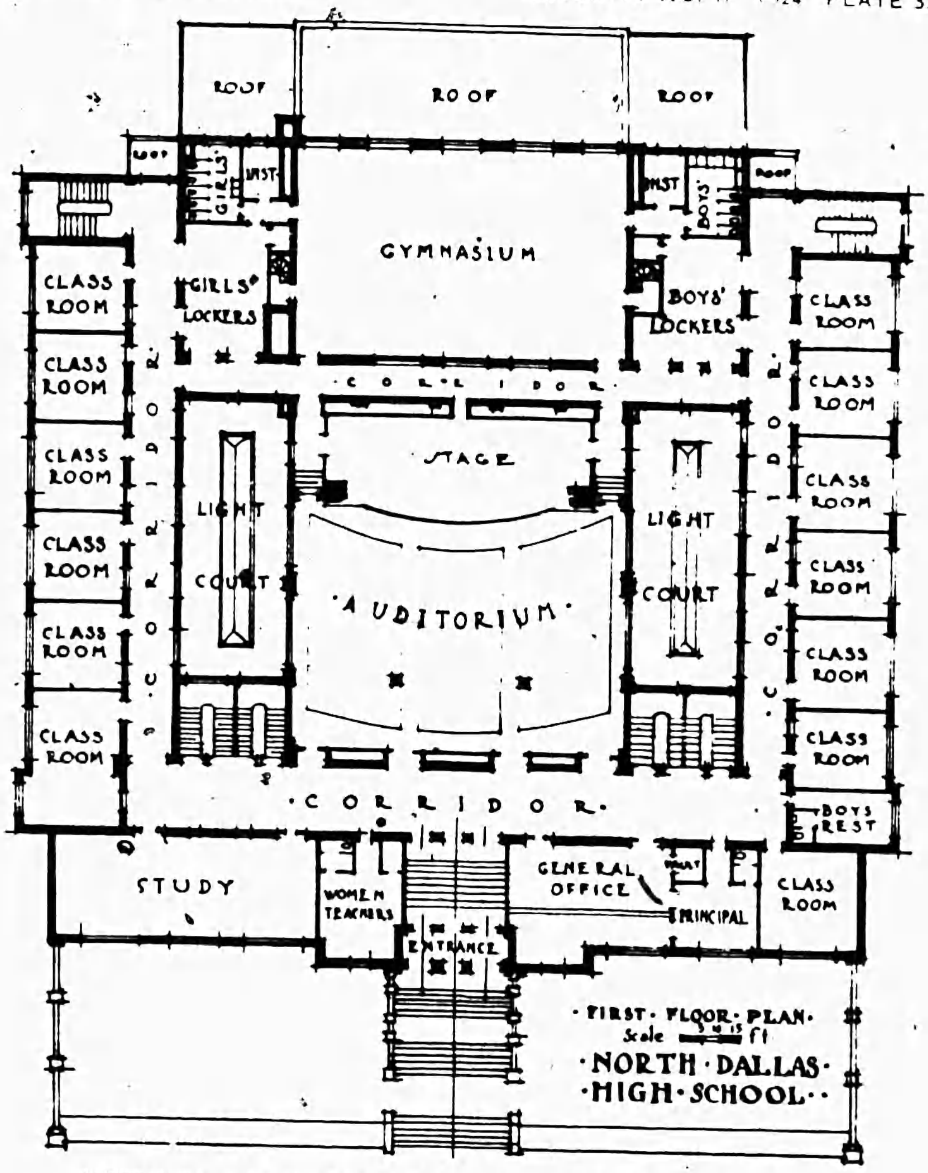


B. BLOCK PLAN

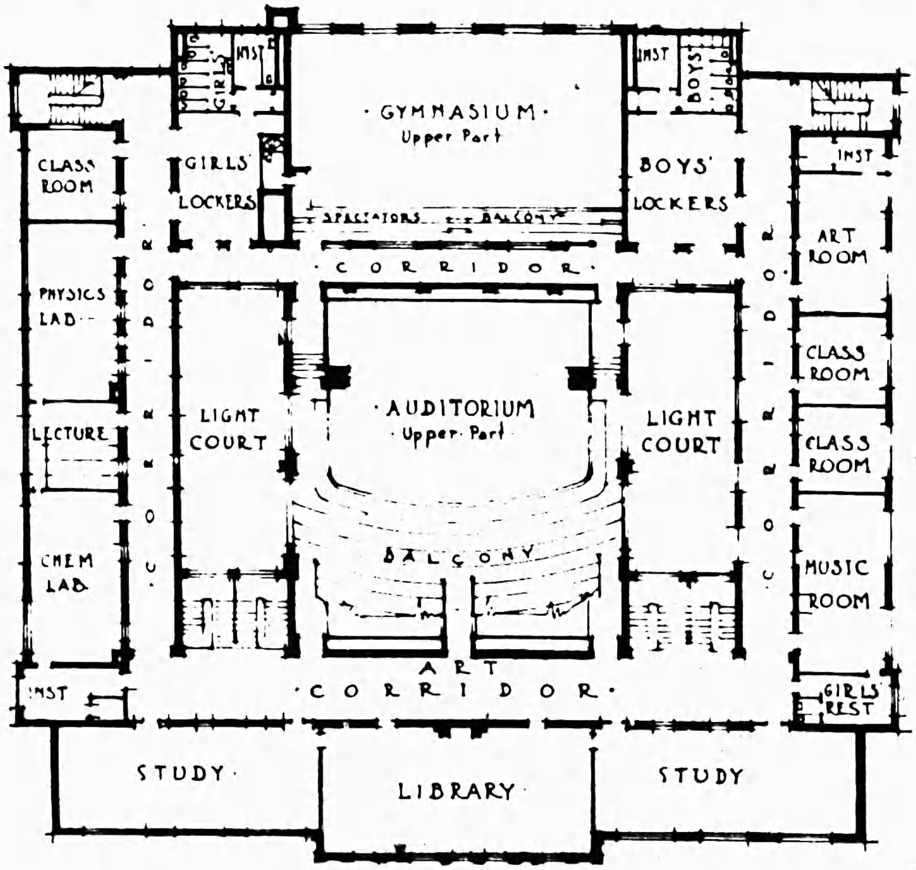
NORTH DALLAS HIGH SCHOOL, TEX.



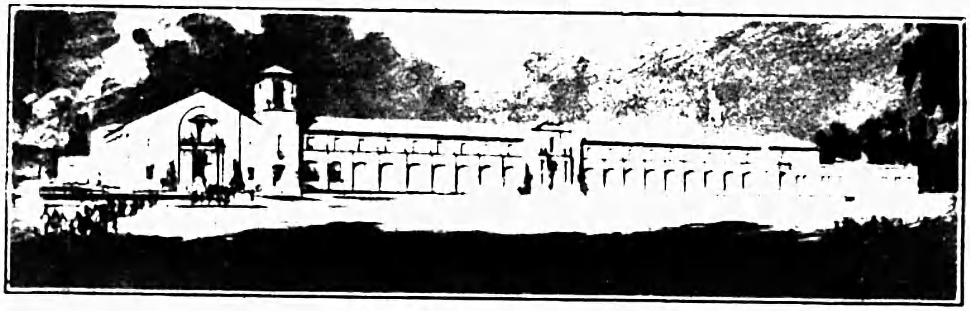
NORTH DALLAS HIGH SCHOOL, TEX. (GROUND-FLOOR PLAN)



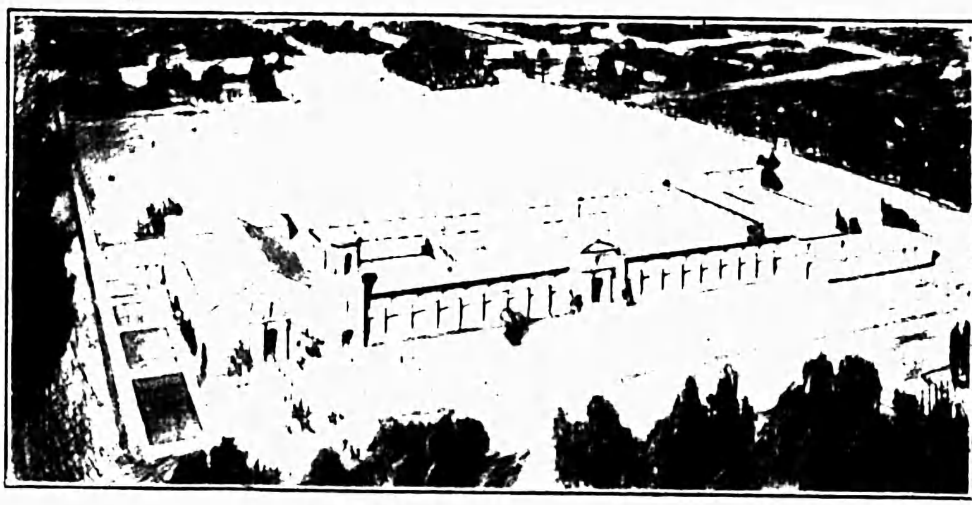
NORTH DALLAS HIGH SCHOOL, TEX. (FIRST-FLOOR PLAN)



NORTH DALLAS HIGH SCHOOL, TEX. (SECOND-FLOOR PLAN)

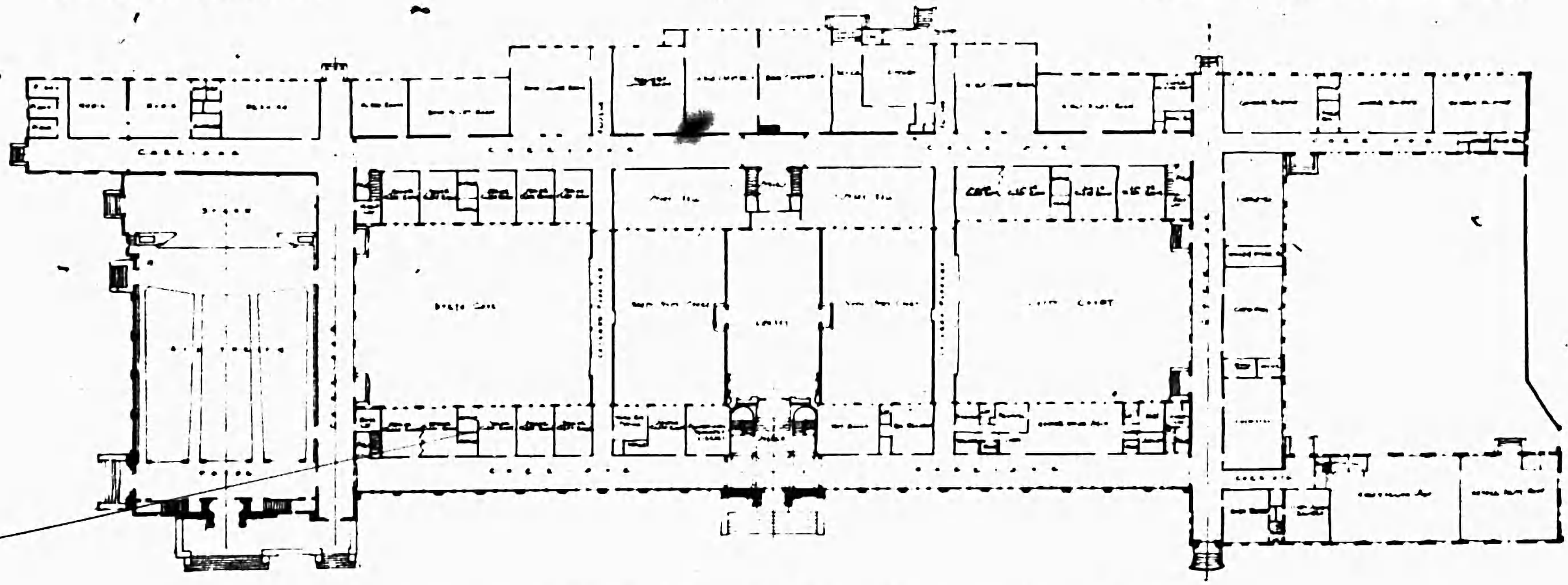


A. FRONT VIEW

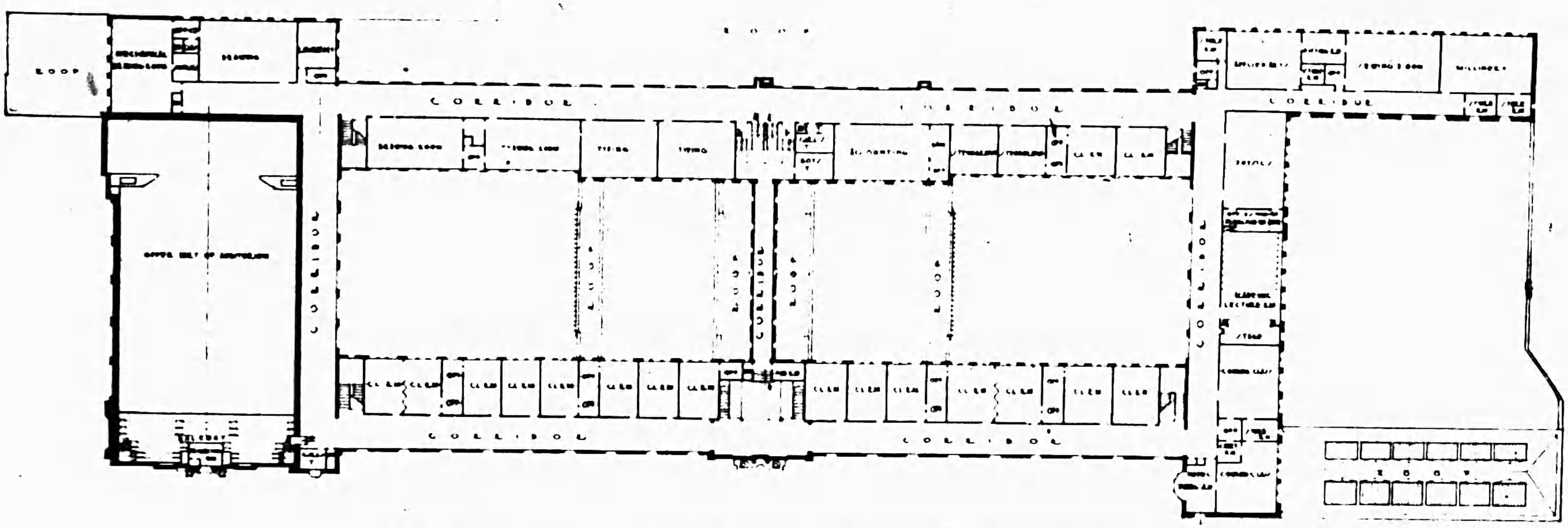


B. BIRD'S-EYE PERSPECTIVE

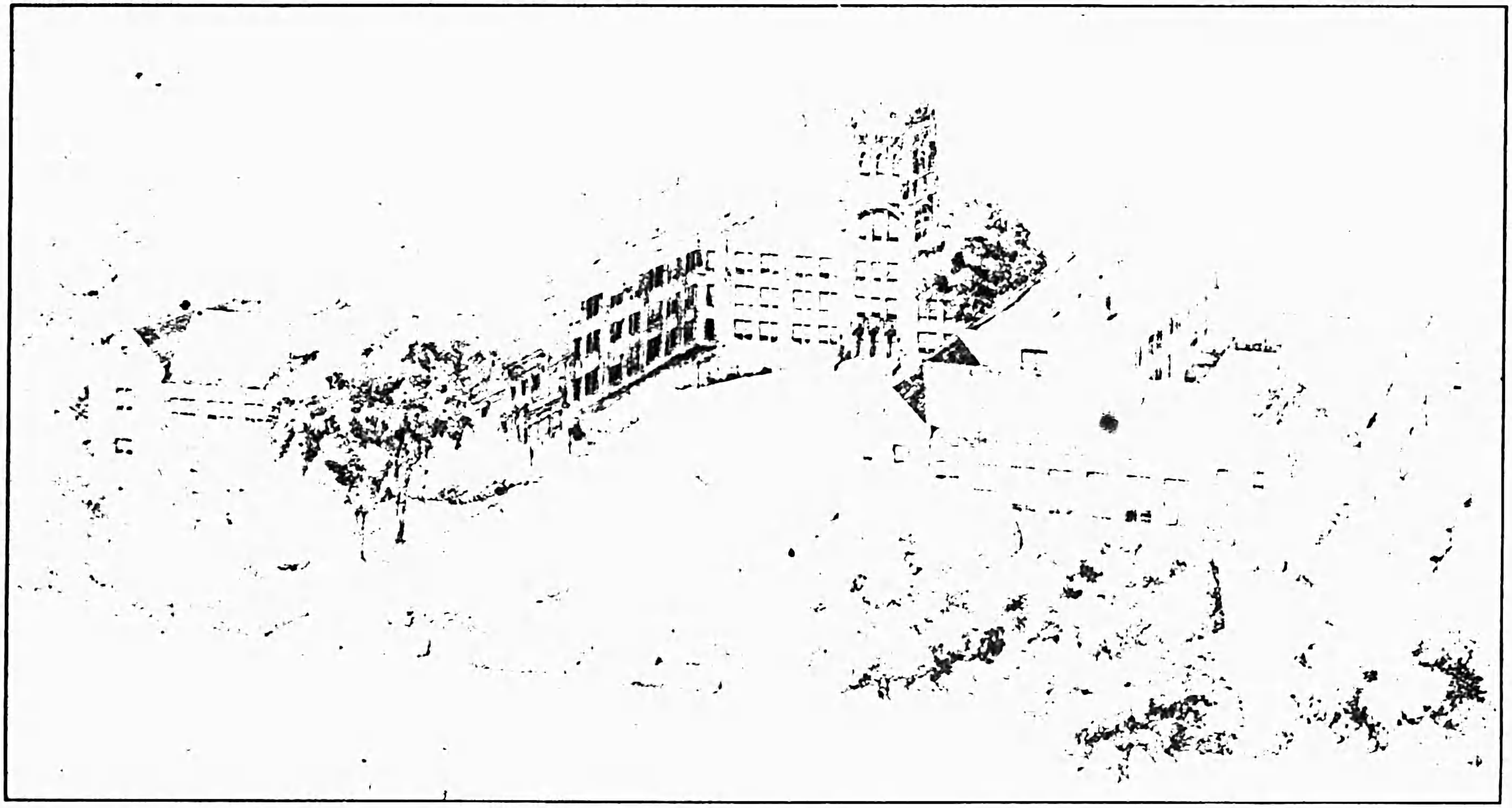
UNIVERSITY HIGH SCHOOL, OAKLAND, CALIF. C. W. DICKEY, ARCHITECT



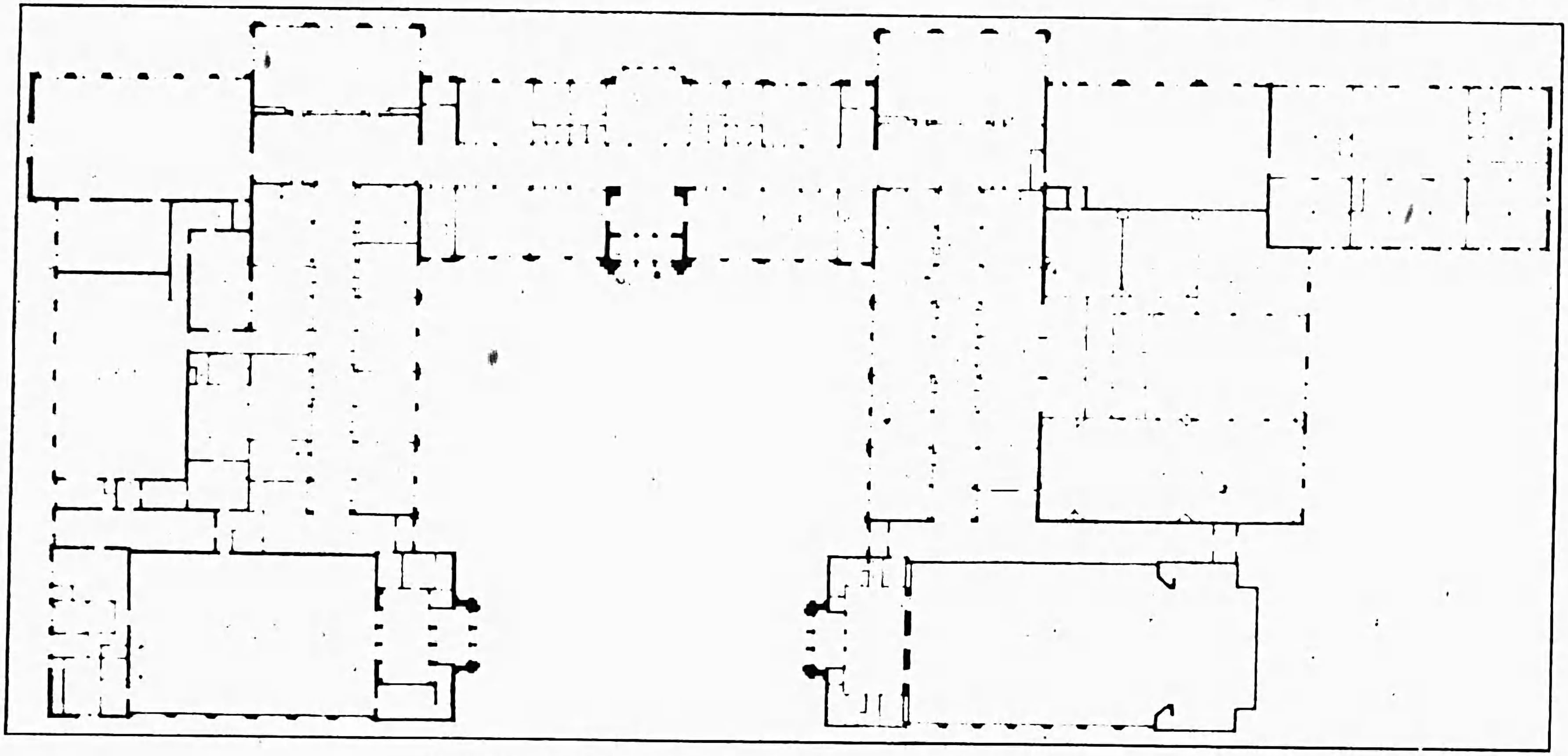
UNIVERSITY HIGH SCHOOL, OAKLAND, CALIF. (FIRST-FLOOR PLAN)



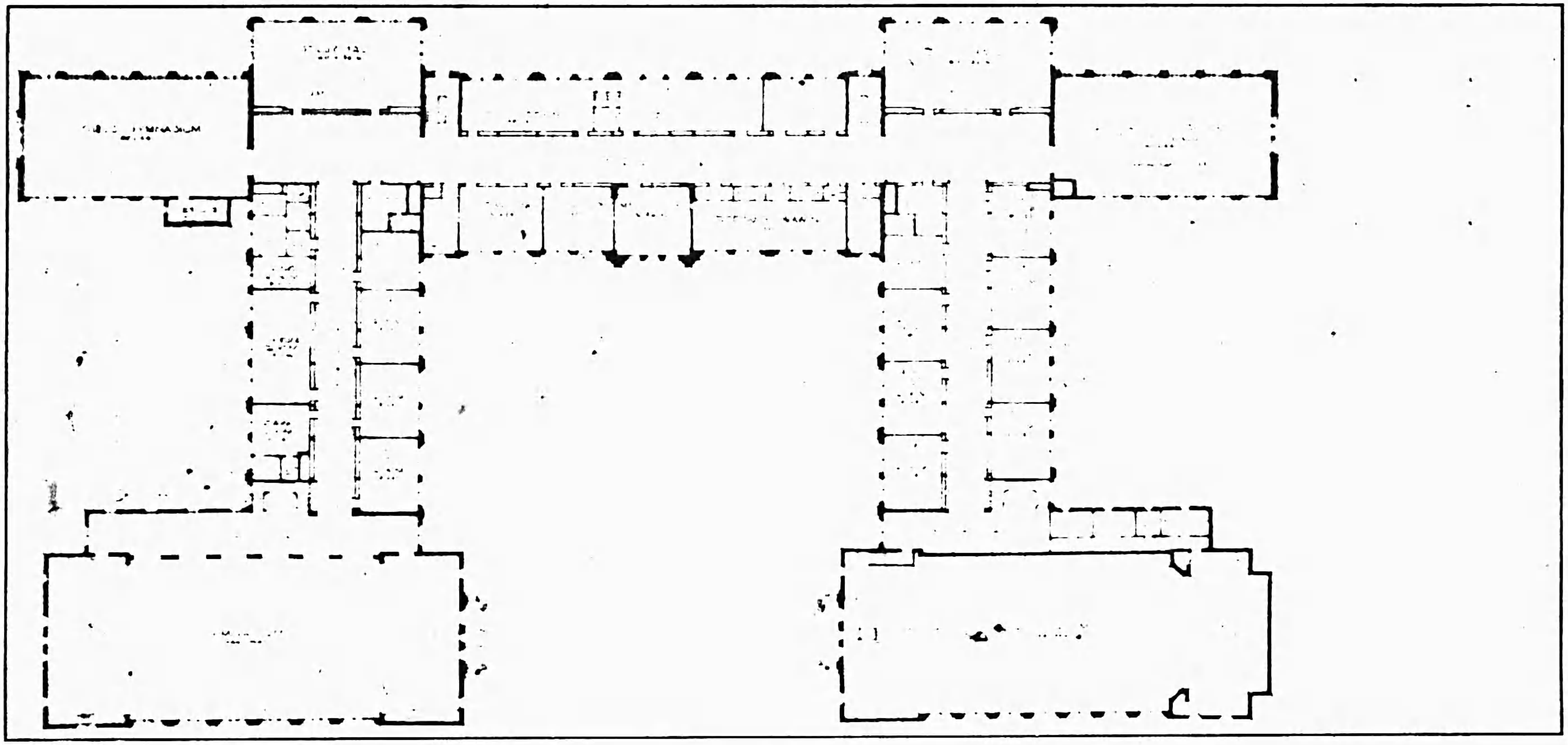
UNIVERSITY HIGH SCHOOL, OAKLAND, CALIF. (SECOND FLOOR PLAN)



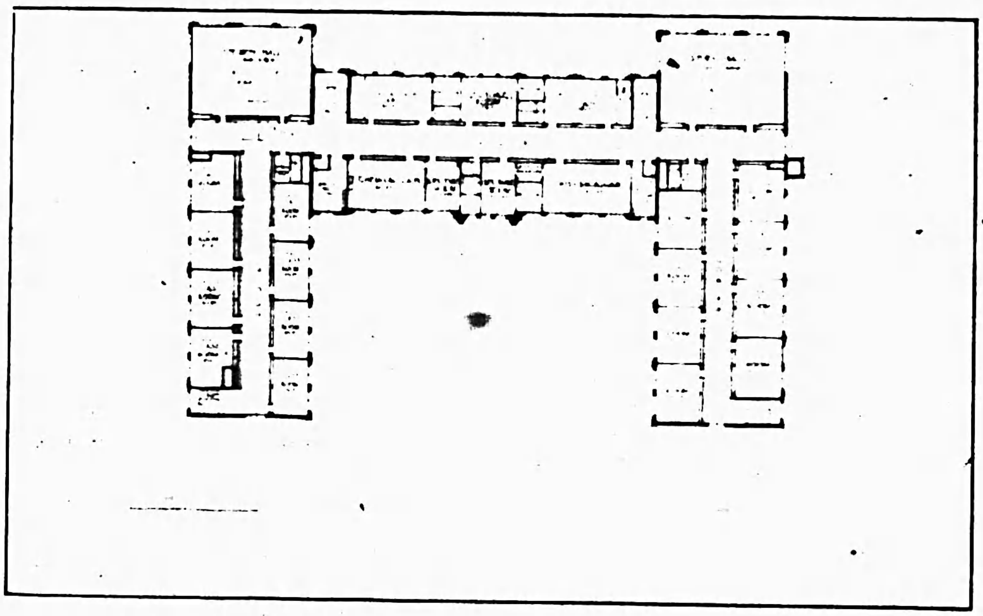
SENIOR HIGH SCHOOL, BAY CITY, MICH. PERKINS, FELLOWS & HAMILTON, ARCHITECTS



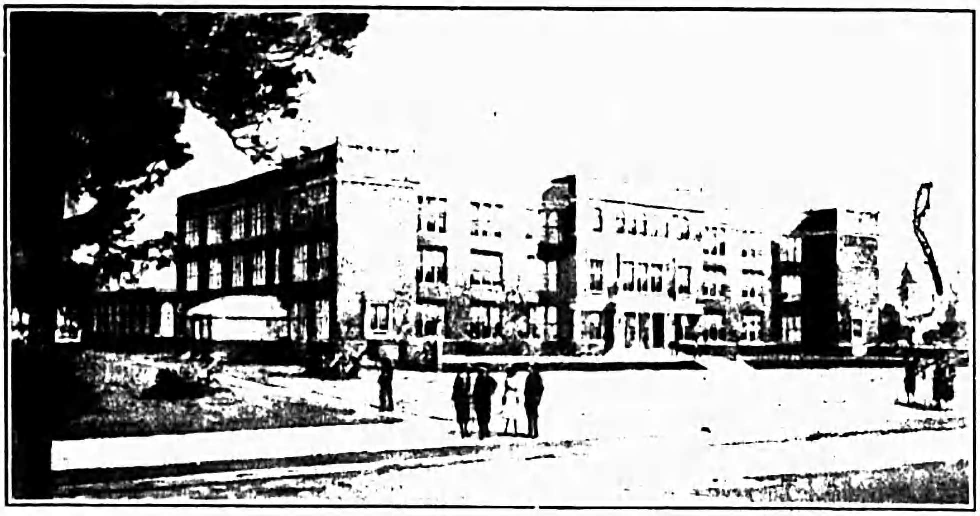
SENIOR HIGH SCHOOL, BAY CITY, MICH. (FIRST-FLOOR PLAN)



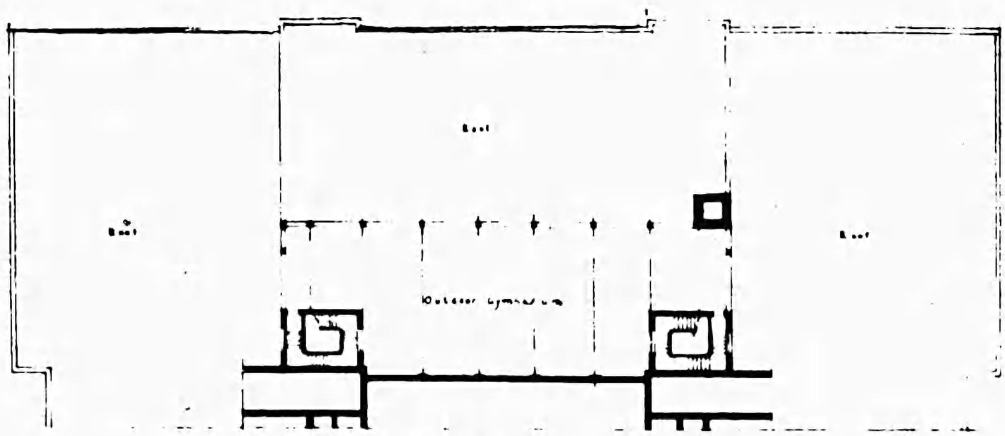
SENIOR HIGH SCHOOL, BAY CITY, MICH. (SECOND FLOOR PLAN)



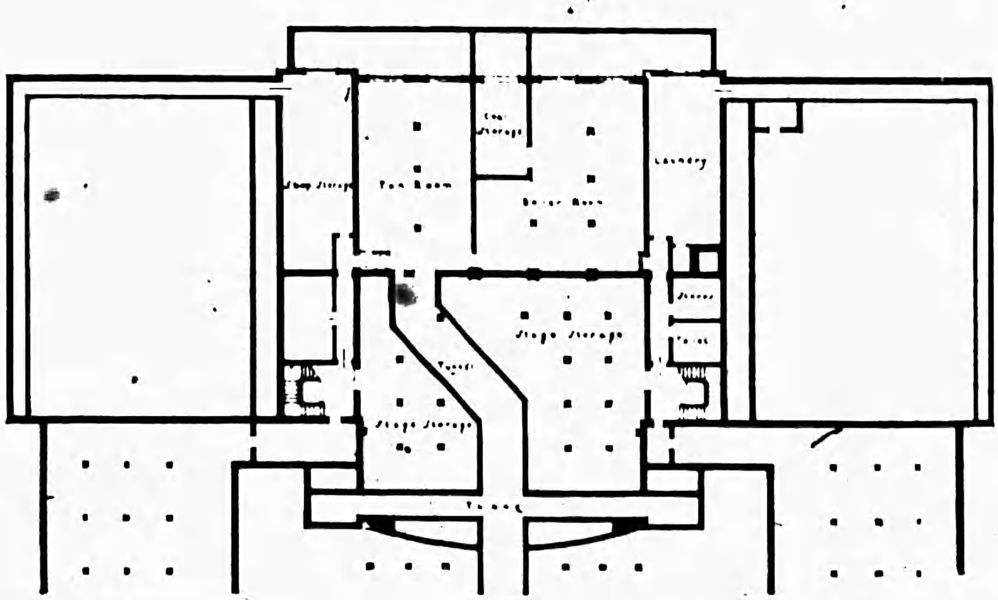
SENIOR HIGH SCHOOL, BAY CITY, MICH. (THIRD-FLOOR PLAN)



A. PERSPECTIVE

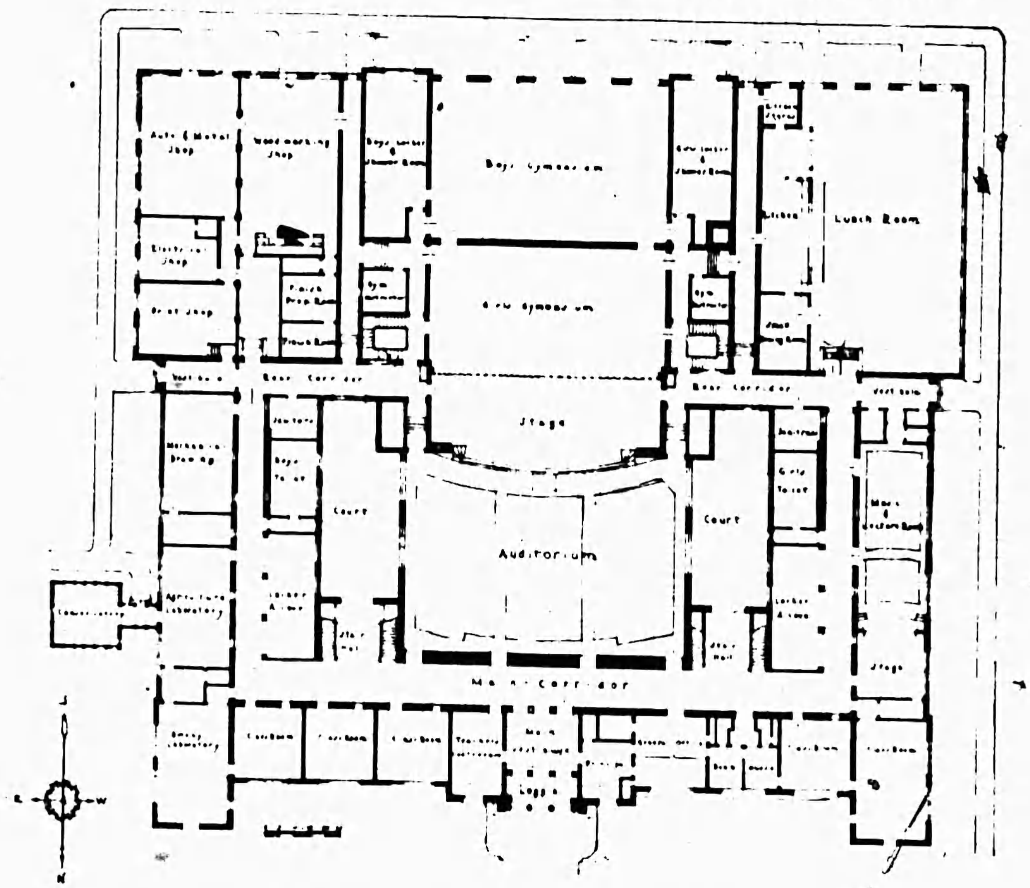


PLAN OF OUTDOOR GYMNASIUM

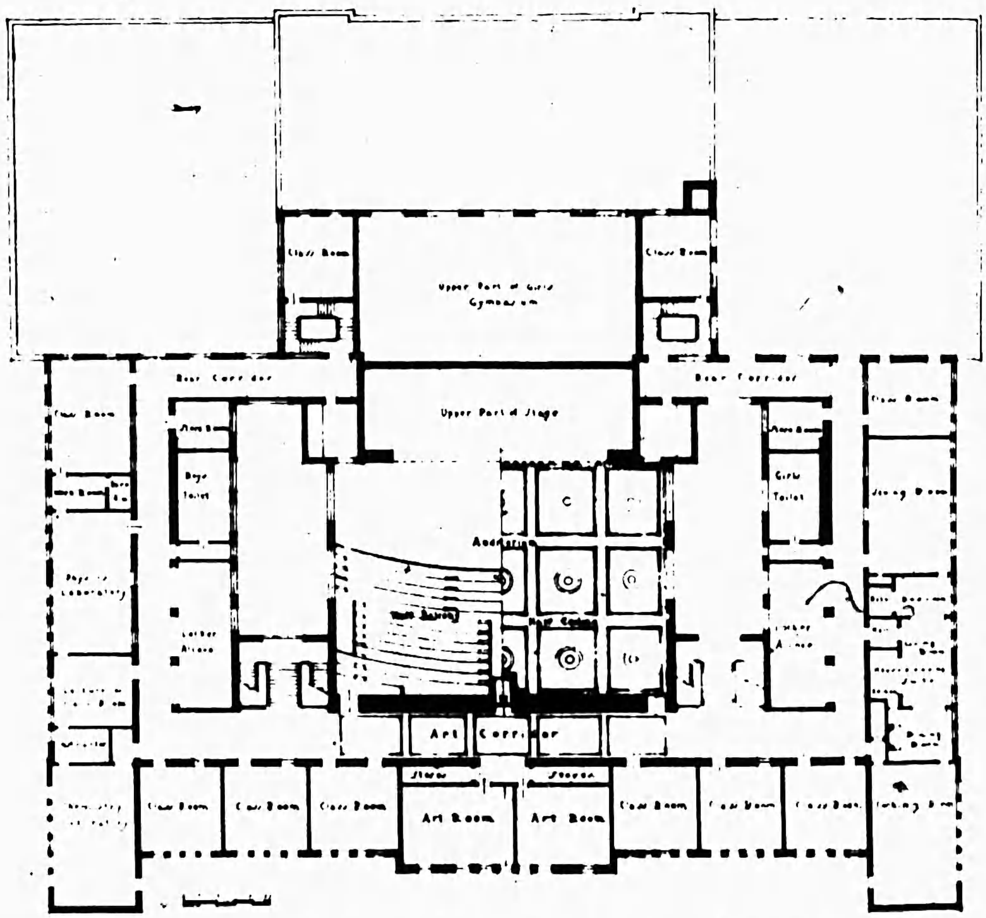


B. GYMNASIUM AND BOILER-ROOM PLANS

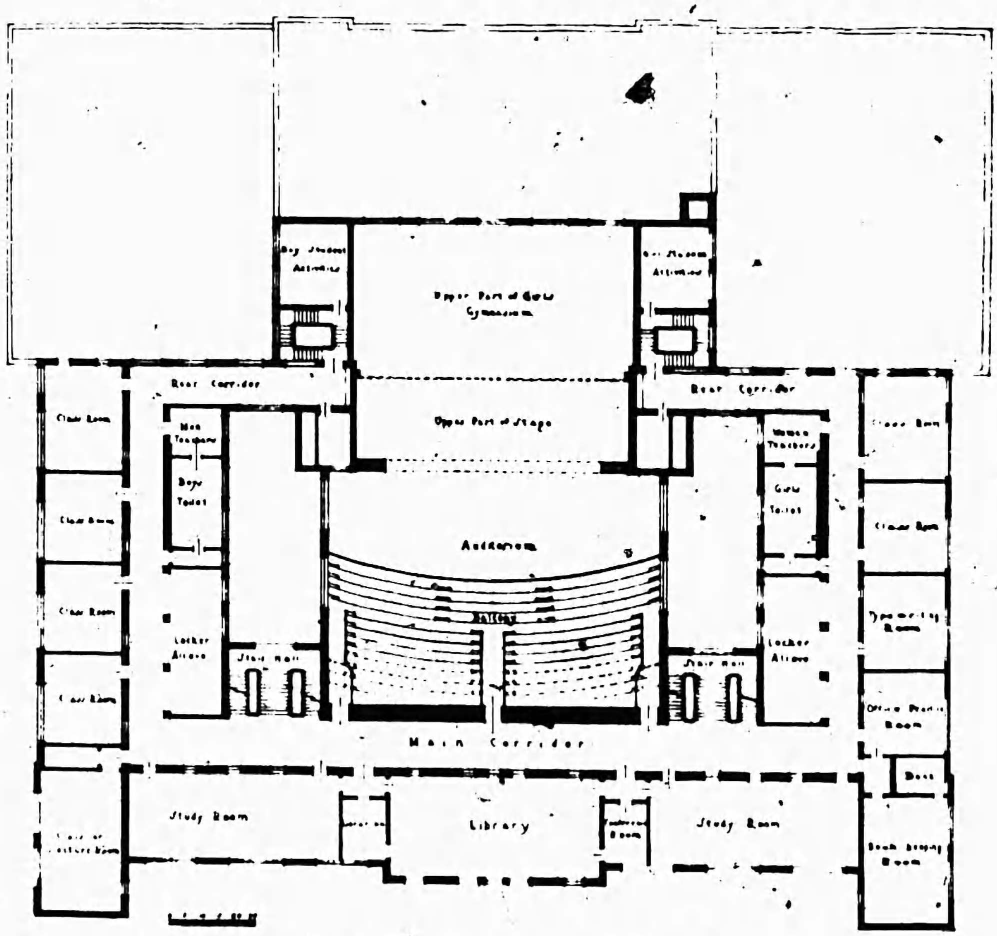
JUNIOR COLLEGE, WICHITA FALLS, TEX. WILLIAM B. ITTNER, ARCHITECT



JUNIOR COLLEGE, WICHITA FALLS, TEX. (GROUND-FLOOR PLAN)



JUNIOR COLLEGE, WICHITA FALLS, TEX. (FIRST-FLOOR PLAN)



JUNIOR COLLEGE, WICHITA FALLS, TEX. (SECOND-FLOOR PLAN)

(Continued from page 2 of cover)

22. Technique of procedure in collegiate registration. George T. Avery. 5 cts.
23. Government publications useful to teachers. E. E. Windes. 10 cts.
24. Organization and administration of the duplicate school in Philadelphia, Pa. Edwin Y. Montanye.
25. A platoon school in Kansas City, Mo. G. W. Diemer.
26. Statistics of State universities and State colleges, year ending June 30, 1923. 5 cts.
27. Record of current educational publications, June 1, 1924. 10 cts.
28. Fiscal support of State universities and State colleges. Clarence H. Thurber.
29. Legislation on the junior high school. Paul W. Terry and W. J. Marquis.
30. Land-grant college education, 1910–1920, Part I. Walton C. John, editor.
31. Statistics of State school systems, 1921–22.
32. A study of 260 school consolidations. J. F. Abel.
33. The quest of youth. Hazel Mackaye. 10 cts.
34. Statistics of city school systems, 1921–22.
35. The trend of college entrance requirements, 1913–1922. Harry C. McKown.
36. A manual of educational legislation.
37. Land-grant college education, 1910–1920, Part II. Walton C. John, editor.
38. Statistical survey of education, 1921–22.
39. Visual education and the St. Louis school museum. Carl G. Rathmann.
40. Legal provision for rural high schools. William R. Hood.