by providing for convertible rooms

In a minute—with FoldeR-Way partition door hardware—you can change a large room into two, three, or any number of smaller ones. That's because they slide easily and noiselessly ... a vast improvement over ordinary folding and sliding door equipment.

Leading architects and builders specify FoldeR-Way partition door hardware for lodge rooms, hotels, schools, Y.W. C.A.'s, or wherever it is necessary to provide a number of quiet rooms or one large one on a moment's notice.

FoldeR-Way equipment does not sag, stick or rattle. It meets all the fine requirements necessary in modern building equipment.

Write us for full information. Richards-Wilcox engineers will be glad to aid you in solving any doorway problem.

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NATCO DEFIES THE FIRE DEMON

In theory, constructing a fire proof building is simple enough. Floors and partitions that will act as fire-tight bulkheads; load bearing members built of, or protected by, refractory material. In practice, it is almost as simple. Just utilize Natco—the Complete Line of Hollow Building Tile.

Natco tile are made of special clay, mined, molded, and hardened in great kilns to the density of rock. No water in them to be driven off by heat, and so cause disintegration. No solid mass to conduct heat inward to the skeleton.

For every need there is a Natco tile. For protecting steel: Natco beam, girder, and column covering. For floors: Natco-flor, Natco Flat Arch, and Natco combination floor systems. For brick-faced walls: Natco Header Backer, Unibacker, Interlocker, and Bakup. Natco Double Shell Load Bearing and Triple X for stucco walls; Natco Textile, and Natco Vitritile for finished face walls. Partition tile, for dividing walls.

Natco effectively bars the fire demon—ushers in increased economies, greater permanence, complete satisfaction.

NATIONAL FIRE PROOFING COMPANY


THE BARRIER

Natco Double Shell, Load Bearing Tile
The wall pictured is Natco Double Shell, Load Bearing Tile, used for stuccoed structures. Each unit is equivalent to from 14 to 21 brick, saving labor, mortar, time and expense. Exterior stucco and interior plaster are applied directly to the tile, whose dovetail scoring provides an enduring bond. Since the tile never rusts, rots, sags, warps, or disintegrates, the stucco stays permanently.

[Natco Hollow Building Tile is susceptible to use in both steel and concrete construction.]
SCHOOL WINDOWS for Health

Truscon Donovan Awning Type Windows are school windows especially designed to provide proper diffusion of light and better regulation of natural ventilation in the classroom. Even in stormy weather the sashes may be arranged to shut out rain or snow while admitting fresh air. Shades are attached directly to the sashes and move in and out with them, providing an awning effect that eliminates glare.

In Truscon Donovan Awning Type Windows, fireproofness is an important feature. They are built throughout of permanent rust-resisting copper-alloy steel. Donovan windows open easily without the aid of poles or chains.

On exhibit at the N. E. A. Convention, Boston, Booth No. 47, February 25th to March 1st.

TRUSCON STEEL COMPANY, YOUNGSTOWN, OHIO

The Complete Line of TRUSCON SCHOOL WINDOWS includes:

DOUBLE-HUNG: Provide refinements in architectural design. Massive strength and rigidity are outstanding features.

STEEL CASEMENTS: Ventilating, fixed and transom units, in any combination of sizes, have unlimited possibilities for maximum fresh air and daylight.

COUNTERBALANCED: A vertically sliding window in which the sashes are balanced against each other providing ease of operation, unusual fire-resisting qualities, dignity and character of design.

ARCHITECTURAL PROJECTED: A less pretentious window, built on the "Awning" principle, possessing all the practical advantages of the other types.

TRUSCON STEEL DONOVAN AWNING TYPE WINDOWS

Information regarding Donovan Awning Type Windows of wood may be secured from the Universal Window Company, 1916 Broadway, Oakland, California.

Inside Elevation showing how shades are attached.

4 light high Window with fixed panel at top.
The spirally reinforced tapering steel shell that is left in the ground on every standard Raymond Concrete Pile PROTECTS the “green” concrete against the natural squeezing pressure of earth and the additional compression created when the shell is driven.

So many things can and do happen to unprotected “green” concrete pile columns underground that experienced architects and engineers KNOW the wisdom of using the Raymond Method.

Raymond Concrete Pile Co.
NEW YORK: 140 Cedar St.
CHICAGO: 111 West Monroe St.
Raymond Concrete Pile Co. of Canada, Ltd.
Montreal
Branches in All Principal Cities
In the purchase of a boiler there are two vital things which must be considered: The first cost and the upkeep cost.

If the first cost is too low you may be sure the upkeep cost will be too high. You'll soon be forced to replace a cheap heater, or else you'll pay added installments on the first cost every year in the form of bigger fuel and repair bills.

With a Kewanee the first cost is paid but once—for a Kewanee Boiler outlasts the building it heats with such high efficiency.

So remember: The upkeep cost of a boiler (which includes all expenditures for fuel and repairs) extends over the whole period of its life. The excess upkeep of an inefficient boiler must be paid every year.

But with Kewanee Boilers repair bills are almost nil and expenditures for fuel as near the minimum as it is possible to attain.

That is why Kewanee has such an enviable reputation as the most economical "boiler buy."

**Low Heating Cost**

**Kewanee Boiler Corporation**

Kewanee, Illinois

STEEL HEATING BOILERS RADIATORS WATER HEATERS TANKS AND WATER HEATING GARBAGE BURNERS

Branches in Most Leading Cities
GENERAL METAL LATHING SPECIFICATION
FOR SCHOOLS

Wood Stud & Joist Construction. Contractors shall use one of the following:

Walls: NorthWestern Kno-Burn or Norwest ½" Rib Lath, wght. 3.0# per sq. yd.
Ceilings: NorthWestern Kno-Burn or Plasta-Saver lath, wght. 3.4# per sq. yd.

Application. Lath shall be first applied to ceilings and sheets carried down 6" on to walls and partitions. Continue on walls, working down from the top to the bottom. Erect lath with long dimension of sheet across supports. All metal lath shall be started one stud from corner, avoiding joints at juncture of walls, unless NorthWestern Corna-lath be used. It is allowable then to let joints come at junctures, applying Nemco Corna-lath to all vertical corners and corners between ceilings and partitions. Attach lath with 6d nails driven in to at least ½" penetration and spaced 6" o.c. Lap ends 1". Tie at least once between supports with 18-ga. tie wire (galv.)

Ceilings Under Concrete Joists. ¾" Longspan rib lath weighing 3.5# per sq. yd. shall be used for standard 5" concrete joists 25" o.c. Lath to be attached to joists by means of No. 10 ga. galv. wire (or equal) hangers placed 6" o.c. in joists before pouring concrete.

Suspended Ceilings. Channel framework for suspended ceilings consists of 1½" runner channels weighing not less than 442# per lin. ft., placed 4 feet o.c., crossed with ¾" furring channels weighing 276# per lin. ft., placed 14" o.c. 3.4# Kno-Burn lath to be wired to this channel framework at 6" centers with 18-ga. galv. annealed tie wire.

Two Inch Solid Partitions. ¾" channel studs to be placed 13½" o.c., fastened at top and bottom. 2.5# Kno-Burn lath to be wired to channel studs lengthwise of sheet, running horizontally. Plaster to be applied on both sides to an all-over thickness of 2".

Steel Joist Floor Construction. ¾" Longspan rib lath to be used for both floors and ceilings. Sheets to run lengthwise across steel joists. Longspan floor lath shall weigh not less than 4.0# per sq. yd., ceiling lath 3.5# per sq. yd. for joist spacings 24" o.c. For ceilings where joists are spaced less than 24", use 4.0# ¾" Longspan rib lath on floors and 3.0# ¾" Longspan lath on ceilings.

Blackboards: Grounds. (To be inserted in Carpenter’s Specification.) Carpenter shall provide grounds over metal lath at proper heights to receive blackboard and trim around same, as shown in architect’s drawing.

Carpenter shall also furnish and install rough bucks for all wall and partition openings where called for and shall secure lower end of bucks to masonry floors by spiking to wood plugs or shall provide other satisfactory and rigid means of attachment.

“A.I.A.” Reference Portfolio Containing Samples of Metal Lath, Descriptions and Specifications Gladly Sent.

NORTH WESTERN EXPANDED METAL CO., 1234 Old Colony Bldg., CHICAGO
16th District School No. 2, Milwaukee, a fine example of a modern school embodying Milcor Products.

Young America deserves more Firesafe Schools

When the National Committee for Chamber of Commerce Cooperation with Public Schools and the American City Bureau completed its investigation of 7150 school buildings in 429 cities, these startling facts were disclosed.

Only 5% of our schools are constructed entirely of fire resistive materials. 13% classify as semi-firesafe, with fire resistive construction in walls, floors, stairways, and ceilings, but with combustible flooring and roof construction over fire resistive ceiling. 17% are in the class that appear safe, with masonry walls, fire resistive corridors and stairways, but ordinary construction otherwise in floors, partitions, roofs and finish. 69% of our schools are unsafe . . . . with ordinary joist construction, combustible interior finish, many with wood foundations and roofs on which Fire thrives!

 Architects who have opportunities to guide the designing and building of schools will find many products in the Milcor Line vitally important to safety. The new 64-page "Milcor Manual" will bring complete data to you. Shall we send it?

MILWAUKEE CORRUGATING COMPANY, Milwaukee, Wis. Chicago, Ill. Kansas City, Mo. La Crosse, Wis.

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for SAFER SCHOOLS

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MILWAUKEE CORRUGATING CO., Milwaukee, Wis.
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A universal desire for complete insulation has been realized in the same operation. Cinder Building Units have been used in all partition walls, as base for stucco, and as backing for brick and stone work.

Tests of every kind, and practical experience in many actual fires have established the superior fire resistance of Cinder Units. The adaptability of this material to all types of architecture makes it possible to utilize its safety factor in any operation.

Cinder Building Units, as manufactured by 84 plants under Straub and Bo Patents, may be obtained throughout the United States and Canada.

Complete information regarding the characteristics of Cinder Concrete Building Units is contained in our new catalogue, which will be sent free upon request.

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THE many large buildings throughout the country that are equipped with MILVACO Heating Systems and Specialties are bona fide evidence that the engineers have been satisfied with their superiority in actual performance.

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MILWAUKEE, WISCONSIN
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Homes of every type now permanently insulated by this thermostatic wood

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He will be especially glad to learn of the permanent insulation assured by Masonite, the thermostatic wood—so called because it actually regulates temperature; because it helps keep every room in the house uniformly warm throughout the winter and uniformly cool all summer.

Masonite is made entirely of long fibres obtained by exploding fresh wood chips under terrific steam pressure. The fibres are formed into broad, smooth boards packed with millions of dead air cells. These boards assure permanent insulation wherever used.

Masonite's co-efficient of heat conductivity per inch thick per hour is 0.328 (flat plate test made by Armour Institute). Write for sample, and for book of Specifications and Details.


Quick heat on starting up in zero weather

A Jennings Pump in the return line of the vacuum steam heating system makes possible quick heat in starting up in the morning, even in zero weather. Steam flow throughout the system is steady, and positive. Each radiator receives its share of the heat—the one farthest from the boiler, as well as the nearest radiator. Heating being more efficient, less fuel is consumed.

There is a Jennings Pump for your small heating jobs—jobs of less than 2500 square feet radiation—as well as the larger sizes, suitable for up to 300,000 square feet equivalent direct radiation.

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Jennings Pumps

At right: a diagrammatic installation of the Jennings Vacuum Heating Pump. Steam, generated in the boiler, flows to the radiators, where it gives up its heat and is condensed into water. Under the action of the vacuum created in the return line by the pump, the condensation and whatever air may be present in the radiators are withdrawn through the thermostatic trap and passed to the return tank. From here, the air is removed and discharged by the pump into the atmosphere; the condensation is pumped back into the boiler.

The pump operates automatically—removing water and air only when the water reaches a predetermined height in the return tank, or when the vacuum in the return line falls below a fixed minimum.
NOW...Automatic Emergency Lighting

Here is... thoroughly dependable lighting protection that fits any building plan...

CONTINUOUS light is vital wherever the public assembles indoors. To insure against lighting failures, many architects are now specifying Exide emergency lighting batteries. In fact, in some states legislation has been passed making the installation of emergency lighting obligatory.

The protection afforded by the Exide emergency lighting battery is automatic. If the main current fails, the lights instantly draw power from the battery—without a hand touching a switch.

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An Exide emergency lighting battery can be obtained to fit the requirements of any building plan. It can be easily adapted to just those rooms or exits where lighting protection is really necessary.

Whether you are specifying an emergency lighting battery for an entire school or theatre auditorium, or merely a single operating room of a hospital, there is an Exide Battery of the proper size and capacity to do the job at a corresponding cost. This battery assures (1) absolute power dependability; (2) long life; (3) freedom from trouble; (4) low first cost; (5) low operating cost.

Send for one of our engineers to consult with you. He will be able to give you helpful information on emergency lighting.

For a more technical description of emergency lighting, see page 2876 of "Sweet's Architectural Catalogue"—Section C.

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THE LAST TOUCH FOR FIFTY YEARS?

When Grauer-Watkins Red Asphalt Floor is installed, that job is off of your budget and off of your mind for the normal life of the building.

Long-term economy — durability — fine appearance — make Grauer-Watkins Asphalt the "top efficiency" floor for schools, hospitals, stores, banks, public buildings. And ideal for foot-traffic — easy to walk on, easy to work on.

RED ASPHALT FLOORS ENDURE

Uniform thickness of 3/8" is positively guaranteed and maintained. Colors: from clear brownish-red through intermediate shades to black. Quiet, warm, dustless, sanitary, waterproof, fire and acid-resistant.

Sanitary Cove Base in the same material, may be carried up the wall to any desired height. Special shapes can be designed. Jointless, smooth, waterproof, easily washed. The glossy, silk-like finish has great natural beauty.

Order the Grauer Bulletins to come to you regularly.

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Sidewalk Lights
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See how this roof deck solves the problem

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Architectural Forum, March, 1928
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It operates at steam pressures from 1 to 150 lbs., and offers the better and more economical way of diffusing heat in Factories, Railroad Shops, Roundhouses, Mills, Warehouses, Garages, Gymnasiums and Industrial Buildings.

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Indestructible, operating at any steam pressure from 1 to 150 lbs., non-corrosive and leak-proof.

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By also discussing the theory and design of masonry structures, giving the fundamental principles and methods of their application in equally convenient and comprehensive manner, the author has so practically covered the two great classes of steel and masonry that are the first essentials in nearly all important structures, that the competent designer may safely adopt his methods, formulae, and supplementary data with great economy of time and labor, and assurance of accuracy and compliance with high standards. This book deals with stresses developed in structures of wood, metal and stone, chiefly buildings, bridges, sub-structures, and their elements, that are subjected to stress in tension, compression, flexure, and torsion; and defines and studies the dead and live loads and their reactions that constitute the outer forces which produce the inner forces of stresses that are analyzed and calculated. Valuable data are given of the amounts, character, application and effects of various kinds of loads, including snow, wind, crowds, trains, vehicles, merchandise, earth pressure, liquid pressure, etc.

In Chapter X, Dr. Swain places the first use of the truss idea in about the year 1560, and sketches the development of the principal types of trusses up to date. He devotes five chapters to stresses in trusses, the analytical method of joints, and the methods of moments, with abundance of diagrams, formulae, explanations and examples. The chapter on economics of simple trusses considers the most advantageous determination of various requirements besides the bare consideration of minimum weight. Several of the book's chapters are devoted to graphical statics, their general principles, and the determination by them of reactions, moments, shears, centers of gravity, moment of inertia, and of stresses by the methods of moments and of joints. The chapters on dimensioning and impact give the most advanced methods, standards, theories and observations, contain extracts from specifications, and give data of great practical value, derived from tests, experiments and investigations, including the impact percentages found in working structures, and the velocity of transmission of stress in materials. The treatment of these subjects is well considered.

The nine chapters covering earth pressure, masonry, retaining walls, piers, arches and dams, give extended consideration to the cohesion of earth, friction, angle of repose, surcharge, comparison of theories, hydrostatic and hydraulic pressures, experiments, masonry types, re- pose, specifications, rules and principles of design, stresses, strength and stability, and detail and design of retaining walls, loads, shape and dimensions of piers and abutments, theory of loads, stresses, design, types and details of hinged and hingeless arches, linear arches, and concrete arches. Dams are considered as substantially straight or curved retaining walls, holding back water instead of earth. Vertical, horizontal, and inclined pressures, uplift, cross section, stresses and stability, foundations, spillways and expansion are considered; diagrams, formulae, and notable examples of important structures are given. The remarkable clearness, attractive presentation, logical treatment, and the combination of mathematical and scientific accuracy, with practical considerations that characterize the entire book, are the natural expression of Dr. Swain's notable experience and services as a distinguished educator and eminent practicing engineer of many years' prominence as Gordon McKay Professor of Civil Engineering, Harvard University; Chairman, Boston Transit Commission; Consulting Engineer, Massachusetts Railroad Commission; Past President American Society Civil Engineers; member of many technical, scientific and engineering societies; consulting engineer, and author of many papers and monographs. The book is equally valuable for reference, for study, and as a working tool. It is at once a handbook, a summary, and a very complete treatise that reduces difficult and complicated problems to their lowest terms, and solves them by the obvious application of simple rules and principles without complex operations, tedious calculations, or intricate mathematics. It should find a place in every technical school and library, and be indispensable for every structural designer as well as to many architects.

ONE of the consequences of the present high costs of construction seems to be careful study into use of materials and methods of building in order to secure whatever may be had in the way of economy in using materials and the best possible results when a building has been completed. Thus different aspects of carpentry, wiring for electricity, and the installation of plumbing, heating and ventilating equipment have been dealt with, and numerous manuals are being published for the guidance of artisans and for the information of architects and their specification writers. The present volume deals with plastering, discussing its history as well as its practical use. While written from an English point of view and making use of terms which are no doubt different from those used in America, the work supplies a most excellent manual for the use of plasterers anywhere.


DURING the past year the presses of many large publishers have been producing volumes dealing with engineering in one or another of its phases, with materials and their use, and with other subjects which to engineers and builders are interesting details of theory or practice. These works are of value not only to established engineers, who desire to keep abreast of the latest, but also the large number of engineers who each year leave academic halls for practice in the field.

This particular work, by two widely known English engineers, deals with its subject from what is naturally an English point of view, and it might be regarded, in a sense, as setting forth the very fundamental elements of professional practice. It deals with the duties and responsibilities of a civil engineer to his clients and to the public in general; with his relations to contractors; with countless matters in regard to contracts and the methods of dealing with the municipal boards or authorities with which civil engineers generally have to do. Then it takes up the choosing of materials, their use, and the matter of the workmanship which is required for the proper use of materials, and then the highly important matter of preparing adequate specifications for the economical obtaining of just what is required; and finally the estimating of the quantities of material which will be needed, and their costs, which logically have much to do with the matter of obtaining cost estimates. The broad scope of the work and the excellence and clarity of its presentation give it a highly practical value to engineers and architects.


It is doubtful if the use of any of even the most adaptable building materials will ever equal in extent the use of wood. Wood enters and always has entered into the construction of buildings of every conceivable kind, and it is not likely that anything else will ever be found to take its place. The wide use of wood naturally gives importance to consideration of its qualities, and study of...
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wood's qualities or characteristics forms the subject matter of this volume, one of the useful works of a more or less technical nature being published by the Manual Arts Press. The author, who is Director of Manual Arts at the Illinois State Normal University, considers the nature and characteristics of woods of different kinds, their growth and composition, matters which have to do with their strength, liability to shrinking, swelling, warping, durability, decay, etc., and part of the volume is devoted to the important matter of wood preservation. The latter chapters are devoted to consideration of lumber, the term used apparently when the wood of a tree has been made ready for marketing and use. These chapters deal with "Lumber Classification and Grading," Lumber Manufacture," and "Sizes of Lumber," fully and adequately.


CERTAIN individuals fully familiar with developments in the building field report that with the slipshod methods by which workmen construct a large part of the building which is being done today there is danger of the trades' losing that strong grasp upon their work which in all ages of our history has characterized the American workman,—a knowledge which has always been a cause for honest pride. The danger, it is further pointed out, is all the greater in that the trade or "vocational" schools, the function of which is to train mechanics or workmen for the different building trades, may find themselves obliged to train men to work not according to traditional standards but to the far less admirable standards maintained by present-day contractors and sub-contractors, the inference being that workmen not so trained may find themselves handicapped when they begin actual work. And yet, as is well known, these trade schools are responsible for training a great part,—possibly greater part,—of the men who must maintain and carry on the traditions of American building. The failure of the schools, by lowering their standard, will mean logically the destruction of the traditions behind the different trades. This valuable work, prepared by the editorial staff of The Building Age and National Builder, is intended for the guidance of carpenters, architects, draftsmen, detailers, contractors and others concerned in building construction.

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There would seem to be no lack of recent works dealing with construction in its many and varied phases, the intention of their authors being no doubt to supplement the training which the workman receives in his trade school and to constitute a kind of encyclopedia or guide to standard practice to which the workman or the superintendent of building may refer. This particular volume, the work of a well known construction engineer, is one of the fruits of considerable experience and much observation. Primarily the book is intended for the use of construction superintendents and others upon whom the responsibility of getting things done may rest. It covers a wide field, as is essential if it is to be useful to men who are expected to have a wide general knowledge of construction work.

"The author has endeavored to make simplicity and preciseness the outstanding characteristics of the book. He has adhered to simple principles and has described only such methods as he has found to be the most useful in the ordinary run of work. Descriptions of 'stunts' and unusual methods have been carefully avoided. In planning the book, each subject has been visualized from the standpoint of a construction superintendent, and the usual and most up-to-date way of doing the work has been described. Sufficient other information has been given in each chapter to make clear the science of the subject. The different classes of work have been arranged in chapters following one another in accordance with the sequence of operations usually followed in construction projects, describing all the steps necessary to carry on a project from excavation to painting. The introductory chapter suggests the organization of the construction force and the layout of the plant and describes the various pieces and types of equipment used on an up-to-date construction project. The first step in the operation being excavation, this is discussed including layout, retaining measures, blasting, water control, and pile driving. Following this, the major portion of the book deals with structural operations divided according to the kind of materials used,—that is concrete, brick and steel construction, describing in some detail each of these materials and the operations and equipment used in assembling them. In the chapters on "Roofs and Flashing," the author seems to have confined himself almost entirely to the application of various kinds of built-up or composition roofing on flat roofs. The interior finish of buildings is then discussed under the heading of "Lathing and Plastering." Following this more detailed information is given on the subject of equipment in a chapter on "Scaffolds," their planning and erection.

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"SMOOTHTOPS SAVE SPACE"
—Sigmund Solomon

NEW YORK apartment house owners know the firm of Solomon & Kahn as builders of many of the city's finest "jobs." Typical of these is "845 West End Avenue." Its immediate acceptance by an exclusive tenancy was, in part, reward for the builders' policy of including only the best in equipment.

"Such as those Smoothtop Gas Ranges in its ninety-one kitchens," said Sigmund Solomon. "Whether you are planning hundred-dollar-a-month combinations or twelve-thousand-a-year duplexes, you always have the problem of saving space. Here, Smoothtops simplify kitchen planning, because they are so remarkably compact. Also, they allow more light to enter—and light is certainly welcome in any kitchen.

"Architects tell us the console lines of this range make it the smartest on the market. Tenants tell us of its wonderful cooking results. Have we any choice but to install Smoothtop?"
THE SCHOOL NEARS COMPLETION

TUCKAHOE HIGH SCHOOL, TUCKAHOE, N. Y.

Tooker & Marsh, Architects
THE CONSTRUCTION OF SCHOOL BUILDINGS

BY
C. B. J. SNYDER
FORMER SCHOOL ARCHITECT FOR NEW YORK

ALTHOUGH all school buildings are intended for the same general use, they present an unusually wide range of construction problems. They vary in size from one to almost 200 rooms, and in height from one story to ten or more. These differences in size are entirely physical, but the character of the scholastic curriculum has an important influence on the construction of a school building. The curriculum usually includes a wide range of subjects, many of which require specific accommodations. The development of and changes in curricula are continuous and sometimes of a decidedly radical nature, and to attempt to envisage their future nature and requirements would be impossible. To provide for new and often radically changed needs requires construction that has a certain measure of flexibility. The correct limitation of materials permits easy and economical alterations and changes in the structure and plans. The architect must consider the possibilities of the site; the required pupil capacity; the amount of money available; the scope and nature of the curriculum; the probability of the necessity of enlarging the building to accommodate an increased pupil population; the probability of there being new and specific requirements for future developments in teaching methods and additions to the curriculum. More remotely, the architect has to consider also the possibility of there being a radical change in the character of the population of the surrounding territory; the intelligence and the ability of the superintendent of schools and the board of education; and public opinion. The factors involved render the designing of a school building a most complex problem.

The operation of a public school might be likened to a production process. The school building should be planned in essentially the same manner as an office or loft building. Suitable facilities for safe entrance and exit of the occupants are essential. In addition, sufficient means of circulation through corridors and stairways is also necessary. With these essentials provided for the safety and convenience of the pupils, the remaining working space should be laid out in such a manner that it can be subdivided to suit general and special requirements as they arise.

Types of Construction. The usual types of construction, from a structural standpoint, used in building schools are the wall-bearing type and the skeleton-frame type. The former usually has brick outside walls and brick bearing walls for the corridors. The floor and roof construction may be of wood, either simple frame or heavier "mill" construction; or light steel or the newer steel trussed joists may be used, fireproofed or not. There are many variations and combinations possible, such as the use of steel beams to support the shorter floor joists, etc. Fireproof construction is not usual in a wall-bearing type of building. Some of the materials may be incombustible or some slow-burning, but fireproof buildings are today practically all of the skeleton-frame type.

Wood and "Mill" Construction. School houses to accommodate a small number of pupils can be very satisfactory when built of wood or standard mill construction, in connection with brick exterior walls and corridor partitions. They can be made entirely safe with certain obvious precautions. The element of fire protection is one of the most important in schoolhouse planning, allied to which is the necessity of providing sufficient means for circulation and egress in case of possible panic conditions among the pupils. Panics may be caused by means other than fire, and if sufficient circulation and exit facilities are provided, fire protection can be safely limited to the construction of fireproof boiler or furnace rooms and the insulation of heating or ventilating ducts and steam pipes. There is little cause for fire hazard in a school building except in these items and in the accumulation of rubbish in basement rooms or closets. Although the wood stud partitions are generally and usually quite rightfully considered a fire hazard, they can be so fire-stopped that with metal lath and plaster they are fire-resistive to a high degree. It is feasible in this type of building to construct fire partitions of hollow tile, made either of clay or gypsum, or solid metal lath and plaster. The only other problems in connection with a mill-constructed school building would be the soundproofing of the floors so that the noise of moving pupils would
It is not likely, however, that buildings of this type would be more than two stories high. There could be no question whatever about the safety of such buildings if they were equipped with automatic sprinklers.

For the light floor loads common to school buildings, a form of steel construction which consists of light steel trussed or bar joists or pressed steel joists has been found very satisfactory. These are placed approximately 2 feet apart, and on them is laid a thin concrete floor slab with such a finished surface as is desired. The ceiling is usually constructed of metal lath and plaster or a gypsum slab.

**Skeleton Frame Construction.** Larger school houses are quite commonly built with skeleton frames. These frames are either constructed of structural steel or of reinforced concrete. Hollow tile arches or reinforced concrete slabs are used for floor construction. The type of construction selected is influenced largely by the plan of the building and to a certain extent by the methods adopted for heating and ventilating. The ventilating system often includes vertical ducts which supply air to the rooms and exhaust it therefrom. It is readily apparent that when these ducts are built in the walls between two adjoining rooms they become a permanent structure and cannot be removed to another position without great expense, as this would amount to a practical rebuilding of the ventilating system. When the ventilating ducts are placed along the corridor walls it is possible to remove the partitions between rooms and rebuild them at any desired place. The location of ventilating ducts therefore differentiates the fixed from the flexible plan. Greater flexibility of plan is secured by placing the main ventilating ducts in the corridor ceilings with openings into the upper parts of the classrooms. If these openings are placed in such a way as to furnish the half-units with the required amount of air, the cross partitions can be placed at will without any interference whatever with the ventilating system. This is perhaps the most flexible plan which has yet been devised for schoolhouse construction.

It is becoming increasingly popular to select the classroom as the basic unit. For this unit two window openings are sometimes provided, which permit this standard unit to be divided in half or to be extended longitudinally to one or more units in length, according to the requirements. In this way it is entirely feasible to plan a schoolhouse without reference to the classroom by merely setting up the limits of the corridors and stairways, permitting the remaining space to be divided into classrooms and laboratories as desired.

The equipment of a modern schoolhouse is such that each linear foot of wall space is definitely allocated to some particular use. This wall use is divided between blackboards, various kinds of cabinets, bulletin boards, map spaces and other facilities. In some schools a certain proportion of the wall is utilized for wardrobe cabinets, so that they will be under the constant surveillance of the teacher in charge. Many school authorities prefer this system to the cloak room system, where the wardrobe is entirely removed from the classroom. The wardrobe placed in the school room is saving of floor space because of the elimination of a partition, and the aisle of the school room also serving the needs of wardrobe use. In other words, the area of a partition and an aisle is saved in the plan. In junior and senior high schools where the pupils are not assigned to any particular room, these wardrobes are often placed in the corridors so that they can be accessible without disturbing the occupants of any one room. It can readily be seen that where the walls of the classroom or laboratories are entirely utilized by standard equipment, designed to fit a certain size classroom with a certain size column, an increased size of columns would disarrange this standard equipment and require either a redesigning of the equipment or mak-
ing the rooms larger in order to provide the necessary lineal feet of wall. The type of fireproof construction used results in a minimum or an increased area of ground coverage due to these conditions. The thickness of the exterior wall is affected by the type of skeleton construction used. In one instance a 12-inch wall may be sufficient as compared with a 16-inch wall required by another type of construction. This would naturally affect the extreme width and length of the building a foot or so. The true worth of the structural parts of the school building is established by their comparative strength, durability and adaptability. All of these characteristics should be possessed in the maximum degree. The strength of the materials should be susceptible of accurate determination, not merely based on a theoretical assumption, before they are incorporated in the structure. The materials should possess an enduring strength which does not decrease with age. All materials of whatsoever kind are injuriously affected by exposure to the elements, and this characteristic entails the necessity of protecting them by means of adequate weatherproofing and fireproofing. It sometimes happens that some materials are commonly accepted as unaffected by exposure to air and moisture in combination, or to fire. Observation of their endurance performance under exposure, however, has demonstrated the necessity of providing essential protection.

Adaptability to Other Uses. The adaptability of the structure to new requirements vitally affects its value. This can be secured only by such a plan in combination with structural parts that are susceptible of alterations, removal, replacement or reinforcement. It sometimes happens that the character of a neighborhood so changes that the need of the school ceases to exist. The problem, then, is whether to adapt the building to an entirely new use in order that it may yield a profitable income or demolish it. In the latter case, the cost of demolition and the amount of valuable salvage are important in establishing the sale value of the property.

Comparative Costs. The comparative initial cost of the structural frame does not establish its real value in the structure. A true comparative cost is determined only by making an estimate of cost based on complete sets of plans and specifications for each of the types of construction. Either one may affect the cost of the foundations because of the difference in the dead weight of the structure; the cost of installing the heating, ventilating and sanitary systems may vary; the cost of plastering, carpentry and brickwork may also be affected. These costs can be known only by making careful, individual estimates.
WILLIAM BUTTS ITTNER was born, September 4, 1864, in St. Louis. He attended the public schools and the Manual Training School of Washington University, and was graduated as a special student of Cornell University in 1887. Travel and study abroad supplemented his education and enriched his professional preparation. He took up his profession with Eames & Young in St. Louis in 1888, establishing an office of his own the next year. In 1897 he was elected Commissioner of School Buildings for St. Louis, and continued to serve in that capacity until March, 1910, when he was elected architect for the Board of Education, which position he filled until 1916. During the past decade Mr. Ittner has served 59 cities and towns in 24 states as planner and designer of schools. Mr. Ittner initiated and developed the "open plan" in school buildings, which automatically brought about maximum light and ventilation and better design. Aside from his school work, he was architect for the recently completed Scottish Rite Cathedral of St. Louis and many prominent buildings. The A. I. A. elected him to Fellowship, and a medal was presented to him for marked and meritorious achievement in the design and construction of school buildings by the St. Louis Chapter of the Institute, of which he was president in 1895-96. He has served as a member of the board of directors and an officer of the American Institute of Architects. Blessed with an excellent baritone voice and with a genial spirit, he takes great pleasure in music and dancing.

JAMES O. BETELLE was born in Wilmington, Delaware, April 1, 1897, where he attended the public schools. He started his architectural career by working for Cope & Stewartson, of Philadelphia. While there he studied at the School of Industrial Arts, and in 1900 came to New York to work for Cass Gilbert. He studied architecture at the atelier of Donn Barber and at other art schools in New York, going to Europe to study in 1905. Returning, he entered the office of John Russell Pope, where he remained until 1910. While with Cass Gilbert and John Russell Pope, he came in contact with Ernest F. Guilbert, and in 1910 they formed the partnership of Guilbert & Betelle. Mr. Guilbert died in 1916. From 1917 to 1925, Mr. Betelle lectured at Columbia University, on "Modern School Buildings and Their Equipment." The course was attended by school principals and superintendents from all parts of the country and from foreign lands, so that his influence on school architecture has not been limited to the buildings he has actually designed. Mr. Betelle believes that architects should render service to the community. Mr. Betelle is now president of the Newark Chamber of Commerce, a member of the North Jersey Transit Commission, and other civic bodies. Mr. Betelle is a past president of the New Jersey Chapter of the A. I. A., and he was elected a Fellow of the Institute in 1927. His hobby is his work, and he seems never to tire, in spite of the fact that he has had but one vacation in four years.
CHECKING SCHEDULE FOR NEW SCHOOL BUILDINGS

BY

JAMES O. BETELLE

GUILBERT & BETELLE, ARCHITECTS

In order to start the preparation of plans and specifications for a new school building, the architect needs certain information. This information must be furnished him by the board of education after careful consideration and after consultation with the superintendent of schools. It would be of considerable assistance to all parties concerned if the various items on which information is needed or instructions desired could be brought together and listed in a convenient way, in order that they may be considered separately and consecutively and thereby develop the type of building to be erected, together with the materials to be used, and the facilities to be included. Such a list of items is given here, with the hope that it may prove useful to not only the architect, but to boards of education and to superintendents of schools as well. When all the questions suggested in the list have been answered, and the special information requested has been furnished, the architect is in a position to proceed with the preparation of his plans and specifications.

For the information of boards of education and superintendents of schools, it might not be amiss to outline the procedure the architect goes through in making his plans and specifications. The architect first makes preliminary plans and specifications, which he submits to the board of education and the superintendent, for their criticism and approval. Changes can easily be made in these preliminary plans, and possibly the architect will submit a number of different preliminary schemes before a final scheme is definitely decided upon and adopted. Preliminary plans and specifications are just what their name implies, and for the reason that they are preliminary, they can be easily modified and changed. Before approving the preliminary plans, the board of education and the superintendent should give ample time to their study, and the architect will gladly make any desired changes and adjustments in them until they are entirely satisfactory. The time for making changes and adjustments is during this preliminary plan stage, and not when the working drawings are being made or after they have been completed and estimates obtained,—or worse still, during the time when the building is being erected. These belated changes and adjustments cause delay and trouble all along the line, and may mean an additional charge by the architect for changing the completed plans and specifications, and by the contractor if the changes are made while the building work is in progress. From the preliminary plans the architect prepares his contract working plans and specifications, and when they are completed they are usually submitted to the board of education for final approval and authority to advertise for bids, and for sending them out to the contractors for estimates. It is also necessary that the final working drawings and contracts be filed with and approved by the department of education of the state in which the building is to be erected.

While it is the duty of the architect to include in his plans and specifications all the various features and instructions given him by the board of education, it is also the duty of the school board or its representative to know in a general way what the finished plans and specifications include or omit. It is practically impossible for the busy superintendent or the busier school board members to read through the entire specifications and check up everything on the plans, and it is with the idea of simplifying the checking of the plans by the superintendent and board members that this checking schedule has been prepared, which at the same time gives the architect the information with which to start his plans. It is the architect's duty to see that the plans and specifications are complete and agree with each other, and that the state and local laws applying to school buildings have been complied with. Also that the instructions given from time to time by the board of education as to the arrangement, materials or finishes are carried out, and that a complete and substantially safe building is produced when the plans and specifications are realized in brick, stone and mortar. The examination and approval of the plans by the superintendent of schools and the board of education is not made with the idea of relieving the architect of any of his responsibility, but simply to assure the owner that the general instructions given the architect have been carried out.

LIST OF ITEMS

Name of Owner:
Get the correct corporate name of the board of education to be mentioned in the specifications as owner of the proposed building. This is often worded incorrectly.

Kind of School:
Consolidated school?
Grade school?
Junior high school?
Senior high school?
Manual training or commercial high school?

Organization of School:
Scheme of organization should be given.
Standard or traditional school program?
Platoon, duplicate, or modified "Gary" system?
Number of grades to be taught in the new building?

Capacity of Building:
Total number of pupils for which accommodations are now required?
Number of pupils in various class units? What excess pupil capacity is desired in the building now to be erected?

Rules for Computing Number of Pupils Accommodated in a School Building:
The American Institute of Architects and the Committee on Standardization of School Buildings of the National Education Association have both adopted this method: "Compute the number of pupils normally accommodated in rooms designed for classes only. Special rooms are to be figured at the actual number of
pupils accommodated for one class period only. Auditoriums and assembly rooms are to be ignored, but gymnasiums may be figured for one or two classes, as the accommodations may provide. No gymnasiums, however, shall be accredited with two classes, if below 40 by 70 feet in size.

It should be noted that the pupil capacity of a building computed on the basis given here represents a maximum capacity. It is not altogether desirable to begin the use of a new school building counting upon such rooms as laboratories, shops and other special rooms as home seats. After the school has been built a few years and before an addition can be constructed, it is often necessary to use these special rooms as home seats or stations for pupils, at which time the maximum pupil capacity will be reached. Pupil capacity can possibly best be stated as "maximum pupil capacity," in accordance with the A. I. A. and N. E. A. rules and upon which the cost per pupil is figured, and "normal pupil capacity," which is the desirable number of pupils any building will accommodate and which represents about 80 to 85 per cent of the maximum capacity.

Scheme of Study Rooms:

- Number of study rooms and seating capacity of each?
- Storage Rooms for Books and Stationery:
  - Give desired number, size, and preferred location.
- Number and Sizes of Rooms for Different Purposes:
  - Number of classrooms and pupil capacity of each?
  - Number and kind of special rooms and pupil capacity of each?

To determine the number of square feet per pupil required by law in each classroom and also by the size and arrangement of the special rooms that changes in sizes of rooms may be easily made to take care of future educational requirements.

Auditoriums:

- Total seating capacity?
- Number of seats desired on main floor?
- Number of seats desired in gallery, if any?
- Main floor to be flat or sloping?
- Area desired for stage?
- Shall stage be arranged for scenery?

Built-in fireproof motion picture booth?

Provision for darkening interior of auditorium in daytime for motion pictures?

Easily accessible for community meetings, or other outside purposes in evenings, or at other times without opening up entire building?

Heating and ventilating systems separate from rest of building so room need only be ventilated when actually in use by a large number of persons?

Will auditorium be used for any other purpose, such as gymnasium or study hall?

Gymnasium:

- Size and height?
- Accommodation for spectators and number of seats desired?
- Will more than one gymnasium be required, or an additional exercise room needed?

Arrangement of locker, dressing and shower rooms, and number of lockers and showers desired in each?

Physical examination rooms?

- Physical director's office?
- Apparatus storage room?

Gymnasium accessible from outside for community uses without opening main part of building?

Note that minimum size of a standard basket-ball court is 35 x 60 feet; maximum size, 50 x 90. A space of at least 3 feet should be allowed all around court.

Swimming pool?

Library:

- Size and preferred location?
- Number of books at present in school library and probable maximum number in future?

- Is it not altogether desirable to begin the use outside school hours, evenings and holidays, also provision for heating without running main heating plant?
test pits dug to determine the character and bearing capacity of the soil; also to locate the level of sub-surface water, and the location of rock, if any. Neglect to determine the character and depth of the underlying soil has many times been the cause of great expense later on, when the construction of the building was under way.

Work to Be Included or Included in Contract:

Are lighting fixtures to be included or purchased later?

Is entire property to be graded, or only just around building?

Are roads, paths and sidewalks to be included?

Is the architect to include the handling of furniture and equipment or any special items?

Temporary Facilities While Building:

Decide who furnishes and pays for water, light and heat, used during the construction of the building,—the owner or contractor.

Investigate cutting down of certain trees within the area of new building and the boxing around or protecting of those trees which are to remain.

fireproof, and also floors and ceiling of boiler room and manual training room fireproof. Other construction of fireproof building it is usual to make the corridors and sometimes built of heavy timber to save money. In a semi-

of rooms below grade waterproof?

Waterproofing:

Certain floors and partitions, such as the floor of a gymnasium, laboratories, etc., are to remain.

Wainscoting in Corridors and Classrooms:

Lower walls of classrooms, and especially corridors, are subjected to heavy wear and abuse. Wainscoting of painted burlap is often used in classrooms, and of glazed brick about 5 feet high in corridors.

Sound Deadening of Floors or Partitions:

Certain floors and partitions, such as the floor of a gymnasium, where located over an auditorium, or a toilet room adjoining a classroom, need to be insulated and have sound deadening. There may also be other cases where such sound deadening may be necessary around music rooms, gymnasiums, noisy shops, etc.

Wiring in Corridors and Classrooms:

Wiring in corridors and stairways is usually done monthly, upon certificate of the architect, and equal to 85 per cent of the value of labor and material actually incorporated into the building at the time of calculating payment. The remaining 15 per cent accumulates as a final payment, which is generally made within 30 days after completion and on acceptance of the building by the owners.

Books, Dumbwaiters, Dust Chutes:

If any are required, number, size and location should be given. Vertical shafts and doors to them should in all cases be fireproof.

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Books, Dumbwaiters, Dust Chutes:

If any are required, number, size and location should be given. Vertical shafts and doors to them should in all cases be fireproof.
Push-button and buzzer from stage to stereopticon location?

Fire alarm bells and their location? How operated?

Bells, telephones and clocks operated by dry batteries or storage batteries?

Long distance outside telephones?

Any interior telephone system? Location of central switchboard for interior telephone system?

Number and location of interior and outside telephones?

Number and location of secondary clocks in classrooms which are operated by master clock in principal's office?

Locations of master clock, program bells, switchboard, fire alarm switchboard, telephone switchboard?

Any electric outlets required for electric irons or electric stoves?

Kind and design of lighting fixtures?

Is electric service wire from street main run exposed overhead on poles or concealed in conduit below ground?

Heating and Ventilating:

Type of heating system: one-pipe, two-pipe, vapor or vacuum system?

Are fans to be used for either or both the fresh air supply and exhaust ventilation?

Type of boiler or furnace?

Kind of boiler grates,—stationary or shaking grates?

Kind and size of coal to be burned? Oil-burning boilers in certain localities?

Special provision for heating principal's office, board of education rooms, superintendent's office during winter holidays and evenings, so entire building will not have to be heated?

Is automatic temperature control called for? What sections are so controlled?

Special ventilation for toilet rooms, independent of school ventilation?

Piping system to be valved for separate control of direct radiators in classrooms, auditorium, etc., and for indirect air heaters for ventilation? Also sections of building to be shut off in case of accident to any part of system?

Classroom and auditorium heating and ventilating controlled separately, so that either section can be used without the other?
PROGRESS in education necessitates constant change in schoolhouse planning. This constant change is due not only to change in the requirements in order to carry out certain newer methods in the teaching but is likewise due to very rapid increase in the high school population. Whatever may have caused this increase in high school population, we have it with us and it must be provided for. School boards are further embarrassed by having thrust upon them the problem of erecting more buildings at a much higher unit cost. The reaction to this very simple problem of providing more buildings for more pupils at enormously increased prices has caused the demand for the strictest economies in floor planning. In the good old days when a high school building meant classrooms of large proportions with an occasional room designated the "laboratory," and another the "library," there was no particular need for research and study of methods for economy; but nowadays, with seating shortage prevailing in almost every school district in the country, and with boards of education bewildered because of no available funds and very serious restrictions as to the measures for increasing their funds, everybody,—architect, school administrator and members of the board itself,—is vitally interested in every measure which will conserve space and at the same time not interfere with the full opportunity of the student and the convenience of the instructor. Unfortunately, this last item has been given little attention. No business corporation would employ high salaried people such as are employed in our modern high schools and handicap them from day to day with a non-workable, unproductive environment.

It is with this situation in mind that this discussion of special rooms is undertaken. The special rooms have become a large factor in the high school. Academic rooms in a modern high school seldom exceed 50 per cent of the number of the total units provided for the operation of the school. In a recently planned high school for 1200 pupils, it was found that only half of the total recitation units to be provided were actually classrooms. In addition to the recitation units, there is required the usual office space, as well as study halls, library, lunch room, gymnasium and assembly hall, all of which may come under the designation of "special rooms."

Laboratories. Within recent years, there has been developed for use in laboratories special equipment built around the necessity for conserving space, adding to the convenience of the pupil, and giving some attention to the administration of the room as a teaching unit. The most recent development in this field is a series of tables connected back to front through the center of the table by a narrow compart-
the best light of the room. In many old laboratories everything except the pupil's table is close to the light, placing the pupil's table on the dark side of the room. For instance, the balance or microscope table is frequently placed under the windows, with the presumption, obviously, that it should be near the light. Modern artificial light is so efficient and so easily provided and these units are used so seldom that we recommend placing these tables on either the rear or corridor wall of the laboratory. The instructor usually objects until he sees how it works.

In a chemistry laboratory, fume hoods are a necessity, but generally a nuisance. If the fume hoods can be located before the structural plans are determined, confusion and expense can be avoided by proper location of vents. In order to get positive exhaust of these fume hoods, the installation of small fans, which, by the way, will improve the ventilating of the whole room, should be made in the vents. Various experiments are under way now for the installation of fume hood facilities on the pupil's desk itself. No doubt this will become a practical device in due time, but as yet we are not ready to accept this idea. It requires much more expenditure than would seem justified for satisfactory operation.

One of the most constant sources of annoyance in all laboratory work is lack of the proper storage for notebooks. Various schemes are being used. Recently the notebook rack has been heralded as the solution for the evil, but in actual operation, the notebook rack is an invitation to copying and petty annoyance. Some protection should be given to the pupil by providing cabinet locks for each class using the racks. It may be the occasion for a little additional expense or inconvenience in distribution, but it saves in the long run those annoying circumstances which so frequently arise in the conducting of the class. Under certain circumstances, office files, each section locked separately, have proved useful.

Ample bulletin board spaces for the posting of announcements or display of excellent work are a great convenience. These should be placed near the most used exit, as should also the file cases or notebook racks. A very limited amount of blackboard is sufficient. A folding blackboard in 4½-foot sections, so that the work of each class may be retained without interfering with that of other classes, is the most serviceable. It costs more to install in the original layout, but it leaves space for other purposes.

Care of Equipment. It is the duty of the architect to provide for the best care of all equipment. It is a remarkable fact that neglect costs more than the actual use of certain apparatus. To place the storage area in some dark corner, frequently in a segregated place, is to insure rapid deterioration because of neglect of the apparatus. Whatever the architect may do to provide for this care, only the most persistent effort on the part of those responsible for the school's administration, will guarantee the proper use of facilities. The architect should assume the responsibility for making this care a possibility.

Accessories. In addition to the regular laboratory space, every suite of laboratories should have well equipped lecture rooms so placed that they may be used to supplement more than one laboratory, and so organized that they will be easily accessible from the private workroom of the instructor. In biology, much confusion is saved by providing growing rooms or greenhouses in connection with lecture rooms.

The accompanying plans proposed for the Fort Smith, Arkansas, High School illustrate most of the measures which have been suggested. We should note, however, that the faculty of the school prefers to use the two-pupil tables in the chemistry department, because of added convenience, and such has, therefore, been planned. The biology laboratory is on the first floor immediately under the physics laboratory; and classrooms, planned for conversion into an additional biology laboratory, should it become necessary, are beneath the chemistry laboratory. The physics laboratory was not needed for full time, and therefore provision was made for extra storage room, so that this laboratory might be used to supplement the one biology laboratory for which the demand was temporarily out of proportion.

Girls' Shops

The cooking room is one of the hardest units in the whole building to plan. There are two major
types of plans. Incidentally, it might be said that those responsible for the operation of this unit are quite positive in support of whichever plan they favor. The older plan is that which became so common some 20 or 25 years ago, when cooking was being generally adopted as a school activity. This consisted of a hollow square, open at one end, furnishing a place where materials could be prepared and cooking operations be conducted either by the pupil individually or by the instructor as a demonstration. It had its advantages, many of which cannot be continued in the newer type of organization. It was cheaper. It gave the instructor an across-the-table contact with the individual pupil with a minimum traveling distance. It had the disadvantage of forcing too many pupils into very limited space.

Recently, there has been developed the so-called "unit" plan, wherein a sample kitchen is built for each two, three or four pupils. Its adherents claim for it the advantages of simulating home conditions. Some of its opponents have pointed out that there is only one cook at home with about twice as much space as that usually devoted to two students in the school, and that the reproduction of home conditions is far from actual. Others seriously question the necessity for an attempt to reproduce the home environment. Somewhere in between the two extremes is the sound middle ground upon which most teachers will finally come to an agreement. As between these two extreme viewpoints, the poor architect does not dare make a choice. If he plans for one type, the other will be wanted within a short time, because the change of teachers in this department is usually due to a change in the opinion as to the proper method of securing results. It is not at all impossible, however, for the architect to provide a distribution of his units in such a way that segregation into individual compartments may be inexpensively provided, or vice versa. Insofar as it is possible, the equipment used by pupils should be common to each station in a cooking room. This lessens the confusion in getting materials and is conducive to continuity in developing any given project. As in other laboratories, provision should be made for adequate storage space of frequently used apparatus, and a compact but easily accessible filing space for notes. One of the most common faults in this particular laboratory is the omission of space for the storage of aprons or other clothing which should be worn by the students while engaged in this activity.

The accompanying plan is not quite illustrative of the point in hand, because we had the distinct advantage here of a room lighted with a skylight. However, it does illustrate the possibility of providing space for small groups with sufficient segregation for good operation. This is on the same principle as that defined in the planning of the laboratories for this same school. The somewhat unusual floor plan of the cooking room was developed by the faculty of the school after much study of the problem and the discarding of many suggested plans.

Sewing Room. As this room does not require fixed equipment to any considerable extent, great freedom can be exercised in its planning. The equipment has usually consisted of sewing tables fitted with individual drawers for the maximum number of pupils using this room. However, as the schools have become crowded and the requirement for full-day use of this unit has developed, it has become practically impossible to provide so many drawers of adequate size in an ordinary sewing table. The tendency now is to use a very simple table with an open space provided for the placing of separate trays, which take the place of the drawers. These trays are individual and are cared for in stacks with locking devices or doors. The proper distribution of these trays is a simple matter, but it seems to have become objectionable to some people who have had difficulty in organizing the procedure. The minute of confusion in the distribution of these trays is fully compensated for by the greater amount of working and storage space which each individual pupil has, and therefore, better opportunity to organize her belongings. The sewing room should be provided with display space as well as storage space. It has been found advisable to segregate these two because the front of the storage space cannot be kept organized for display purposes, and if the display space is used for storage, it is always out of order.

Where both sewing and millinery courses are of-
fied, the school can very readily use the same room for both purposes if, in addition to the main room, a small room is provided with storage space, well equipped with shelving. One of the most frequently misused features of equipment of the sewing room is a triple mirror. These are not only expensive, but they are easily and frequently broken. Taking the cue from the large department stores, the architect will find that a much simpler device is much more efficient. Setting one mirror on the wall with one side extended from the wall line a few inches, and then using one other mirror hinged to the opposite wall or else on a movable frame, gives an efficiency fully equal to that of the triple mirror.

Placing sewing machines in disappearing cabinets improves the appearance of the room and leaves the well lighted portion for the work tables. In general, the equipment of this room can be simplified and made more efficient by a careful study of the best practices in our large department stores.

*Model Apartment.* The home-management or home-making courses offered in our schools frequently lead to the building of a model apartment within the school building. This may seem to be an extravagance at first thought, but when one remembers the many purposes for which such a space may be used, the expenditure can be justified. Where nothing more can be provided, at least the kitchen and dining room should be built in close proximity to the cooking laboratory. The accompanying diagram of the Fort Smith, Arkansas, girls' shop illustrates well how the two may be coordinated. For instance, the refrigerator which serves the cooking laboratory, is a part of the kitchen in the model apartment. Frequently, the appearance of the model apartment has been ruined by the use of a ceiling height equal to that of the regular classrooms. This is not necessary, and should be avoided.

*Small School Requirements*

We who have been planning school buildings for large urban centers have almost completely lost sight of the problem confronting our neighbors in the smaller communities. A very large percentage of our high school children are housed in schools where the number of pupils does not justify the provision of all of the facilities ordinarily found in our larger high schools. This should pique the interest of the architect and the school man to develop a combination which will be effective and inexpensive. A plan of a combined laboratory and household arts room accompanies this article. (Page 430). It shows how, by providing separate storage space for the materials and apparatus of chemistry, for physics, for household arts, etc., the same room may be used for all purposes. It is essential that separate units be vented. Many other combinations, of course, could be made for this type of combined laboratory. The equipment would consist of a plain, easily modified table; even a separate top for this table might be provided when it is used for chemistry. Of course this does not meet all of the requirements of a modern laboratory, but some of the best chemists in this country had their early training in a laboratory where all waste was handled through the medium of a half-barrel in the middle of the room. The farm boy needs his chemistry as much as does anyone else. A similar combination can be made of commercial art and mechanical drawing rooms. It is pitiable to see how students in the smaller districts are handicapped by lack of thinking in terms of combining.

*Boys' Shops*

**Wood Shop.** This department has become quite standardized. For the lower grades, say the junior high school, the standard form of work benches together with a simple saw, and possibly a sanding machine, are generally accepted as sufficient. For senior high schools and trade schools, more equipment is necessary. Teaching through production requires modern industrial machinery. One of the main problems in these wood shops is the care of tools, which are used by successive groups throughout the day. We are recommending an accessory room where an individual tool kit equipped with all the cutting tools required in this work can be stored. This requires a little more time for distribution, but it saves enormously in the time spent with poor tools because somebody else was not responsible for their care. These individual kits can be placed in sections which can be locked, thus avoiding borrowing. Everyone takes greater pride in that which is his own. The school's investment is not materially increased, because the individual set of tools for each pupil gets less proportionate wear in the long run because of its more particular care. The space required for these tools is not expensive when properly organized. A very simple method is to provide storage space to the ceiling with iron stair and platform at convenient height. If this scheme is used, the old-fashioned tool room can be reduced in size or eliminated.

**Auto Shop.** The auto shop is the most variable of all shops that have been provided in our schools. It is essential that it may be entered from the street. Outside of this there is nothing in common in the general practices throughout the country.

**Electric Shop.** To teach the electrical trades in a high school, it is necessary to have quite adequate space. There is a growing tendency to combine this with the auto shop, and to confine the instruction in principles to the physics laboratory. However, as electricity has come more and more into common use, the trade schools especially have required a segregated shop for teaching purposes. In the electrical shop, much shelving is required. It is shallow, however, and simply means that the architect provides wall shelving in small narrow compartments. Deep bins and drawers should be had only in limited number.

**Print Shop.** One of the most serious problems in laying out a print shop is the securing of adequate light. Natural illumination in a print shop is less
practical than in any other place in the school. The work is such that it requires adequate artificial light, and therefore it is not objectionable to use some space which has shortage of natural light, and thus definitely depend upon artificial light. To equip a print shop in the school as a commercial shop is necessary only where advanced courses are given, or where full-fledged journeymen are trained. The problem confronting the architect is to get the school to definitely define its limitations in this field.

Sheet Metal. To give adequate courses in sheet metal work, only a very limited amount of space is necessary. It is not essential to do work on large units. The principles involved can be taught with very simple equipment, and by the use of small projects. Probably the most effective organization is found in a shop with a well equipped 30-inch, counter-high table underneath the windows. For this purpose, a bilateral lighted room is desirable. The space underneath the bench can be organized into storage space; the corridor side of the room can be equipped with shelving for display of projects and the housing of tools, equipment, etc.

Locker Rooms. In our boys' shops, it is quite essential that adequate locker space and washing space be provided. Most boys like to remove their ordinary clothing and change into working clothing before going into the regular daily exercises. This is one of the essential reasons for the increased size of the shop unit, so as to provide this locker and dressing room space. A simple equipment consists of a double tier of lockers about 10 x 15 x 36 inches, one compartment for each boy in the maximum sized class, and basket racks for the storage of work clothing, one compartment for each boy taking the course.

Mechanical Drawing. It is well to locate the mechanical drawing room near the shops, because of the general articulation of the work in these. Mechanical drawing supplements shopwork. Shopwork should not be undertaken without definite drawings. To motivate mechanical drawing, it is essential that these principles should be recognized. Adequate artificial light must supplement the best natural light obtainable. It is almost impossible to secure adequate natural illumination at all times. Many prefer north light for this purpose, but well regulated skylight is equally valuable.

The equipment of the mechanical drawing room requires great care. Too often its utilization is limited by the number of individual compartments in the pupil's desk. In order to get more compartments in a desk, the space for each pupil has often been re-
duced until it is hopelessly inadequate. The compart­ments should conveniently hold full-sized drawing kits and drawing boards with unfinished work attached. Extra classes to any desired number may each be served by a locked cabinet with the same compartments as those built into the desks. The instructor's table should be equipped with large shallow drawers for the storage of materials and drawings, and if many pupils are housed, this should be supplemented by a separate cabinet. Ample blackboard space is needed.

A blue-print room should be incorporated in, or adjoin the mechanical drawing unit. If the blue­print room is well equipped, it can occupy a very limited space and yet be thoroughly efficient. It does not need outside light, and therefore, it can fre­quently be provided out of space undesirable for regular classroom purposes.

Art Rooms

What has just been said about mechanical drawing, applies equally well to the art room. This room must, for its best operation, be proportionately large, be­cause it is necessary to have much open space in the front of the room, or, where movable furniture is used, in the center of the room. The art room should have running water, preferably in a sink with ample drainboard space. Running water in an ordi­nary wash bowl is almost useless. In addition to the requirements for the storage of large materials and individual kits and drawing boards needed in the me­chanical drawing department, the art room requires much space for apparatus and its more varied mate­rials. A generous sized room left to be equipped as needed is a great convenience to the art department.

Music Room

Probably no other one factor has contributed more to the shortcomings of the American people in the development of an appreciation and production of good music than has the handicap of inadequate space with which the American teacher has been re­quired to work. The assembly hall is still the music room in many schools, and it is a rare teacher who can get results in this environment. In the first place, it invites overloading of the classes. In the second place, it is frequently unavailable at the regular class periods; and finally, the proper care of materials is an impossibility. A unit where music and dramatics can be equally well housed has much better possi­bilities. An oversized classroom,—as much as a unit and a half,—fitted with a small stage or platform, having adequate storage space, and located so that it can be segregated from the rest of the building, gives a much better opportunity for doing those unusual things which must be done in order to pro­duce the best results. The use of the top story for this unit adds something in the way of isolation. In large high schools, a top story consisting of the music and possibly the radio departments only, is quite feasible. Where the music department must be provided for on the same floor with other units of the school, a simple scheme for isolation is to build all of the storage space on the wall or walls adjoining the other units. If this amount of storage space be not needed, it does not add greatly to the expense of the building to have a dead air area pro­vided by turning out some distance from the wall.

Commercial Department

The proportion of the building needed for this department varies so extremely in different commu­nities, and for that matter at different times in the same community, that planning for future expansion becomes essential. This can be done by planning classrooms with no unusual equipment adjoining the commercial department in sufficient number, so that practically an unlimited expansion is possible.

There is a distinct advantage in planning the com­mercial department as one unit. However, admin­istration on adjoining floors near a stairway is less difficult than it is to have widely separated units on the same floor. There are only a few new move­ments in this department which require the special attention of the architect. The outstanding one of these is the replacement of the old method of book­keeping by the machine method. Numerous electrical outlets, giving a maximum of flexibility in arrange­ment of the room, is less expensive than continuous alterations in order to get this flexibility later.

Bookkeeping. In bookkeeping, the utilization of the room is too frequently lessened by the number of drawers in the desk adopted. Six drawers seem to be about the maximum that can be provided, yet the school is called upon to organize as many as eight or ten classes in this subject. This can be done by providing a vacant space in the desk where the drawer or other container for the pupil in the extra classes can be placed while he is working. Cabinet space will house the extra drawers when not in use by the pupil. The individual lighting of desks may prevent eye strain, but care should be taken to pre­vent light from one desk reaching other desks.
Typewriting and Stenography. The teaching of typewriting and stenography may be combined in one room for advanced courses. The first courses in each of these should be given in separate rooms to avoid duplication of equipment which lies idle in a room housing both courses. In the typewriting room, ample file cases will make it possible for each pupil to learn something about filing, and at the same time keep a record of his own progress. The self-appraisal of one's own work in this subject makes for progress. In both the typewriting and the stenography room, a folding blackboard with tack board and display rail increases the efficiency of the room.

Library and Study Halls

The major features of a high school library are quite different from those of a public library, yet there are times when the same quarters may be used to house both, the public library being operated out of school hours, and, if necessary, its books being distributed to high school pupils only during regular library hours. The community use of this portion of the building is usually at its peak in other than school hours, so that there is no necessity for increasing the seating capacity of the reading room much beyond that demanded by the school. There is a general feeling among librarians, not shared fully by school people, that all libraries should be on first floors, because of better access. In planning buildings, to put the library on the top floor is a distinct advantage, because both sides of the corridor and the corridor itself can be combined in one unit without expensive structural features. This distinct advantage is lost when the library is put on the ground floor.

The school that utilizes study halls as a part of its program has an excellent opportunity to develop self-reliance and individual power in its pupils, if the school assures the pupil of the equipment,—texts, materials, etc., which may be necessary to keep him profitably occupied when he finds himself without assignment sufficient to take the full period in the study hall. A few copies of every textbook used and the most generally used reference material should be easily accessible to every student in the study hall. Book shelving, material racks, dictionary stands, and some deep bins for storage of materials, will aid the school administration in carrying out such a program. If the library is kept close to the study hall, additional advantages arise. Every pupil should form the habit of using the library before leaving the school.

Gymnasiums

There are some changes taking place in the attitude toward equipping the gymnasium. One of these is the demand that it be treated as a playing space, equipped for basketball, volley ball, and similar games, but not equipped with the numerous devices for individual exercise, which are infrequently used. These devices do have a place in the school program, but their use should be restricted to a small corrective department. They clutter up the appearance and
the use of the main gymnasium. Locker and shower space can easily be placed beneath the bleachers or seating space if this be concentrated on one side of the playing floor. The relative merit of this scheme, as compared with placing seating on both sides of the playing floor and housing the shower and locker room in another part of the building, varies in different communities. Where the cost of construction of cement seating space, which is the only fireproof form of construction feasible, is very much cheaper in narrow sections, it sometimes becomes less expensive to forget the space beneath it, and to provide the shower and locker space in light construction adjoining the gymnasium.

The Lunch Room or Cafeteria

From the early high school lunch room, operated by the struggling household art department, to the present-day elaborate cafeteria, operated on a strictly commercial basis, was a long jump. Perhaps the planner of high school lunch rooms can do no better than to keep closely in touch with the commercial development in this field, and incorporate for his client the best ideas produced. The equipment has been thoroughly standardized and is briefly discussed elsewhere. The chief problem in current planning is how to make use of the lunch room floor area at times when not in use as a cafeteria. The high school administrator begging for more room is tempted to make use of this space for purposes for which it never was intended. Here is where the architect serves his purpose. In developing a plan, dual use should be kept in mind. Two questions arise. The first is, “Why must the whole unit be one open space?” This is a universal demand, based upon ease in supervision, but which is subject to considerable criticism. The second is, “What device is best for segregating the unit into smaller units for classroom or other purposes?” Folding partitions, roll curtains, light screens, have all been tried and found wanting. Will not someone, with more daring than the rest of us, plan a dining room with the outside, well lighted area divided into approximately standard classroom sizes by permanent partitions, and let us see how it works? Some extra doors in these partitions would facilitate the use of the recitation units for lunch room purposes. I believe this would be superior to any attempt to use movable partitions. The size of the lunch room is an important factor. School administrators are inclined to underestimate the number of pupils who will demand service when a new project is being introduced in a community. Considerable expansion of the use of the lunch room can be made by extending the number of lunch periods. Many pupils are ready to eat their lunch at 11:30, and 30 minutes seems to be long enough in most schools. By using three 30-minute periods, pupils who do not take lunch at school can usually be given two of these periods, which automatically increases the range within which it is possible for pupils to go home for their lunch.
STANDARD ARRANGEMENTS OF SCHOOL CAFETERIAS

BY
A. E. MERRILL
EQUIPMENT ENGINEER

The accompanying plans represent standard arrangements for school cafeterias, and were adapted from actual installations in the central portion of the United States, where probably the largest number of schools have been so equipped.

Number of Patrons. In determining the space that is required for the particular school, it is customary to assume that approximately 40 per cent of the total enrollment will avail themselves of cafeteria privileges. Furthermore, as this equipment is to be used but once a day, it is always advisable in the larger schools, where there are 1000 or more pupils, to divide them into two or more shifts. A logical division is to have the girls come in at one time and the boys come in at another.

Counters. Even with such a division, there will often be more than could be conveniently handled by the maximum service counter in one shift, and in such cases, the arrangement shown as Outfit "D" is doubled, and two or more identical service counters are installed, preferably paralleling the walls separating the dining room from the kitchen. If space does not permit of such an arrangement, these counters are arranged in horseshoes with two services to each such division, extending vertically from the kitchen wall into the dining room.

Pupils per Counter. Thus, taking an actual case as an example, a school of 1000 pupils, where at least 400 would be expected to use a cafeteria dining room, could be handled by one service counter and dining room, as shown in Outfit "D," providing the girls and boys used the room at different times. Whereas, if the school had an enrollment of from 1600 to 1800, it would be necessary to at least double this counter arrangement and seating capacity, even though the pupils were separated into divisions.

Time for Service. It has been found by experience that under normal conditions it is impossible to serve students more rapidly than at the rate of 12 or 13 per minute; consequently, if 200 pupils are to use a dining room at once, it would be approximately 15 minutes from the time the first was served until the last one had been taken care of.

Seating Capacity. In order that seats may be assured for all the pupils after they leave the counter, it would be necessary to have at least 175 chairs provided for this length of counter, and the extra seats on the plan "D" are for those who will bring their lunch and not require counter service.

Outfits. The various plans indicate different types of table arrangement. Outfit "A" shows 36-inch square tables, diagonally placed through the dining room, which gives more freedom of space than any other arrangement, but is more expensive in floor space required, as at least 14 square feet per seat is necessary. Outfit "C" used 30 x 48-inch tables, placed end to end, and this type of arrangement is most economical of space, as it requires 12 square feet or less per seat, including counter service.

Type of Equipment. In selecting the kitchen equipment and dining room equipment, a wide range of qualities are available, and in the summary which is given here it is a standard serviceable variety, which is not ornate or elaborate. These prices may be lowered by at least 25 per cent for the cheapest or may be doubled if a particularly fine place is desired. Galvanized iron sinks are included and, with the exception of Outfit "A," glass-top tables are used. Where a wooden-top table and bentwood chair are used, the tables and chairs together may be secured for as little as $5.50 per seat, whereas when a glass-top table with a better grade of chair is se-
lected, the cost per seat may run as high as $15 each.

Power Machinery. The use of power machinery is recommended in Outfits "C" and "D," including in the latter a vegetable peeler, mixing machine, meat chopper and dishwashing machine, all of which labor-saving devices are an economy in operation. If any of these were to be eliminated, the dish-washer should be the last to be considered, as for sterilizing purposes alone it is practically a necessity. Only those types using the overhead spray should be given consideration, the type in which the dishes are held in racks, over the washing tank.

Electric Refrigerators and Refrigeration. No electrical refrigeration is included in the cost summary, although this is specified in the majority of the larger installations, and it adds only about $400 for each box of 75-cubic foot capacity or thereabouts. All refrigerators are figured with sheet cork insulation, and all boxes should be adaptable for the use of either ice or mechanical refrigeration.

Cafeteria with Two Units Similar to "D"  
High School, Asbury Park, N. J.

COST ESTIMATES
Outfit "A," seating capacity of 32:
- Serving Counter and Equipment $550
- Cooking Department $410
- Dishwashing $150
- Tables and Chairs $220
- Utensils and Trays $250
- Total $1,580

Outfit "C," seating capacity of 120:
- Serving Counter and Equipment $1,850
- Cooking Department $1,650
- Dishwashing $200
- Tables and Chairs $1,500
- Utensils and Trays $650
- Total $5,850

Outfit "D," seating capacity of 224:
- Serving Counter and Equipment $2,600
- Cooking Department $4,000
- Dishwashing $950
- Tables and Chairs $2,600
- Utensils and Trays $1,150
- Total $11,300
RECREATIONAL AND ATHLETIC FACILITIES IN SCHOOLS

BY
JOSEPH C. LLEWELLYN, ARCHITECT

THE part which recreation and athletics play in schools of the higher educational organizations of the country today, as compared with the same work in schools only a few years ago forms an interesting topic. Not very many years ago, in order to get a gymnasium into a school building without a great deal of opposition, it was necessary to camouflage it as a playroom, recreation room, or something similar,—the word “gymnasium” being not wholly understood. But with the playroom actually provided, its use became more clearly understood; it was extended and supervised, and the gymnasium grew into being. Whether the facilities provided are useful to the fullest advantage may be a topic for discussion, but it is certain that the activities in this field of school life can be made useful in promoting health, in building character, and enabling boys and girls to get on with their fellows in after life. The adaptation of recreation and athletics so as to build and maintain good health and good character is the part of and is in the hands of the nation’s educators, and we believe they are equal to the responsibility. It is the work of the architect to provide the housing and facilities with which to do the work to the best advantage, and to do this work well he must acquaint himself with the educators’ viewpoint as fully as possible.

In the limits of this article it is possible to give only an outline of the essential requirements, and that in terms of the average present-day school, such as is found in the smaller cities and community groups. Briefly, the topic can be divided into two general heads: 1st, provisions for indoor athletics, including the gymnasium and the necessary locker and shower rooms and other accessories, and the swimming pool; and 2nd, provision for outdoor athletics and recreation.

Originally, any rectangular room having a width of 40 to 50 feet, a length of 60 to 70 feet, and a height of 16 feet or more, would class as a gymnasium. Shower facilities were meager, seating space for the public absent or very small, running track and straightaways for the most part absent. Public interest grew, however, and facilities for witnessing the games became necessary. This necessity, together with the necessity of economy, led to the use of many plans looking to the double use of floor space, as, for instance, a corridor converted into a visitors’ gallery by the installation of movable windows between the corridor and the gymnasium; the double use of the same floor space for an auditorium, when provided with movable chairs, and a gymnasium when chairs were removed,—a small stage being provided at one side of the room. These and similar arrangements have their drawbacks as they necessitate the use of removable chairs or bleachers.

The Stage-Gymnasium and the Auditorium. As athletics became popular the auditorium also came into more general demand, and the stage-gymnasium, in which the stage of the auditorium is enlarged to gymnasium proportions, with a proscenium practically the full width of the auditorium, came into use. The auditorium was provided with fixed seats, thus eliminating the storing and moving of chairs every time the occupancy changed, and it became possible to use both gymnasium and auditorium for different purposes at the same time. Improvement in the constructions of accordion doors of light construction and sound-resisting materials has made it possible to reduce to a very considerable degree any interference with the work of either gymnasium or auditorium by the other. The stage-gymnasium in conjunction with the auditorium having fixed seats is an economical arrangement for schools of medium size,—say of from 750 to 1,000 pupils,—and it is well liked by many who have used it, although the first reaction may have been one of opposition.

In large schools, and where funds are available, the arrangement will give way to a wholly separate auditorium and stage, and to separate gymnasiums for boys and girls. In some instances, the stage gymnasium is used by the girls and a separate gymnasium by the boys, the latter without bleachers or seating for the public, as all contests and athletic entertainments, exhibitions, drills, pageants, etc., are given on the stage-gymnasium. The tendency, however, is for larger gymnasiums and larger playing floors to permit more than one class to work at the same time and thus provide for growth in school enrollment; and to have permanent seating accommodations for an average audience, with movable bleachers for expansion upon special occasions.

Gymnasium Essentials. The essentials of a gymnasium are, 1st, a good floor, level, smooth and resilient; 2nd, smooth, hard walls for 10 to 12 feet above the floor and, above this wainscot, plaster quite porous to diminish sound reverberation; 3rd, sufficient height to accommodate the desired apparatus; 4th, permanent seats for average attendance at games, and provisions for caring for special occasions; 5th, shower and locker accommodations; 6th, good light and ventilation in gymnasiums, locker rooms and showers; 7th, other rooms such as coaches’ offices, storeroom, workroom, special corrective gymnastic rooms, and rest room facilities for girls.

The floor for the majority of gymnasiums is maple, a serviceable floor when laid with proper care upon nailing strips supported on felt-lined screeds to give resiliency, with the nailing strips anchored to floor at intervals. Proper provision must be made for the expansion of the floor in damp weather. A fine playing floor is obtained by using blocks of yellow
pine on end, glued to strips, then grooved and splined, and secured to nailing strips brought to true level. Wood floors should be sanded and treated with penetrating oil, placed with mop and left to penetrate the wood. Floors of short wood, laid herringbone or in small squares in mastic and sanded and treated as before, have been used in a limited way. Also a mastic top on a 3/4-inch base of asphaltic concrete has come into use. It has the advantage of neither shrinking nor swelling, is easily repaired, and, in the case of basement gymnasiums especially, is well worth considering.

Walls of smooth, impervious, matt finish face brick laid with smooth flush joints for a wainscot 10 or 12 feet high will resist wear and tear. The ceiling should be covered with a sound-absorbing material. Heights of rooms will be governed by conditions, and must be sufficient to care for all suspended apparatus (usually 22 to 24 feet), and to provide clearance for running track, when installed, so as not to
Stage, Girls’ Gymnasium, Benjamin Bosse High School, Evansville, Ind.
Joseph C. Llewellyn Co., Architects

interfere with a full use of the entire floor area. For the bleachers, sight lines should be well considered. The fronts of the permanent bleachers should be as near to the floor as possible to permit of good view of practically the full playing floor, but high enough to permit of three or four rows of portable bleacher seats. Concrete construction, smooth finish, painted or chemically treated, forms a good base for seats made of 2 x 4-inch cypress or quarter-sawed yellow pine strips, shaped to proper section and secured to blocks to give required height, and well bolted to concrete.

Running tracks are less common now than formerly in the smaller gymnasiums. For large schools, the coaches want them. The construction must be able to carry the standard floor load, for while they should not be used for spectators, they often are so used, regardless of their inconvenience. The floor of the running track must be carefully planned with proper banking at all turns, and laid with narrow

Boys’ Gymnasium, Lyons Township High School, La Grange, Ind.
Joseph C. Llewellyn Co., Architects
flooring which will take the bending. It must be thoroughly nailed and dressed smooth, and finished with cork carpet or similar material well glued to the wood. Straightaways in schools are not common, though often desirable. However, opportunity offers at times in large schools to use a rear corridor adjoining the gymnasium as a straightaway by providing a suitable resilient floor.

**Shower and Locker Rooms.** The structure of shower stalls and floors, and materials used to secure impervious divisions and walls, the treatment of walls, lighting and ventilation, all call for care and close attention. Careful planning is required to secure maximum locker facilities without crowding, to care for pupils and for home and visiting teams,—to give each the desired accommodation. For the larger schools, twin locker rooms, having shower, team and toilet rooms, make a convenient arrangement. (See page 438). In inter-school games the visitors occupy one room, the home team the other.

Various materials can be used for shower stalls. Built-up stalls of monolithic terrazzo on steel and metal cores built into the floors and ground to a smooth surface and polished, are of attractive appearance and are economical. In girls' locker rooms, dressing stalls are provided under various arrangements, varying from one dressing room to three to each shower. Some large schools, after experimenting, have adopted two dressing rooms to one shower as the best proportion, taking into consideration the time required to change classes. The size of classes determines the number of showers and dressing rooms. The average size of shower stalls is 3 feet to 3 feet, 4 inches in width and 3 feet, 6 inches in depth. A triangular locker in each girl's dressing stall permits the use of box lockers only in the locker room and is economical of space. A small mirror in each dressing room avoids crowding before general mirrors at the end of class periods.

Accessories for gymnasium and shower rooms,—such as wall drinking fountains and cuspidors in gymnasiums,—located so as not to interfere with play,—add materially to the comfort of the pupils. Mechanical means of drying hands and for hair drying are sometimes used. Their success depends on the way they are used and the care in maintenance. Ventilation of gymnasiums and locker rooms should be carefully considered. Warm air, blown into the
locker rooms and mechanically exhausted, will aid in maintaining dry rooms. It is desirable to locate shower rooms so that plenty of light and sunshine can be had if possible. Without warmth and good ventilation, shower room walls and ceilings will condense moisture and produce in time more or less disintegration of wall surfaces.

Swimming Pools. Where swimming pools are used, it is desirable to plan them en suite with the gymnasiums so that the same locker rooms and showers can serve both and so avoid duplication. Overhead light with lifting skylights, where possible, gives considerable flexibility to the ventilation of these rooms. Insulation of roofs over pools will be a material help, and care in selection of wall and ceiling finish is necessary. The building of the pool itself is not necessarily an expensive operation. If money is limited, a substantial pool can be constructed with a concrete pan reinforced horizontally and crosswise and waterproofed with integral waterproofing. It can be lined with a bottom of white vitreous tile, sides being of white tile or terrazzo waterproofed; terrazzo gutter and rail, with markings of inlaid tile. This gives a clean, sanitary, and quite satisfactory pool. The floors of pool room can be terrazzo with a mixture to prevent slipping. The room can be finished at a reasonable cost with smooth, light gray or buff impervious brick for walls, and cement plaster, properly painted, for the ceiling. Enameded brick, tile, or terrazzo make attractive walls at a somewhat higher cost.

Water purification in addition to filtering can be by use of chlorination, ozone, or violet ray. Each has its advocates; chlorination by mechanical means furnishes a simple and economical means. Much depends on the proper sizing of supply and circula-
tion piping. Often pipe sizes are too small, causing sluggish circulation. Filters, heaters, and piping to recirculate in eight hours at least are desirable.

In schools of from 750 to 1,000 pupils, coaches for boys are provided with one or two rooms, shower, and storeroom; and the physical directors for girls are given two or three small rooms for offices and workrooms and a rest room for the girls. In larger schools, these suites will expand somewhat to provide a room for corrective gymnastics or exercises for boys, and the rest room facilities for girls will be enlarged to meet the larger enrollment. For the larger schools, also, boys and girls will have their separate gymnasia and in many schools separate swimming pools. The size of the school, its possible future growth, and the financial capacity of the school district are determining factors in planning the recreational facilities for schools. Provision should be made for maximum classes in the gymnasiums, in case of rapidly growing districts, by making larger floors than needed at first and providing for expansion of locker facilities as required. Provision for expansion of space for special work or rest room requirements can easily be taken care of and should always be kept in mind in planning.

In the foregoing paragraphs, the high school has been primarily in mind, but the trend of education today recognizes the value of work and play and is making use of them in elementary schools as well. The architect must incorporate in his elementary buildings the auditorium and the gymnasium with their accessories. The school building is also becoming more than a school for children and is a community asset as well, as the public uses various parts, especially the auditorium, gymnasium, swimming pool and possibly the library. The auditorium or gymnasium can be made accessible and separated from the rest of the school as occasion demands.

The Athletic Field. The chief of outdoor features is the athletic field. The laying out of an athletic field is pretty well established as to necessary size and shape of ground required for the various games. What is not always cared for as it should be is the preparation of the field to give proper drainage, treatment of soil to properly prepare it for seeding, and the foundations for track and straightaways. These require care, not in the preparation and seeding alone, but in the use of the field itself, until a turf is grown and track is brought to a proper condition. This work is in the province of a landscape architect familiar with the locality in laying out drainage and seeding, and it is the work of the gardener to properly maintain it; in the hands of careful and capable men, it can be made of moderate cost when its benefits are taken into account. To preserve the field in condition for school athletics, it should be enclosed. Enclosure can be made by use of woven wire and steel posts, or by brick or concrete walls. The type used will usually be determined by the location of the school, by cost and the ability to pay for it. The enclosure simplifies control in all interscholastic games in the open air.

Outdoor games, as well as indoor, draw crowds, provision for which brings up the matter of permanent seating for the public to take the place of portable or wooden bleachers. These stadia are of various forms from the built-up banks of earth, faced with steps of wood or flat building stone and concrete, to those of wholly concrete construction (open or covered) and faced with brick walls to make a shelter as well as to provide seats. The concrete construction, covered or not, permits of providing various facilities for the comfort of the public which earlier forms of seating do not, and which are essential.

In conclusion, school athletics and recreational activities constitute one large element in creating and maintaining school spirit and in building up school traditions, in teaching young men and women to do team work and, in doing team work, to concentrate attention on the thing to be done; to think and act quickly when necessary; to be one with one’s fellows,—all qualities quite essential in after life. To plan for the requirements of athletics and recreation in our schools and give the buildings all flexibility possible in providing for the present and anticipating the future is, as was said in the beginning, an interesting thing to do. It cannot be done in a haphazard way but calls for all the care and attention possible.
UNDER the liberal appropriations of what the next generation may refer to as the “frenzied twenties,” American schoolhouses have been developed to an astonishing degree, and while the proportion of cubic space devoted to education still remains an appropriate factor, sizes of rooms more particularly destined for athletics, amusement and times of general enthusiasm have increased by leaps and bounds, so that the planning of what might be called the “country club” type of building has come to absorb much attention from present-day architects, sometimes to the detriment of carefully thought out details. Happily the age of Romanesque monastery windows, guaranteed to exclude light from classrooms, has passed, as has the period when English hammer-beam trusses carefully constructed of plaster were considered the prime essentials for a good school auditorium; but careless or ill-considered interior details still often mar (or at least it seems so to the practiced eye) the effect of many a near-sumptuous high school. This article will consider a few of the many items which must come under the care of the schoolhouse architect and sooner or later call for prompt decision. Experience has been defined as something everyone gets when it is too late to use it; if some of these suggestions arrive in time to be helpful, the effort will not have been made in vain. As many features of schoolhouse detailing have been previously considered at length, the main discussion in this article will relate to developments in material and design which have come about since the war.

The Classroom. No matter how many accessories the modern schoolhouse may have accumulated, the classroom still remains the predominant feature, and its main attributes do not undergo many changes. The average size for 35 pupils of the sixth grade to high school remains at 22 x 30 feet, which accommodates five rows of desks across and seven rows deep, with a 3-foot wall aisle, four 18-inch interior aisles, and a blackboard aisle of 3 feet, counting the desks as 24 inches wide. The whole width then totals 22 feet, not too much for the inner part to receive a fair amount of light, but still not down to the standard of the future, which will some day reduce it to four rows or maybe 18 feet, when standard classes shall have been reduced to 28 or 30 pupils.

Windows. The standard window space remains at the empirical figure of 20 per cent of the floor area, which seems to be as much as can generally be obtained, considering the difficulties of wall and window frame construction and the height of window radiators; and if the light is not affected by lowering shades, it is fairly satisfactory on bright days. The future may see a general adoption of some form of white “blackboard” which would materially reduce the absorption of light. The difficulties of wall construction, as far as they relate to wide window spaces, are largely overcome in steel or concrete frame construction, but the average rural or suburban schoolhouse is still far from being of that type, and depends on wall-bearing brickwork for its main supports. A certain amount of pier space along the 30-foot length of the room is therefore necessary, and the architect, while holding these piers down to the least width compatible with strength, has to see to it that they are not so wide as to cast any troublesome shadows.

The sashes themselves, which for the present may be considered as of wood, should also be kept reasonably narrow for ease in operation. If made over 4 feet, 6 inches or 5 feet wide they become unduly heavy, requiring larger weights and stronger frames, and are weak unless made with a liberal amount of woodwork. A good arrangement from the sash manufacturer’s point of view is that of three pairs of double windows for each room, providing it does not interfere with the exterior architectural design. Three pairs of such windows, each about 3 feet, 6 inches x 9 feet will fulfill all the legal requirements for a room 22 x 30, and all the sashes will fall within comfortable sizes for glass, cords, weights and woodwork, and will be free from any tendency to stick. The question of “double-hung” versus tilting windows still remains open. Both types have warm friends and vigorous enemies, though the friends of the tilting type are very positive and numerous among the teachers—who usually like the larger quantities of fresh air which they can thus secure in defiance of the heating engineer’s calculations. Local ventilating units, locally controlled, by which the supply of pre-heated air can be shut off when it is desired to open the windows, are being installed in many schools. Their use obviates the long runs of warm air ducts of central systems and reduces cubicage factors, which appeals to most architects, while teachers welcome the possibility of room control over the vexing matter of ventilation, a privilege which is not, however, very freely granted to them as yet. The objection to this type of ventilation is that it is dependent entirely on the ideas, whims and control of the teachers, who may or may not understand ventilating needs. As what constitutes proper ventilation is a moot question, which is considered in a separate article, we mention here only the space saving that attends the use of the local ventilating units. The whole unit apparatus is contained in a neat steel casing of unobjectionable appearance as far as its design is concerned, but it constitutes a certain obstacle if placed in the window aisle. This location is the most favorable from the point of view of economy, as no long runs of sheet
metal ducts are required to reach the outer air, but various efforts have been made to remove the unit from the room and to place it in a less conspicuous location. One of these sketches shows an arrangement designed by the writer for the James Russell Lowell School at Watertown, Mass., which places the unit in the space ordinarily wasted above the tops of the "Chicago" wardrobes, thus releasing the floor space and clearing the window aisles. A slight increase in cost, hardly appreciable in the total for the building, is caused by the short runs of galvanized duct between the unit and the outer walls.

Blackboards and Tack Boards. Still another development seems to be the growing encroachment of the tack board on the time-honored blackboard space. Many teachers ask for as much as 50 per cent tack board space, going the full width of the blackboard, while others, generally those in the lower grades, want a cork carpet border about a foot wide going all around on top of the blackboard, which is reduced in height for this purpose; still others eschew the cork carpet and demand a board of soft pine or whitewood into which thumb-tacks can be easily pushed, leaving their marks, however, behind. There are ingenious devices available that provide easy means of hanging drawings and other exhibits without marring or danger of falling. Whichever fashion prevails, it is a useful practice to provide an instrument board near the door on which the switches, telephones, thermostats, etc., can be mounted,—that is, providing the electrician can be induced to forego his insuitable desire to put these contraptions in the center of the best wall space in the room.

Blackboards. Blackboards should never, of course, be placed on the window side, and as much space as possible should be saved for them along the inner wall and behind the teacher. A good general rule for heights of chalk troughs above floors is:

- 2' 2" from the floor in kindergarten.
- 2' 4" to 2' 6" from floor in grade IV.
- 2' 8" from floor in grades V to VIII.
- 2' 8" to 2' 10" from floor in high schools.

Screens for erasers above the chalk rail are not generally regarded as being standard equipment, but they are occasionally demanded. They should be of light but strong construction. The ideal, of course, would be a type supported from the back on brackets, so that the troughs could be wiped out with a continuous motion of the hand, but in practice some front supports are necessary.

Wardrobes. In grades below the senior high, the "Chicago" type of wardrobe, integral with the classroom, seems to have found great favor with school authorities on account of its convenience, and with architects on account of its saving of cubage, though probably no one would attempt to say that it is superior to the old separate coat room, especially if the latter is provided with an outside window on the sunny side of the building. Others like placing lockers or wardrobes along the corridor walls, an arrangement more suitable for high schools than the lower grades. The "Chicago" wardrobe saves cubic and square foot space, but it causes loss of a lot of blackboard space, unless it is placed at the rear end of the room opposite the teacher, which should, of course, always be done, but which is not always economical. The most difficult problem about it, after its location is settled, is that of the doors. Shall the doors be hung with weights and slide up and down, or shall they fold back into the wardrobe, or shall they pull down in roller-slat fashion? If they slide up like windows, the long frames and weight boxes are rather a disfigurement to the room, though space is certainly saved. If the doors are mounted on any of the clever folding hardware devices, each is likely to require a little of the length of the wardrobe for folding back, space which may be sorely needed for hook space in case the wardrobe shares the narrow end of the room with a bookcase, a communicating door, and the heat and vent ducts. Details included here show methods of constructing both of these types in recent buildings. The wardrobe may well have a cement floor with a coved base, raised an inch above the classroom floor at the front with a bevel and sloped back to prevent water from umbrellas or wet clothing running out on the classroom floor, and it should have a 6- or 8-inch vent connection in the top and suitable air intakes with
doors at the floor, so that the draft will always be into the wardrobe from the room. The racks for coat and hat hooks may be either poles on metal brackets or flat 1x4-inch strips on wood or metal frames. The flat type has the advantage of never slipping and being adapted to stenciling numbers, should this be desired.

**General Trim.** This should be of simple design, without elaborate moldings or sharp edges which could readily be injured. Architraves are desirable around doors, to prevent injuring the plaster, but they may be omitted at the windows if plaster jambs are substituted with corner guards, if the committee really wants to reduce upkeep costs in the future. Slate or artificial stone is a good substitute for wood window stools to prevent the deterioration of wood where exposed to water of condensation, strong sun and perhaps rain beating in if the window is open. On the whole, some architects think block trim more practical than mitered. Transoms over doors are usually unnecessary. Steel trim of course demands consideration for each project, but a form of substantially enameled base is wanted, as paint quickly disappears from the ordinary steel base when the floor is subjected to mopping. Bookcases are essential, but their type has undergone little change.

**Stairs and Corridors.** Here again the advent of battleship linoleum, cork and plastic floors has changed the scene and effected an enormous reduction in the amount of noise. The use of fabric flooring has done away with the old terrazzo cracks which always appeared to greet the critical visitor right inside the main entrance. The corridor dado needs to have eminently wear-resisting qualities, and can be made of tiling or salt-glazed brick in the more “Ritzy” type of buildings, or of plaster covered with cloth in plainer structures; but only a confirmed optimist will build them of that material hopefully termed “hard plaster” without protective covering.

A considerable variety of materials is now offered for stair treads. Steel pans filled with cement, asphalt, terrazzo, non-slip abrasive tiles, linoleum and many other products are available, as well as blue stone, slate, etc. A steel non-slip nosing is a guarantee against undue wear. Some schools have had wooden treads thus fortified go through over 25 years of hard usage without perceptible damage. Different states have various rules for the height of the balustrade, but in any case a handrail at the usual height on both sides of the run is essential. Some states even require a 5-foot balustrade. Careful checking up of local regulations in this respect is necessary. The balustrade, if of iron, should be of simple type, and consist mainly of vertical mem-
bers for easy cleaning. In some cities solid balustrades are preferred to prevent objects’ dropping through. The nature and characteristics of the stairwell or tower also need thorough study. So many fires have gained headway by shooting up the stair wells that it seems that enclosing the platforms at each floor with self-closing fireproof doors should be universal practice, even though it is not always obligatory. These doors and the partitions which contain them are generally made of kalameined wood, which is neat in appearance and sufficiently fire-resistant. The panels and transoms are filled with wired glass to transmit light from the outer windows, that in the door being clear wire-glass. The “smoke doors” so called, should open toward the stairs and should preferably consist of one pair without a central bar, so as to direct the stream of pupils toward the downward flight. The hardware should consist only of self-closing door checks, butts, pulls, and push and kick plates. Floor stops, hooks, or other attachments for holding doors open should be omitted, in spite of the tearful protests often received from the teachers, for such accessories defeat the primary object of the doors, which is to provide constant protection against smoke or flame in the stair wells by closing off any up-draft of air. Massachusetts and some other states require that the outer wall material, in the opinion of some architects, is glazed or salt-glazed brick, which is durable, cleanly and does not require painting. The stairs when practicable should be located at the ends of corridors, so that light from the stair windows will shine through the smoke partitions and along the corridors. Stair towers should not be more than 125 feet apart. Some states allow, and others forbid, by-passes through schoolrooms with communicating doors, so the architect has little option in this respect, and he can best serve the community by insisting on plenty of stairways, easily accessible. The riser and tread sizes are also subject to public regulation and should be kept at a comfortable proportion, for obvious reasons. Closets should never be constructed beneath stairways, under any conditions.

Toilets. The science of sanitation in this respect is well advanced; in fact, in the opinion of many foreign writers the character of American civilization is expressed in our plumbing, and the matter of designing toilet rooms for its accommodation is not less well developed. The architect will, however, have to decide upon the materials with which the floors, walls, and partitions are to be constructed. It should be said that the essential requirements are first, light, which shows up dirt; and second, ease of cleaning. To this end a light colored floor is most desirable, even though it keeps the janitor busy mopping up, for a black floor absorbs light, conceals dirt and is always unattractive. White vitreous tile or mosaic, perhaps with black dots or pattern, and white glazed tile dados are none too good for the purpose. For toilet partitions, marble or some of the white products are ideal, but costly. Slate has the disadvantage of absorbing light and being easily marked. Enameled steel is in quite general use, but wood doors are sometimes preferable to steel doors, as they are less noisy and easier to adjust when a measurement goes wrong.

A technical discussion of various types of plumbing fixtures would occupy more space than is afforded by the limits of this article and is more adequately treated elsewhere in this issue of The Forum. In passing, one might question the use of expensive individual vitreous china basins for hand washing, when a good white enameled sink provided with plenty of faucets where the hands may be washed under running water might serve the purpose far better and actually be in closer accord with modern ideas of cleanliness. The single basin, seldom cleaned, with self-closing cocks which limit the supply of water, while pleasing in appearance, is often more of an obstacle than a help to personal cleanliness. Some sort of screens, or deflected passages to toilet rooms from corridors are thought necessary by educators.

Museum Cases. A good many schools gradually acquire specimens of minerals and all sorts of natural history or other exhibits, not to mention athletic

Demonstration Table
Alexander Hamilton Junior High School, Elizabeth, N. J.
Kilham, Hopkins & Greeley, Architects
cups and trophies, for which no suitable place is provided. It is often easy to provide cases which can be snuggled into spaces around the heat and vent ducts, with glazed doors opening on the corridors where such objects can be properly displayed. Most cases should be white inside, and if the matter is of sufficient interest, may even be provided with lights.

The Kindergarten. The consensus of opinion requires that this room shall have a full southern exposure so as to obtain all the beneficial effect of floods of sunlight. This is mentioned somewhat guardedly, as the writer was recently a dissenting member of a jury of A. I. A. architects which awarded a competition to a plan which placed the kindergarten on the north side, mainly on account of an artistically drawn lilac bush placed in front of it by the skillful renderer. The program forbade any accessories! Having been then over-ruled on this point by prominent members of the profession, he is still a little timid about it, but continues to cherish the notion that the south side is best. The kindergarten should have its own separate entrance and, if possible, a level and sunny playground, even with the door sill, so that the juniors will not have to be helped up and down steps when they go out to take the air. Their coat room should be of a size which will allow a bench for the attendant to use when putting on their rubbers and arctics and buttoning them into their what-alls. The toilet, which should be of an extreme handiness to the main room, will need special low-height fixtures and plenty of light. As considerable time will be spent by the pupils on the floor, that detail of a kindergarten requires special consideration. The ideal material would be something warm, or at least not too much of a heat conductor, which is at the same time easily cleaned,—cork, either tile or carpet, or one of the new rubber fabric floors seems to fill the bill as well as anything. Some regard cork carpet as not being susceptible of easy cleaning, but it has been successfully used in a good many kindergartens and is warmer than linoleum. The fittings of a kindergarten will vary according to individual wishes, but will generally include boxes and compartments for blocks and playthings, a large amount of tackboard space, and probably a small amount of blackboard.

Hood in Science Room

Alexander Hamilton Junior High School, Elizabeth, N. J.

Kilham, Hopkins & Greeley, Architects
The larger and smaller rooms which usually constitute the kindergarten suite are sometimes separated by rolling or accordion doors, to allow them to be easily thrown together. Custom seems to decree that the kindergarten should have a fireplace, but committees seldom appropriate money to buy wood, so its bricks often retain their virgin cleanliness for generations, unmellowed by smoke. However, an inglenook with seats looks well, and sometimes there is a gift of firewood, so that a fire is actually started. For this reason it is always well for the architect to see that a practical flue is constructed, which does not end in an air duct! Bay windows and other attractive features are appropriate for this part of the building and are sure to be appreciated.

The Auditorium. It must be said that the type of school auditoriums seems to be passing through a transitional stage. For large schools of 1,000 to 2,000 pupils the effort has heretofore been directed toward providing an auditorium capable of seating the entire membership at once. The expense of building such rooms as these, as well as their somewhat unwieldy sizes, has led to the consideration of the suitability of smaller types. If, for example, a two-platoon school of 1,500 were equipped with an auditorium for 750, the costly overhanging balcony could be omitted and the entire number comfortably seated on a rising floor with every occupant in full view of the others and not hidden by balconies. For the construction of such a room the general specifications for a theater minus the expensive decorative effects, could well be followed. Every effort should be made to assure good acoustics. Fortunately, several commercial systems of treatment for the walls and ceilings are available, and they can be trusted to produce reasonably good results. Upholstered seats will help, and linoleum or fabric for the aisles, if not for the entire floor, is desirable to minimize the noise made by persons entering and leaving. A form of wainscoting, for which purpose there is really nothing much better than wood, is necessary to protect the walls from hard usage, and no projecting radiators should be tolerated. An auditorium, however, differs from a theater in that it usually has windows for day lighting, and means must be provided for excluding light when it is desired to give picture exhibitions. This may be accomplished by means of opaque rolling shades, running in grooves at the sides of the windows, or by heavy draw curtains, which are simpler and perhaps fully as good, as well as being more decorative. The windows themselves will require some thought, as the sashes should not be too large and heavy, and provision must be made for cleaning them.

Some schools wish completely equipped theatrical stages, with switchboards, fly galleries, smoke ventilators and even grids. Such halls will probably also want sunken musicians' pits and complete dressing room layouts. It is difficult to know just where to draw the line in these cases. Good school shows can be put on with very modest equipment, and if modern ideas of stage lighting effects are followed, the expensive borders and drops can be omitted. In any case, the architect must remember that his stage problem is four-fold, for he must provide facilities for (a) a single speaker with perhaps a few persons in chairs to form an entourage; (b) provision for a class of maybe 100 or 200 for graduations, or producing cantatas; (c) accommodation for a dramatic production, either by the students or by a regular troupe, professional or amateur; and (d) facilities for showing motion pictures. To fulfill all these requirements and satisfy everyone will require ingenuity and some tact. A "cyclorama" of velours provides a good background for the single speaker and closes off the somewhat dreary look of an empty back stage. The back of the proscenium must be arranged for the fire curtain, draw curtain, sprinkler pipes, picture screen and lighting effects. The switchboard should be sunk or raised so as not to interfere with the operation of the play, and all the local regulations will have to be carefully studied; and adequate special exits must be provided for the stage. Other special features of the auditorium are the motion picture booth and its ventilating system; the manner of lighting, which must not interfere with the projection machine; the type of entrance doors,—whether with or without transparent glass; and the type of ceiling. If the auditorium is contained in the center of the building, outside light is often admitted from the roof, which involves much care of the glass ceiling. This arrangement, however, seems to be passing out in favor of the exterior auditorium with side windows.

Aside from these observations regarding various special items of schoolhouse construction, there are certain basic requirements which ought to be kept in mind in drawing up the details. Among these are durability; ease of maintenance; economy in first cost, (which would include transportation and time required for obtaining the product); suitability for attractiveness of appearance. Mouldings with sharp edges or wide flat surfaces which collect dust are easily damaged and unsuitable, and yet one often sees clothes racks or stair newels carrying the full Doric order as decoration. Wall tiling has its place in toilets and corridors, but one of the most costly and highly praised of the recent high schools has the boiler room finished in white glazed tile and the main corridor in cheap textured plaster! Many chapters might be written about exterior detailing. Some optimistic members of the profession believe that painting the back of a parapet wall with some evil-smelling compound is a perfectly good substitute for 16-ounce copper, and they wonder why their million dollar roof leaks after a couple of years. Others are completely in the dark about the mysterious efflorescence which appears under their window sills, or the strange disintegration of elaborate pinnacles and ornaments. To all concerned in schoolhouse building, the question of detailing is a fascinating and profitable subject, which will repay study.
TWO billion, three hundred forty-four million, nine hundred eighty-four thousand dollars! This represents the contract expenditure for school building construction and equipment in 36 states for the past seven years only. As the greater part of this construction work has been financed either by long term or short term serial bonds, it is fair to estimate that the actual cost to the tax-paying public for these schoolhouses by the time the bonds are retired will be 50 per cent more than the principal sum, or a grand total of $3,517,476,000. For the entire United States the gross investment in school building construction for the seven years, for which the foregoing figures were compiled, was a sum considerably more than $3,500,000,000, practically all of which must be paid by taxation.

With the completion of a school building, its cost to the public does not cease; there at once begins the cost of operation and maintenance. This latter cost becomes an index of the wisdom shown by those responsible for the original construction investment. The figures involved are so large that even a small percentage of saving becomes an impressive amount. It behooves those accountable for the handling of public school funds to carefully consider every item entering into the construction and equipment of a school building and to weigh its original cost against its subsequent cost of maintenance. It has been repeatedly demonstrated that, by carefully revising the plans and specifications of school buildings upon which bids have exceeded appropriations, a saving of from 5 to 10 per cent can be made. School board members, superintendents and school architects are called upon as never before to study the problems of schoolhouse construction, in order that the tax dollar may provide the best buildings possible, and that these buildings may be so constructed and equipped that subsequent maintenance costs will be a minimum.

Not many years ago, when a school building was wanted, the common practice was for the school board, or the superintendent, or the school building committee to select an architect and tell him to prepare plans for a school building of a stated number of rooms or to accommodate a certain number of pupils. In many instances the architect selected was totally unfamiliar with schoolhouse design. During this period, questions of economy and efficiency in schoolhouse design, construction and equipment received but slight study; as for standards for heating, ventilation, lighting and sanitation,—there were none.

Of recent years specialists in schoolhouse architecture, with their engineers, have made exhaustive and extremely valuable studies of the school housing problems in many cities, involving many types of school administration and widely divergent curricula. Surveys were made to establish relationships between educational activities and requisite floor space needed. The ultimate outcome of these surveys was use of the "candle of efficiency" in the report of the Committee of Standardization of Schoolhouse Planning and Construction of the National Education Association. Mechanical and physical data were worked out and made the bases for state and city laws, ordinances and regulations governing schoolhouse construction and mechanical equipment. These men carried their ideas from one part of the United States to another. During this period, architects and engineers practically determined all school building policy insofar as design, planning, construction and equipment were concerned, the superintendents confining their activities to instructional policy only.

The pendulum had swung to the extreme of the arc. Schoolhouses were built almost without any consideration being given the superintendent; in many instances without regard to cost, elaborateness, or sizes and number of rooms. Time and time again a schoolhouse was handed over to the superintendent with the admonition to "go ahead and run it,"—a building in which he had had no part whatever in planning, designing or equipping.

Whether it was the high cost of the school buildings which were designed and constructed during this period of development, or a recognition on the part of the superintendents of their waning control,—whatever the cause, by the year 1915 the pendulum began to swing back. Both educators and laymen began to recognize that the superintendent of a school system holds a dual position, which in industry is more often designated by the title of "general manager." He is not only responsible for the instructional phases of education, but also for the physical surroundings in which the youth of the nation are being educated. He is charged with the task of preparing the building and financial programs, and of appearing before the boards through which the money to carry out the programs must be secured, and of getting from them the needed appropriations. It gradually became fixed in consciousness that the principle of direct responsibility should be applied to school business as it is to industry, namely, that the person responsible for the quality of the product and its cost should also be made responsible for the complete organization and machinery by which the quality and cost of the product are determined.

As the superintendent began to be recognized in his dual role, we find the architect and superintendent discussing and selecting designs and elevations as to architectural beauty, grace and dignity; working out the problems of space allocation and economical floor planning for the kind, size and relationship of rooms needed and their utilitarian arrange-
ment; examining construction features and studying and comparing original costs and subsequent mainte-
nance charges; judging building materials with re-
spect to their practicality and lasting qualities, and
selecting efficient mechanical and educational equip-
ment on the basis of low original cost commensurate
with economical operating expense and cost of main-
tenance.

"Cost" has become an important word in the mod-
ern school world. It represents a factor entering into
every phase of modern school administration. Simply
stating the cost of building construction, no matter
upon what basis,—whether cubic foot, square foot,
classroom, pupil, or any other,—does not reveal
where a lack of economy may exist in design and
equipment, either as to original cost or subsequent
maintenance. A detailed analysis of all costs,—a
picking to pieces of all the factors of cost that
enter into the design, plans, construction, equip-
ment, construction superintendence, and architectu-
tural and engineering fees,—often reveals places
where economies may be made to very favorably
affect construction and maintenance costs without
lowering in any way the ultimate educational, archi-
tectural and mechanical value of the building. What,
then, are some of the items through which savings
may be effected?

Types of Construction. The only three types of
construction which have been countenanced in recent
years for schoolhouses are defined in the Classifica-
tion Code of the American Institute of Architects, as:

"Type A. A building constructed entirely of fire-
resistive materials, including its roof, windows,
doors, floors and finish.

"Type B. A building of fire-resistive construction
in its walls, floors, stairways and ceilings, but
with wood finish, wood or composition floor
surfaces, and wood roof construction over fire-
resistive ceilings.

"Type C. A building with masonry walls, fire-
resistive corridors and stairways, but with ordi-
nary construction otherwise, i.e., combustible
floors, partitions, roofs and finish."

Type A construction seems impractical for a
school building. To provide fire-resistive materials
for classroom floors and built-in furniture and equip-
ment would involve not only a high cost, but would
be prejudicial to the comfort and well-being of the
pupils. A schoolhouse must be made safe for the
youth housed therein. For this reason, Type C con-
struction, often referred to as "slow-burning mill
construction," is not as desirable as Type B con-
struction. Furthermore, as it has been repeatedly
proved that the difference between the cost of a
Type B and a Type C building is often as low as
5 per cent and seldom above 10 per cent, it is ex-
tremely unwise to attempt a saving in this direction
if for no other reason than to safeguard child life.

The factors of insurance rates and maintenance
charges are financial considerations which militate
against any type of construction below that of

Type B. Not infrequently the temptation presents
itself to build all one-story parts of school buildings
of non-fire-resistive material. This is highly inad-
visable, as the burning of these parts of otherwise
fire-resistive buildings has not only caused large
financial losses and the closing of buildings while
repairs were being made but has caused stampedes
which have resulted in large losses of life.

Materials and Details

Face Brick. In addition to making a comparison
of the appearance and prices of brick which are to
be used on the outside of the building, special con-
sideration should be given to their size, durability
and weather-resistive qualities. The selection of a
small brick will involve use of many thousands of
additional wall brick and a much greater labor cost
in laying them; the increased number of joints will
multiply the chances for maintenance trouble; while
the gross cost of the brick and labor is often much
more than that of a larger size of brick at higher
cost per thousand. Soft, underburned brick with
poor wearing qualities, laminated brick, and glazed
brick with surfaces that may easily be chipped,
should not be used, if subsequent maintenance ex-
 pense is to be avoided. In addition to natural wear
and tear, the defacement of these bricks by school
children is to be considered.

Parapets. There are certain kinds of parapets
which should be omitted from a schoolhouse regard-
less of their artistic beauty, simply because they
are costly to maintain, especially in cold climates
where frost and freezing occur. Parapets which are
irregular in shape, highly ornamented, or with port
holes are especially subject to rapid deterioration.
The cost, utility and durability of the materials used
as the covering for parapets should be carefully com-
pared. The principal consideration is securing a
covering which will not disintegrate under the
action of either time or the elements. The method
of application of the material is also of vital im-
portance. A material of strength and durability, if
applied with exposed joints and meeting strips so
that the weather can penetrate them, is soon forced
out of position and rain water is admitted. When
this happens the coping is loosened and is likely to
fall; the wall beneath the coping disintegrates; and
water leaks into the building, causing ruin of plas-
ter, woodwork and paint. It is a costly operation
to repair roof parapets and chimney tops, so a care-
ful consideration of the material used to protect
them and its application is important. Copings of
tin and galvanized iron are not durable. Bronze
and copper copings are not sufficiently serviceable
to warrant their high cost. Plain stone copings or
copings of glazed salt tile of a selected quality will
endure, if the joints are made properly, as long as
the building itself, and they are moderate in cost.

Roofs. A flat roof is less expensive in original
cost than almost any other type of roof construction,
is cheaper to maintain, is more easily accessible, and is safe for the public. Sloping roofs covered with slate are deserving of special consideration. Unless the slate is applied with extreme care, and the roof provided with guards, the slate often becomes detached in windy weather and slides off, as does also the accumulation of snow, endangering the lives of persons who may be below. Tile roofs are difficult to lay so that they will be perfectly weather-tight and are difficult to insulate. Maintenance costs are not as much of a problem in their case as is the heating cost of the building.

Chimneys. In these days when chimneys on school buildings are no longer looked upon by architects as disfigurements, these shafts have become the objects of special architectural study. When confined to simple and dignified lines they can be made beautiful and attractive. Costly patterns built into chimneys are often obliterated by soot and dirt, especially if these designs are near the tops of the chimneys. A poorly constructed chimney is a perpetual cause of maintenance expenditures; a badly designed chimney results in high heating costs and often develops into a smoke nuisance. The inside of the chimney should be perfectly straight, or preferably somewhat smaller at the top than at the bottom. This is for the reason that as the gases ascend they cool and contract and require less area for discharge at the top of the chimney than they require at the bottom when leaving the breeching. If the stack is larger at the top than at the bottom, the draft is destroyed by the air rushing down the stack and establishing cross currents. This will also result in the chimney smoking badly.

Windows. Schoolhouse windows have been for years and still are the matter of much debate. Wood versus steel sash; double-hung versus swivel sash; casements versus French windows;—around use of these various types there goes on a seemingly never-ending dispute. It is claimed that use of steel sash increases the operating expense of a building because steel conducts heat out of the structure so rapidly that the burning of a considerable larger amount of coal is required to properly heat the building. The original cost of installing window shades on steel window sash and their subsequent maintenance cost have also provoked much discussion. The experience of the writer has been that wood sash are preferable in northern climates.

Window Sills and Stools. It is false economy both in original investment and subsequent maintenance cost to build window sills and stools of any other than the very best materials. The drying, rotting, paint-removing, and wetting effects of the sun, rain water, and drippings from flower pots which are so often used in school buildings, have repeatedly demonstrated that sills and stools should be built of a durable material such as stone, brick or marble.

Entrance Doors. Heavy, metal-covered entrance doors were formerly looked upon as safety devices, in some mysterious way linked up with safety in case of fire. They were also looked upon as a means for protection from thieves, but are no longer considered in this light. Thieves enter through windows and by other easier means of ingress. Double-hung, light weight, glass paneled doors are being looked upon with more and more favor in school-house construction from the standpoints of appearance, ease of operation, economy in first cost, low cost of maintenance, and light for the space just inside the entrance. Instead of using double doors in a full width of opening without a mullion, the practice is becoming quite general of having two single doors with a small mullion between them. This type of construction reduces weight, minimizes shrinking and swelling, simplifies the application of panic bolts, makes possible the installation of weatherproof doors, and makes possible the use of compact, light weight, standardized door units at low maintenance costs at all entrance openings.

Door Hooks. Only too often means of holding entrance doors open are omitted, resulting in some would-be mechanic's applying hooks or cleats which mar and cut the woodwork and not infrequently gouge deep grooves in valuable stonework. All such appliances should be avoided, and preference be
given to one of the many kinds of automatic door catches which protect both door and woodwork and involve practically no maintenance charge whatever.  

Outside Door Sills. Door sills which are made of a soft material, such as wood or slate, soon become cupped and present a very dangerous hazard for the school children who must cross them several times daily. Ordinary iron sills are slippery and, therefore, hazardous. Sills which become cupped need to be frequently replaced, since they admit large amounts of cold air in winter weather under the doors. Granite sills are durable, safe, and afford an unquestioned economy in maintenance. There are various durable non-slip sills which are satisfactory.

Window Glass. Plate glass for general use in a school building is an extravagance when compared with the use of the high grade, single-strength, selected glass of modern manufacture. The lower cost of the latter is noteworthy, as glass-breakage is a considerable item of maintenance expense in all school buildings. It has been said that New York spends $90,000 every year for glass replacement, and Chicago $75,000.

Flooring. No other feature of schoolhouse construction has been given more consideration than the material which should be used for schoolhouse floors. Wood, cement, tile, asphalt, rubber, stone, linoleum, mastic, terrazzo, cork, and many other materials have been used more or less successfully. In this problem of selection, the matter of appearance is often the deciding factor, whereas durability, ease of cleaning, and maintenance cost should be the main considerations. If pupils' desks are changed frequently, will the floors be damaged by reason of the many screw holes? Will the floors be soft and sticky? Will the floors be cold, hard and noisy? Will the floors hurt the feet of the children? Will the softness of the floors cause breakage of tools which may be dropped on them? Will the floors be full of bumps and holes? These are some of the questions to be answered when selecting a schoolhouse floor. Not infrequently the faulty installation of an otherwise excellent floor material builds up subsequent maintenance costs as much as does the selection of an inappropriate kind of flooring.

Inside Trim, Toilet and Shower Stalls. In a school building filled with irresponsible youth, the use of materials which will withstand the onslaughts of jackknife and pencil artists is a phase of the construction problem which is frequently overlooked. A child likes to lean against the walls, or to stand with one leg crooked with foot against the dado. For these reasons; corridor dadoes should be of hard surfaced brick, or tiling, or some other hard material which can easily be washed. Shower and toilet stall partitions should be of rugged construction and of a material that cannot be readily cut, scratched or marked. In toilet and shower rooms, and wherever there is any moisture, the use of wood should be avoided as it is unsanitary and costly to maintain. Enamed cement or steel partitions are good looking, sanitary, durable, less likely to be marked and cut by pupils, easily repaired, and their use is attended with low maintenance cost.

Wood and other materials of an absorbent nature should not be used in any room where there is a great amount of moisture or where immaculate cleanliness is demanded and frequent scouring necessary to prevent insanitation. The original low cost of wood construction in all such locations is offset many times by subsequent cost of upkeep.

Specially Fabricated Steel. The widening of a classroom by a few inches sometimes requires that the beams be enlarged or that especially designed beams of specially fabricated steel reinforcing be used. This at once adds considerably to the cost of construction. The superintendent should not interfere with purely architectural structural matters, such as foundations, walls, floor slabs, girders, beams, spans and other physical details. There have been many instances, however, where a general inquiry by the superintendent or architect has revealed that, without interfering with the educational efficiency of the building in any way, the reduction by a few inches of the width of classrooms has made possible a complete change in the structural framing detail of the building at a great saving in cost of construction and maintenance. The use of standard steel materials and forms results in large economies. The only places where the use of expensive, specially fabricated steel is excusable are under balconies in auditoriums, in order to avoid use of columns which would reduce the seating capacity and impair the visibility of the stage, in special study rooms, and in gymnasiums when classrooms are to be built over them.

Heights of Ceilings. The standard height of a school classroom is 12 feet, measured from floor to finished ceiling. The finishing of the ceiling generally comprises metal lath on the under side of the ceiling beams and the finished plaster applied to this lath. The thickness of this construction, from the under side of the finished plaster ceiling to the top of the ceiling beam is, on the average, about 1 foot. In schoolhouses recently constructed, a little more attention has been given to the formwork in order to produce a more even finish to the concrete after the forms are removed. The concrete is then treated with a light application of cement wash which gives the entire surface a smooth finish. The metal lath and plaster are omitted. The concrete beams are left exposed and present a very pleasing appearance. This construction is very much less expensive and reduces maintenance cost to practically nothing. It possesses the additional advantage of reducing the floor-to-floor height by 1 foot. In the average 18-room elementary school building this represents a saving of about 17,920 cubic feet per floor. Exposed beams improve acoustical properties.

Wall Finish. The wall finish in schoolhouses is,
Heavy Solid Doors
Lighter Glazed Doors

Lighter Doors Are Growing in Favor for Several Reasons

generally, either smooth or rough plaster. Many years of experience with both kinds of finish and of observation in hundreds of schoolhouses, leads to the opinion that smooth plaster is much more easily marked and damaged than is rough-finish plaster, the original cost is higher, and the making of repairs is more difficult and costly. In industrial rooms the environment should approximate, as nearly as possible, the conditions which prevail in industry. It is not objectionable, therefore, to leave the tile walls unplastered, but painted. There is no need of plaster on the walls of these rooms, and its absence adds to their industrial "atmosphere" and reduces the cost of construction and maintenance.

Corridor Walls. Corridor walls are usually built flush on both the classroom and corridor sides of all supporting columns, and frequently with an additional breathing wall on the corridor side. This is done in most instances for two reasons—to avoid the exposure of supporting columns and to hide the ventilation ducts carried up through the building. Wherever experiments have been made in the elimination of all unnecessary filler tile, there has been a great gain in corridor space, part of which has then been used for built-in lockers and cupboards. Exposed columns in public school corridors are no longer considered objectionable. Where unit classroom ventilation is used, all vertical duct work and breathing walls are eliminated. This saves from 12 inches to 18 inches of corridor space, resulting in a very noticeable reduction in construction cost.

Lintels and Door Anchors. One of the most aggravating and persistent sources of schoolhouse maintenance cost is due to badly constructed door lintels and poorly anchored door frames. Every door lintel should be reinforced to prevent it from cracking or sagging. When a door frame is not securely anchored into the supporting walls, the constant jarring due to the opening and closing of the door soon breaks the plaster surrounding the frame. When this happens the only thing to do is to reset the entire frame, or there will be a continual maintenance charge.

Wardrobes. Schoolhouse wardrobes or coat closets present a problem which causes much discussion among architects. It is safe to say that there can be no quarrel with the statement that exposed wardrobes are objectionable. Of other types there are three which are being quite generally used,—the wardrobe which is a separate room at the end of the classroom; the wardrobe which is built into either the end or the corridor wall of the classroom and which may be shut off from the classroom by pivoted or sliding doors; and individual lockers. If an opinion may be ventured, it would be that lockers have not been found to be satisfactory or practical in elementary grade school buildings. Small children cannot reach the hooks in the upper tier of lockers, with the result that their wraps are jammed into the bottoms of the lockers along with overshoes and other articles. In wet weather this condition is highly objectionable and unsanitary. The locker doors are frequently left open, and no little damage is constantly inflicted upon the hinges, locks and
handles, which quickly runs up a considerable main­
tenance charge. Built-in wardrobes occupy wall
space which may be used to better advantage by
continuous blackboard surfaces. This type of ward­
robe, when built into the corridor wall, also either
reduces the width of the classroom or increases the
width of the building, thus increasing construction
cost,—and as in most instances where there are a
large number of moving parts of some weight, the
cost of maintenance is considerable.

Modern education is requiring more and more
storage space in every classroom for materials and
supplies. To meet this trend, the separate room
end wardrobe is meeting with much favor. This
room may be separated from the classroom by a
half-height cupboard and bookcase. The low height
permits sufficient light to pass over the top of the
cupboard to light the wardrobe well. The cupboard
may have deep shelves at the bottom, for storage
of the largest sizes of project work, and narrow
shelves above for storage of books and supplies.
This type of wardrobe permits a better circulation
of the pupils in the classroom, reduces the use of all
other closets in the classroom, and reduces mainte­
nance and operating charges to a minimum.

In General. A large maintenance expense is al­
ways introduced in schoolhouses where classroom
display work, pictures, maps and charts are fastened
to the wood trim and walls with pins, tacks, nails
and stickers. Picture moulding should be furnished
throughout the building, and no pictures should be
hung except from this moulding. Means should be
provided above the blackboard frame and below the
chalk rail in every classroom, and display work
should be hung by small clamps.

Schoolhouses are being built to last for 50 years
or more. It, therefore, behooves the schoolhouse
architect to equip his building with appurtenances
which will have an equally long life under severe
usage. Under this heading fall hardware, which
should be of standard stock designs, strong and
durable; kick-plates at the bottom of all doors to
withstand the agile boot toes of children in a hurry;
door checks to prevent doors from slamming, which
is not only distracting but involves a severe strain on
the doors and casings; natural slate blackboards, which
will outlast the building itself, and when in need of
resurfacing can be inexpensively rehabilitated with
a piece of pumice stone or a common brick at a
cost of less than five cents a square foot; balus­
trades, which may be built of reinforced concrete
and made an integral part of the stairs themselves
and never require any maintenance outlay, especially
if the handrail brackets are anchored clear through
the thickness of the balustrade and bolted; and a
multitude of seemingly minor details, inconspicuous
in themselves but which, when assembled in a com­
posite list, constitute a formidable array of features
indispensable in schoolhouse construction and equip­
ment.

These are some of the items in connection with
schoolhouse construction,—the selection of materials
and maintenance cost,—which are receiving the
analytical attention of all progressive school super­
intendents and architects. In addition, there are
many items of mechanical equipment and educational
equipment which are deserving of as careful study
and selection as is given the items entering into the
building construction, in order that much unneces­
sary expense in both original cost and subsequent
operation and maintenance cost may be avoided.
As it becomes more and more difficult to secure the
enormous sums of money needed to meet the grow­
ing cost of public school activities, the first form of
pressure that has been brought to bear is the demand
that a saving be made on the material side,—the
building construction side,—so as to release more
of the available funds to the instructional side of
education. This movement has brought the mem­
bers of the school board, the superintendent and his
assistants, the architect and the engineer into closer
contact than ever before in the history of the public
schools. Each has his important part to play in the
great business of education.
HEATING AND VENTILATING THE SCHOOL

BY

ALFRED KELLOGG

CONSULTING ENGINEER

The unusual interest aroused in 1923 by the publication of the "Report of the New York Commission on Ventilation," which interest still continues, is sufficient warrant for an article reviewing the present status of school heating and ventilation from the standpoint of the architect.

The Present Situation. Since the beginning of the century and up to the year 1920, the several methods, or so-called "systems" of school ventilation were considered reasonably standardized. During the last 25 years the newer thought had evolved the broader idea of what is now termed "air conditioning," involving something more than the supply of warmed air; but for various reasons its application to school ventilation had made but little progress. In the latter half of the decade from 1880 to 1890, the results of research work by Pettenkoffer, confirmed by similar work carried on by French and English scientists, began to take practical form in an effort to supply a given volume of air to the pupil. The theory then advanced as the result of the research of that period seemed to indicate the need of supplying 30 cubic feet of fresh air per minute to each occupant of a schoolroom,—not that all of the 30 feet was deemed necessary for the actual need of the pupil, but rather for lack of known means of procuring proper dilution throughout the occupied space and consequent dilution to a standard condition of purity.

Just here it is well to draw attention to the fact that no standards of air volume and purity have ever originated with the engineer or the architect. On the contrary, such requirements have always been laid down by the biologist, physiologist and their followers in the medical profession. There are today many among the same professions who would relegiate the work of the past delvers into this particular branch of science to the limbo of those scientific truths that are not so. The subject, therefore, is at the moment highly controversial, but sooner or later the present fog of uncertainty will be lifted, and a rational scheme of school ventilation will probably be evolved which the writer suspects will measurably differ from the extreme positions now occupied by both parties to the present controversy.

If ever the medical profession, the physicists and the hygienists agree among themselves as to the proper atmospheric conditions to be maintained in our schools, the architects and engineers may be depended upon to fully meet the newer requirements. But before ignoring the sign posts of the past, reckoning them as entirely worthless, let the truth be ascertained by those best qualified for the task. This means broad-minded research by those branches of the medical profession qualified by some experience other than that of the laboratory, and it is gratifying to know that at this time whole-hearted efforts looking to a better understanding of the primary relation of fresh air to the health of the pupil are under way. As a hint to the school teaching profession, the engineer and architect and those not specially trained in the biological aspects of the subject, it would be the part of wisdom to reserve judgment with that modesty inspired by ignorance, until those better qualified than themselves reach a solution of the problem. With this brief review of present status on the subject, it may be well to consider the surviving schemes of school ventilation, for upon some or all of them must we still rely until such time as we shall know of something better,—keeping in mind also that those states heretofore having laws or regulations governing the matter have so far failed to remove them from their statute books.

The School Unit. In a short article a full discussion of all the controlling factors is impossible; therefore only the school unit,—the classroom,—will be considered. If the class and recitation rooms are properly warmed and ventilated, the other school apartments can be readily disposed of, and these will be briefly considered later on.

Systems Available. There are today probably not more than a half-dozen so-called systems of school heating and ventilation worthy of consideration, and these will be briefly described, omitting consideration of the one-, two- or three-room rural schools wherein the ventilating stove or the warm air furnace is usually found which affords reasonably good results where properly installed and operated. These small schools constitute by far the greater number, taking the country as a whole, and deserve greater care in design than is usually accorded them.

In the larger school buildings steam or vapor systems of supplying heat are generally employed. Vapor heating, it may be said, is nothing more or less than heating by steam at very low pressures, say not to exceed 8 ounces. In its simpler forms, no moving machinery, pumps, and the like are required for their successful and satisfactory operation; therefore, starting with the assumption that steam is to be the heating medium and for classrooms to accommodate about 40 pupils, the systems in more common use today are:

1. The gravity indirect system of heating with gravity ventilation.
2. The plenum fan system, better known as the "straight" or control fan system.
3. The "split" system.
4. The unit ventilator system.
5. The so-called "open-window system."

The Gravity Indirect System. This system is
rarely used today in other than small buildings of from 4 to 12 rooms. It is one of the least valuable of the survivors of early experiments. It consists of a single flue for supplying warm air to the room and a single exhaust flue. In the basement there is installed an indirect radiator placed about 20 inches below the ceiling and just to one side of the warm air flue. Fresh air from outside is brought to the radiator where it is heated, passing thence to the room. A mixing damper is so placed at the base of the warm air flue that the temperature of the room may be kept at the proper point. The warm air, in volume (according to accepted standards) equal to 30 cubic feet per minute per pupil, should enter the room not less than 7 feet above the floor, and this flue should be placed in the same wall or in a wall adjacent to the exhaust flue. The opening into the vent flue should be at the floor. Neither flue should be on an outside wall, nor should the flues be on opposite walls.

Occasionally in this system, direct radiation is also installed in the room, but while the heating results may thereby be simplified, it is inevitably at the expense of the ventilation, due to the lower temperature required in the fresh air supplied, keeping in mind that the volume of air supplied by this system is dependent upon its temperature. The velocity of the air in the flues may be taken as 300 feet per minute in a two-story building. This velocity will be exceeded in very cold weather, thereby supplying more than the required volume of air, but in average winter weather the velocity is likely to be much less, with correspondingly less ventilation, than any other.

The advantages of this system are: 1. It is usually low in first cost, probably lower than any other. 2. It is simple to operate and usually not extravagant in fuel consumption. 3. Maintenance costs are reasonably low.

The disadvantages are: 1. That it usually precludes the use of the basement for any purpose other than boiler and coal space and playrooms. 2. It is unreliable in results, as the supply of fresh air to the rooms and consequent ventilation are dependent wholly on the outside temperature. The result is that official inspectors are not required to test for air supply and ventilation when there is less than 40° difference between the outdoor temperature and that of the air entering the room. That, in practice, usually means a deficiency in ventilation when the outdoor temperature is 35° to 40° or higher; ventilation by such a system is inadequate for at least half the heating season. 3. Its difficulty in keeping the indirect radiators and flues clean.

The Plenum Fan System. Considered simply from the standpoint of positive ventilation attained, good diffusion throughout the occupied space, and heating results generally, this system in the average sized school leaves little to be desired. Unfortunately, however, the fan cannot well be kept running during the night, resulting in there being a cold building in the morning, and requiring considerable time to get the walls up to room temperature and comfort. This condition also results usually in high fuel cost, and for that reason this system is infrequently employed. It has the advantage, however, of supplying at all times when heat is required, an adequate degree of ventilation, for in order to keep warm, the school authorities necessarily have to supply air for ventilation.

In designing a building for this system, the same arrangement of flues would be followed as outlined for use with the gravity indirect system previously described, except that the warm air flues may be proportioned for a higher air velocity, say 400 to 450 feet per minute; but the openings into the room should be kept down to 300 to 350 feet per minute in order to avoid objectionable drafts. In some states 300-foot velocity is the legal maximum for a standard-sized classroom. In this system the location and size of the vent flue remain as previously described for the gravity indirect system. The supply ducts from the fan, usually in the basement, may be of a size permitting much higher air velocities, reaching 800 to 1000 feet in main ducts, and in branch ducts to base of upcast warm air flues of from 500 feet to 700 feet.

For heating the air before delivery to the rooms,
an indirect radiator, or "Stack," so-called, is usually placed at the base of each warm air flue with a by-pass or mixing damper permitting temperature control either manually or from a room thermostat. In this arrangement the air at outdoor temperature is blown by the fan through ducts to the radiators where it is raised to whatever temperature may be required by the different rooms. In a modified and somewhat better designed installation the outdoor air may first be warmed by radiators or primary heater to 50° or 60° as it enters the fan chamber, and thence is delivered to the re-heaters at the base of the warm air flues as just described. In extremely cold weather, in order to maintain 68° to 70° room temperature, the temperature of the air as it enters the rooms might be as high as 115° (or even more) on the exposed side of the building, while at the same time it might not exceed 95° to 100° on the sheltered or sunny side. In the afternoon, with the sun farther around in its daily cycle, this condition may be found reversed, showing the need of adequate means for controlling the room temperature under all weather and exposure conditions.

All in all, the straight central fan system has much to offer in its favor, and were it as economical in fuel consumption as some other systems, it would no doubt be more generally installed. The advantages of this system are: 1. That it is reasonable in first cost. 2. It is adequate in heating and ventilating results. 3. Its maintenance or cost of upkeep is low.

The disadvantages are: 1. That it means continuous power expense, but no greater than in any other mechanically-operated system. 2. In cold weather some difficulty is frequently met in average building construction in getting the walls of the rooms up to a temperature that will not cause a feeling of chilliness to those sitting near them, although the air temperature may indicate 68° to 70° on an inside wall. 3. It is generally uneconomical in fuel requirements.

The "Split" System. This mechanical system is perhaps that most commonly employed in schools of considerable size, for with all its defects it does provide facilities, where properly operated, for adequate heating and ventilation according to present standards. It combines the use of direct radiation placed along the outside walls beneath the windows with a positive fan supply of fresh air warmed to from 70° to 80°, with the exhaust flue of usual size and location. It provides the air diffusion so greatly desired.

Alas, however, its very flexibility often defeats the virtue of its employment, for the frugally minded public authorities and that well known official, the janitor, severally or jointly contrive in average winter weather to heat the school rooms from the direct radiation only, without the use of the fan, thus saving fuel, but providing no adequate degree of ventilation. In this system the permissible air velocities through ducts and flues would be the same as in the plenum fan system. The location and use of the indirect surfaces (radiators) likewise are the same, but the degree of heat to be obtained thereby may differ from the preceding illustrations. In some cases the primary heater may be designed to heat all of the incoming air to from 60° to 80° which with the direct radiation in the rooms, usually proves sufficient regardless of north or south exposure. This is especially true where the direct radiators are under thermostatic control, it being understood that the primary heaters are similarly controlled. In larger buildings or in those where varying temperatures are needed in certain rooms, the tempered air at the fan may be only 45° to 60°, and in such cases a re-heater is placed at the base of the warm air flues serving to raise the temperature of the air delivered to the rooms to the desired point. This latter arrangement requires, in order to afford satisfactory results, the use of thermostatic control of the radiators both primary and direct. Occasionally, also, there may be found in this system the installation of one or more fans connected with the exhaust flues. Their use would not alter the location of the exhaust flues, but would permit higher velocities therein, say up to 450 to 500 feet per minute where the exhaust fans are to be depended upon at all times. The inlet velocity from the room to the exhaust flue should not, however, exceed 300 feet per minute to avoid uncomfortable drafts at the floor. Where direct radiators are placed under the win-
dows alongside the outer row of desks, complaint is often heard of the excessive heat to which the pupils are subjected. A sheet metal shield may be attached to a radiator extending from a point about 6 or 8 inches above the floor to the top of the radiator, and thus afford the desired protection. With this system the arrangement of the flues and their relation to the classroom would be as shown in Fig. 2.

The advantages of this system are: 1. Its being very low in fuel consumption. 2. That it is simple to operate, flexible. 3. Its being low in upkeep or maintenance costs.

The disadvantages are: 1. That installation costs are greater than for a gravity indirect or plenum fan system. 2. That from its very flexibility it is too easily subject to human manipulation in the sole interest of fuel economy.

The Unit Ventilator System. This is one of the most flexible systems known, combining in the individual classroom everything needed for its satisfactory heating and ventilation other than the boiler and pipe connections. The installation consists essentially of an indirect radiator; a small fan for the positive supply of fresh air taken from without the building through a wall opening; a fractional horse-power motor for the fan propulsion; all contained within a substantial metal enclosure. Usually a direct radiator also is placed against an outside wall to supply the heat necessary to compensate for that lost through wall and glass surfaces. A suitably placed damper excludes the air from outside when school is not in session, and a by-pass damper in the unit heater is employed to regulate the room temperature either manually or by thermostat.

All unit ventilators, so-called, are provided with means for recirculating the air from the room through the device and for the exclusion of fresh air from outside. This type also strongly appeals to those civic authorities having an eye solely to the conservation of fuel, for in practice the unit ventilator will frequently be found shut down, and for heating the room, dependence will be placed on the direct radiator; or perhaps the device may be used to recirculate the warm air in the room with no fresh air supply. It is often best to specify that the recirculating feature be omitted, and where possible, that the direct radiator be also omitted from the room, thus assuring positive ventilation, at least whenever heat is required. Some unit ventilators operate upon the high velocity jet principle, the air leaving the unit directed toward the ceiling and at velocity varying from 800 to 900 feet per minute. These high velocities secure ample diffusion and equality in temperatures throughout the room.

Efficient installation requires that the unit be placed near the source of fresh air, as on an outside wall, with the exhaust on an inside wall located as far from the unit as possible. The exhaust flue may be proportioned for a higher velocity than is permissible in other gravity exhaust systems, say as high as 600 to 700 feet per minute, the flue being carried through the roof in the usual manner.

The advantages of this system are:
1. That each room may be treated as a unit, in no way dependent upon any other room for its successful operation. This is of greater importance in high schools than in the lower grade schools.
2. It affords a positive supply of fresh air to the rooms, properly warmed and generally well diffused.
3. It eliminates the warm air flue and connecting basement ducts of either masonry or sheet metal.
4. That the units are reasonably quiet in operation.
5. Maintenance or upkeep costs reasonably low.
6. That fuel cost is about the same as in any systems supplying an equivalent volume of outdoor air.

Its disadvantages are: 1. That it involves a higher initial cost than the other systems here described. 2. That it requires a multiplicity of small fans and motors to be looked after and kept in repair. 3. That it takes up some space on the outside wall of the classroom, varying from 14 inches to 20 inches from the wall and from 3 feet to 4 feet in length.

The "Open Window" System. This means a new adaptation of an ancient unsuccessful attempt to ventilate school rooms, which a former generation endured and then happily discarded. This observation must by no means be construed as an indirect expression of opinion concerning the merits of the
controversy now in full swing as to what constitutes the proper air conditioning of schools. It is just a plain statement of fact, as any observer of the conditions existing in urban schools of the early 90's can testify. Neither is the system referred to herein for any reason other than to acquaint the architect with its salient features.

In its entirety this system consists of just two exhaust flues, each of 4 square feet area, and of one or more radiators having a total surface of from 250 to 300 square feet. Each exhaust flue has an opening at the floor and also one at the ceiling. No means for creating a movement of air in these flues is advocated by the proponents of the system. Hand control only of the radiators is permissible. Deflectors at the window sills give direction to the increasing air when the lower sash is raised. In theory the incoming air (with the wind from the right direction) is warmed from the radiators, is deflected to the upper part of the room, and passes out through the upper openings into the exhaust flues; but if by chance the air falls, then opportunity is afforded for its passage into the exhaust flues at the floor. In this natural process of diffusion, drafts are ever present. Perchance luck may favor the anaemic (by no means rarely) in having for a teacher one whose comfort zone hovers around the 80° median, in which case the windows stay down. In practice, with the wind blowing from some other direction, expired and fresh air from other rooms and sources reaches the classroom under consideration via the corridors, or perhaps down the exhaust flues, thence, after being duly warmed by the radiators, passes out of the windows. This, of course, assumes that the windows are open, but usually for some reason or other they are kept closed. That the windows will be found in large part closed when the outside temperature is below 50°, is not an idle statement concerning the usual manner of operating the ventilation of such schools, after the investigating commission or other authority has completed its occasional or periodical survey. It should also be unnecessary to say that during such a survey the system is, of course, operated the way it was intended to be, but the same may as truly be said of any other system under similar circumstances. This system is not suitable for assembly halls, gymnasiums or classrooms accommodating more than 40 to 50 pupils.

Briefly, the human element in the operation of schools equipped with this system reacts in precisely the same fashion as in schools otherwise equipped, but with this difference: that when an "open window" system is installed there is an absence of control over the volume, temperature, humidity or any other desirable (yet to be determined) quality of the air the pupils breathe. If the room gets too cold, the remedy is to close or partially close the windows, and incidentally cut off or reduce the supply of fresh air.

The advantages of this system are:
1. That installation cost when properly installed, is about 10 to 15 per cent less than for a "split" system.
2. Its upkeep or maintenance cost is low.

Its disadvantages are:
1. That no control of proper air conditions is assured.
2. That to maintain the best room conditions with this system requires the constant and intelligent watchfulness of the teacher, and takes her from her legitimate duties.
3. Its fuel consumption is fully as great as in a well designed "split" or unit ventilator system, either of which will provide under all weather conditions from two to three times as much ventilation.

The Auditorium. Such rooms cannot well be standardized as to their heating and ventilation, varying as they do in design and outside window spaces. Those with small exposed walls and few windows usually require the supply by positive means, of fresh air, with of course means of heating. The air supply to auditoriums where not governed by official regulations, may be much less than in classrooms, owing to the usually shorter periods during which they are occupied. Based upon the full seat-
Fig. 5. The "Open Window" System

ing capacity,—allowing 6 square feet floor and gallery area per occupant,—the supply of from 10 to 15 cubic feet of fresh, warmed air per minute is considered sufficient. The temperature of the incoming air should be under thermostatic control, and it is desirable also, that the direct radiators should be similarly controlled. On the score of fuel saving, direct radiation should be installed in sufficient amount to keep the walls and furniture warmed.

Where there is an abundance of window space, and especially an opportunity for cross ventilation, roof ventilators for the relief of an overheated room, due to a combination of a large audience and mild weather will seldom be required. The warm air flues should be of an area for an air velocity of from 350 to 500 feet per minute, with a velocity through the openings into the auditorium varying from 350 to 500 feet per minute, depending upon the height from the floor to the bottom of the warm air grille. The flues may be located at one or more points in the room, and in some cases the exhaust may be taken through the front of, and under, the stage, if any, there connecting to upcast flues to ventilators or fans on the roof. Where an exhaust fan is installed, the exhaust flue velocity may be from 500 to 700 feet per minute.

Gymnasium. Such a room, in the absence of official regulations, would be heated and ventilated much the same as an auditorium, but owing to the character of the exercises, greater reliance can be placed upon window ventilation, and such a room should not be heated above 60° unless it is to be used as a combination gymnasium and auditorium.

Swimming Pool and Shower Rooms. There should be sufficient direct radiation properly installed and controlled, to maintain 80° temperature with adequate ventilation, either through exhaust fans or ample gravity exhaust flues. Fan supply of fresh air is rarely desirable in such rooms. Dependence for ventilation should be placed wholly upon the exhaust, with inlets for gravity supply of warm air.

Dressing and Locker Rooms. These should be warmed by direct radiation to about 70°, and there should be ample exhaust, preferably by fans.

Toilet Rooms. Such rooms with one or two fixtures, if located with ample outside windows, are seldom provided with special means of ventilation. General toilet rooms should be ventilated by means of fans to the extent of eight to ten air changes per hour, and heated by direct radiation only to about 65°.

Plant Operation. No matter how well a heating and ventilating plant is designed and installed, unless there is to be cooperative effort on the part of the school and town or city authorities, the best results from the installation will rarely be obtained. Whatever may be the final decision concerning the proper atmospheric conditions to be maintained in schools, so long as the authorities place fuel saving above the health of the pupil, or the janitor is inefficient and incompetent, anything but satisfaction is to be expected from any installation. In the final analysis, however, it is the public that must be brought to realize the facts,—by educational methods,—and to insist upon an adequate return for the expenditure of public funds.

Auxiliary Equipment. No mention has been made of air washing, humidifying or ozonating apparatus, and but brief reference to automatic temperature control. These auxiliaries are essential in many instances, but they require more space for their adequate description than can be accorded in this article.
THE ARTIFICIAL LIGHTING OF SCHOOLS

BY

D. J. FRANDSEN

ELECTRICAL ENGINEER

THERE are certain quite fundamental and obvious reasons why artificial lighting should be provided in all schools. Perhaps the most important of these is the fact that provision must be made for those inevitable cloudy or stormy days, which, in some localities, comprise such a startlingly large percentage of the school year. The increasing prevalence of night schools and the fact that the school building is often used for various community meetings, in addition to school activities, are direct evidences of the need of artificial light.

Of all the facilities placed at the disposal of the school child, good lighting is one of the cheapest. The American City Bureau reported a few years ago that the average cost of teaching each child, per year, was $57. The average child will reach the equivalent of the eighth grade at the age of 14 years, at a cost of $456 to the state. On account of defective vision caused by poor illumination, or slowness due to lack of visual stimulus, the child reaches only the sixth grade, the cost to the state has been the same, with only three-fourths the result. The state loses money, and the child will probably leave school poorly prepared to earn a living. At an estimated cost of less than $1.50 per child, per year, good illumination, which would tend to greatly decrease eye troubles and resultant backwardness, can be provided.

Lighting and the Eyes. That defective vision is frequently acquired and is often progressive is shown by the fact that eye troubles are more prevalent among children in the advanced grades. For instance, 10 per cent of the children entering school are near-sighted, while about 33 per cent are near-sighted at the end of their eighth year. That adequate illumination can offset to a great extent the handicap of defective vision caused by poor illumination, or slowness due to lack of visual stimulus, was demonstrated in a test conducted on a group of public school children who were decidedly backward in their studies. These children were observed under various intensities of artificial illumination, and a marked increase in mental alertness was noticed as the amount of illumination under which they worked was increased. This improvement in work continued until a maximum illumination, in the neighborhood of 17-foot candles, was reached. The results of this single test are in line with the results of other tests, and indicate that higher standards of illumination are desirable, and that the present standards of illumination for classwork are by no means final and may require future revisions. Progress of the children under the higher standards of illumination was so gratifying that specially lighted classrooms have been installed for their benefit.

Unlike home lighting or office lighting, school lighting is likely to remain unchanged for a long time, even if it is unsatisfactory. The architect must use care to insure permanent utility by correct design and planning consistent with the needs of the school.

Lighting Requisites. Before entering into any descriptions of the methods of securing proper results in school lighting, it will be well to consider a few of the desirable qualities of good illumination, and then to show by illustrations and data examples of these principles applied to typical buildings. The requirements of lighting are few, but important:

1. Adequate Light. Sufficient illumination for the work at hand; too little light is productive of eyestrain, fatigue and consequent poor work, and may be the cause of permanent eye trouble.
2. Elimination of Glare. This point cannot be over-emphasized.
3. Diffusion. Sharp shadows and harsh contrasts should be carefully avoided.
4. Distribution. This point must receive careful attention if good lighting is to be obtained.

In considering the first point, it is evident that a suitable amount of light must be supplied if work of any kind is to be properly performed. Regardless of what type of lighting system is used, a sufficient amount of light must reach the work,—otherwise the system must be considered as inadequate.

Standards of Intensity. The unit ordinarily used in speaking of the illumination on any surface is the foot-candle (defined as the illumination on a surface normal to a one-candle power source at a distance of 1 foot). This value is measured with a foot-candle meter or other portable photometer. The values given in this table have been found from experience and observation to be desirable standards of illumination of schoolrooms:

<table>
<thead>
<tr>
<th>Room Type</th>
<th>Recommended Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classrooms</td>
<td>8- to 12-foot candles on desks</td>
</tr>
<tr>
<td>Study Rooms</td>
<td>10- to 12-foot candles on desks</td>
</tr>
<tr>
<td>Offices</td>
<td>10- to 12-foot candles on desks</td>
</tr>
<tr>
<td>Drawing Rooms</td>
<td>15- to 25-foot candles on tables</td>
</tr>
<tr>
<td>Laboratories</td>
<td>8- to 12-foot candles on tables</td>
</tr>
<tr>
<td>Cloak Rooms</td>
<td>1- to 3-foot candles on floors</td>
</tr>
<tr>
<td>Corridors</td>
<td>2- to 5-foot candles on floors</td>
</tr>
<tr>
<td>Auditoriums (if used for study room purposes)</td>
<td>8- to 12-foot candles on chairs</td>
</tr>
</tbody>
</table>

While such values as given here will produce satisfactory results, the application of the higher rather than the lower values might be advisable. With the higher values of illumination increased perception is obtained, and better results may be expected.

Diffusion and Glare. Sufficient diffusion and the elimination of glare are of importance in any lighting system, yet nowhere are they more important than in the schoolroom. Practically all commercial light sources are far too brilliant to be directly in the field of vision without causing a blinding effect and reducing the ability to see. The construction of our buildings places definite limits upon the heights at which lamps may be hung. We must,
therefore, always reduce the brilliancy of the light sources by means of diffusing globes, shades or reflectors, which either effectively enlarge the light sources or actually hide them from view. Diffusion is necessary in order that shadows be softened and harsh contrasts be eliminated. It is not desirable, however, to go to such an extreme of diffusion as to entirely eliminate shadows, for they are essential in showing the contours or shapes of objects.

The walls, ceilings and woodwork have a very large effect on the efficiency of a lighting system, and upon the way in which the light is distributed. In general, it is advisable to provide walls of a moderate reflection factor, the preferred colors being light gray, light buff, dark cream and some tints of green. Ceilings should have a high reflection factor, either a flat white or light cream color being suitable. In order to eliminate annoying reflections, desk tops and other woodwork should have dull rather than glossy finishes.

Distribution of Light. The fourth point to be considered in designing a lighting system is that of the distribution of light. We have, in general, two extremes,—local lighting and general illumination. In local lighting relatively low-wattage lamps located close to the work furnish a high level of illumination over a small area. Such lighting has very limited applications, none of which are found in the school. A system of local lighting usually abounds in those conditions which cause eye strain and eye fatigue. In general illumination, much larger lamps are used, these lamps being hung as high as possible in order to get them out of the field of view, and in order to provide good distribution. General lighting is, without question, the system best suited to schoolroom lighting. The wiring costs are lower, and the efficiency of the system is higher, due to the fact that higher-wattage lamps are much more efficient than low-wattage lamps. Proper location of outlets insures almost uniform distribution of light throughout the room; in fact, there is possible a much more uniform distribution than with daylight.

This table, taking the light from a 100-watt lamp as unity, indicates the relative amount of light which may be expected from the higher wattage lamps:

<table>
<thead>
<tr>
<th>Wattage</th>
<th>Relative Amount of Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>150</td>
<td>1.75</td>
</tr>
<tr>
<td>200</td>
<td>2.45</td>
</tr>
<tr>
<td>300</td>
<td>4</td>
</tr>
<tr>
<td>500</td>
<td>7.2</td>
</tr>
</tbody>
</table>

It is essential that light should be directed on the object to be seen and not directed to the eye; therefore, since it is necessary to hang lamps high and out of the line of sight, we must equip them with reflectors or other devices in order to direct the light to the desk or to the ceiling to be re-directed downward.

Types of Lighting Fixtures. Direct, semi-indirect and totally indirect systems are all employed for school lighting. Each has certain inherent advantages, although they are all satisfactory if properly applied. Ordinarily more outlets are required for direct lighting, in order to obtain proper distribution and diffusion, than are needed for either the semi-indirect or the totally indirect systems. This is offset to some extent by the fact that direct lighting by enclosing diffusing globes is ordinarily more efficient than either of the indirect systems.

Indirect Lighting. Totally indirect lighting produces an extremely good quality of illumination, but it is somewhat less efficient than direct lighting with enclosing globes. In general, the illumination from a totally indirect or semi-indirect installation is about 66 per cent of that which would be produced by a direct lighting installation, using enclosing globes, if the same size and number of lamps were used in each case. A very light colored ceiling is absolutely essential if indirect lighting is to be used to best advantage, since with dark colored walls and ceilings, a larger percentage of light would be absorbed and the over-all efficiency of the installation would be considerably lowered. With indirect lighting there is little possibility of glare, and the resultant light is quite soft and free from shadows; glaring reflec-
Totally Indirect Lighting Provides 10-Foot Candles at Chair-tops
S. John's Law School, Brooklyn

The principal objection to indirect lighting, other than from the standpoint of initial efficiency, is that bowls tend to accumulate dust, making frequent cleaning necessary.

Semi-indirect Lighting. The luminaire employed in this type directs the greater part of the light toward the ceiling (as in the totally indirect system), yet a small portion of the light is permitted to pass downward through opal or frosted glass. This downward light serves the purpose of illuminating the luminaire so that it does not stand out as a dark spot against the lighted ceiling area. The directional quality of this downward light has, in some cases, an added advantage, in that it serves to emphasize to a slight extent shadows which might be wholly lost under totally indirect lighting. Semi-indirect lighting is slightly more efficient than totally indirect lighting. The resultant illumination is well diffused, and such shadows as are produced cause no annoyance. The better forms of semi-indirect units employ dense glass or some other means of reducing the brightness of the lighting unit. This type of lighting is particularly well adapted to schoolrooms, especially if the totally enclosing type of semi-indirect luminaire, of which the upper portion is of clear glass, is used. The open type, semi-indirect units are open to the objections applied to totally indirect luminaire as regards accumulation of dust.

Direct Lighting. Open-bottom direct lighting units are found in many of the older installations. These units are obviously efficient from the standpoint of light output, but their other characteristics are not such as to make them suitable for use in the schoolroom. The diffusion is not of the highest order, and sharp shadows and contrasts are likely to be extremely prevalent. Such units are also objectionable from the standpoint of direct and reflected glare, especially if clear bulb lamps are used. The use of this form of lighting is advisable only where cost must be kept at the absolute minimum, and where secondary consideration is given to the quality of the light. If such lighting is employed, it is advisable to use dense opal or etched prismatic glass deep bowl reflectors. Such reflectors will not produce an unpleasant glare. Plat type reflectors, of either metal or glass, should never be used in the schoolroom, for it is almost impossible to conceal the lamp filaments from view when this type of equipment is employed. Opaque reflectors, in general, are unsuitable, since the ceiling would be very dark if they were used. Diffusing bowls or white bowl lamps should always be used in preference to clear lamps if open-bottom lighting units are installed.

The enclosing, diffusing, direct lighting luminaire or enclosing globe seems to quite satisfactorily fulfill all of the major requirements of classroom lighting. If the proper type is chosen, a well diffused illumination, free from direct or reflected glare, is produced. With this type of equipment the major portion of the light is directed downward, although a considerable portion is transmitted upward, thus giving a character of illumination somewhat similar to that produced by semi-indirect units. The equipment is easily cleaned, and, in general, does not depreciate as rapidly from dust accumulation as do other fixtures giving comparable qualities of illumination. Of course, cleaning should never be neglected, for it is only from clean lamps and clean accessories that maximum light output is obtained.

Ventilating the Fixture. The question as to whether or not it is necessary to provide ventilation for totally enclosing units is one that has often been raised. The results of carefully conducted tests have indicated that with a sufficiently large radiating surface, in other words the proper size of globe and fixture, ventilation is unnecessary.

Globe Sizes. In making a choice between commercial types of equipment of any one class, there are a number of factors which must be given consideration. With the enclosing globe, one very important element is the brilliance of the glassware. This depends on the character of the glass, the size of the globe, and the wattage of the lamp used. The
diffusion should be such that the entire globe will be quite uniformly lighted when the proper size of lamp is used. There should be no bright spots opposite the filament. Assuming that the globe gives good diffusion, the brightness will then depend on the diameter of the globe and the size of the lamp used. Care should be taken to provide globes of a sufficient size to care for the lamp used. Glassware designed for 200-watt lamps will accommodate lower wattage lamps quite nicely, but a globe which might be entirely satisfactory with a 100-watt lamp would probably be unsatisfactory with a 200-watt lamp.

This table indicates the minimum desired diameter of enclosing globes, the diameter to be measured at the point of maximum width:

<table>
<thead>
<tr>
<th>Watts</th>
<th>Diameter</th>
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<tbody>
<tr>
<td>100</td>
<td>12 inches</td>
</tr>
<tr>
<td>150</td>
<td>14 inches</td>
</tr>
<tr>
<td>200</td>
<td>16 inches</td>
</tr>
<tr>
<td>300-500</td>
<td>18 inches</td>
</tr>
</tbody>
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With light colored surroundings there is comparatively little choice between the various fixtures of the type under consideration as to shape, since the light walls and ceilings will be of material assistance in redirecting and diffusing the light. In general, an enclosing globe (of opal glass) will give off the major portion of the light in a direction approximately normal to its greatest projected area. That is, a globe of the stalactite shape will direct the greater portion of its light toward the walls, while a globe of the squat type will be more efficient in directing the light downward. This, of course, does not apply to those luminaires in which distribution of the light is controlled by the use of prisms moulded into the crystal glass body of the luminaire.

Spacing of Luminaires. The location of the luminaire in a classroom as well as in any other room depends upon the dimensions of the room and the type of lighting which is to be used. Indirect and semi-indirect systems permit of a slightly wider spacing than would be satisfactory if enclosing diffusing globes were to be used. With direct lighting from enclosing globes or reflectors, the spacing should never greatly exceed the hanging height of the luminaire. Ordinarily this spacing may be increased to one and one-half times the hanging height; if semi-indirect or totally indirect lighting is employed, however, it is frequently found that the same spacing is necessary for either direct or indirect lighting. For instance, in a room 21 x 21 feet, with a 13-foot ceiling, four outlets would be essential if good lighting is to be obtained. These four outlets would be necessary with either direct or indirect lighting. They should be spaced on approximately 11-foot centers, about 5 feet from the walls.

The calculation of the sizes of lamps which should be used involves consideration of the type of equipment, the colors of the walls, ceiling and other woodwork, and the dimensions of the room. Direct estimates based upon an assumption of a certain number of watts per square foot of floor area are liable to lead to erroneous results. The flux of light or lumen method as set forth in the standard texts on illumination and in the bulletins issued by the large lamp companies, will ordinarily give more accurate results, since it is based on the light output rather than the power consumption of the lamps.

Lighting of Gymnasiums. The lighting of those various rooms other than classrooms which are found in the typical school building presents no especially difficult problems. The high ceiling of the typical gymnasium makes the use of mirrored glass or other efficient light-directing reflectors quite feasible. The equipment should always be provided with suitable guards in order to protect it from possibly injury. It is becoming quite common practice to provide recesses in the ceiling in which lighting equipment may be installed. Care should be taken to avoid glaring light sources, since by their blinding effect they may become the cause of a serious fall or other injury. Shower and locker rooms may be quite adequately lighted by 100-watt lamps in opal bowl reflectors, although high percentages of moisture often necessitate the use of vapor-proof fixtures in the shower rooms.
SANITATION FOR SCHOOL BUILDINGS

BY A. R. MCGONEGAL
MEMBER AMERICAN SOCIETY OF SANITARY ENGINEERS

THE little old red schoolhouse of fond memory has faded into history, and even its successor, the two- or three-room village school is slowly but surely giving way to the new in school building and administration. The family flivver and the school "bus," cheap, rapid and dependable transports that fairly eat the miles that were too much for sturdy, plodding little feet, have wrought the transformation. Instead of many small township and cross-roads schools, we build a replica of the city school building to care for the entire county, and we bring the children to the school instead of taking the school to the children. Thus centralizing educational facilities, the rural community obtains most or all of the advantages of the city school system.

The rural community school building and the average city school building being alike in their physical aspects, the plumbing systems of the structures will be the same. The basic principles of sanitation as applied to the theory and design of plumbing are the same whether the school be located in Maine, Minnesota, California, Texas or Florida, in a small town or in a great city. There will be slight differences in detail to accord with differences in climate, such as protection of pipes. County or small town schools may not have the advantages of a public water or sewer system, but isolated automatic water systems and modern sewage disposal plants take their places, and the plumbing installations in the buildings will be identical. The really immense school structures in some of our larger cities differ from the small town buildings only in size, so that the plumbing requirements of an average school building apply to all.

Site and Sanitation. The county school usually has an advantage over the city school in the matter of site, both as to suitability and amount of ground. It goes without saying that a school should have ample space for light and air on all sides, and it should have, if possible, sufficient playground area to keep the children off the adjacent highways. A suitable location is just off the main traveled thoroughfare, as it is less noisy and the air is less laden with dust and burnt gasoline fumes, but it should be close enough for easy access. If selection is not restricted, there are but four items to consider in a site, and "two of these items are water." As the old saying goes, "good property has water as is, and water as isn't." If a city or community water supply of unquestioned quality and ample quantity is not available, it will be necessary to depend on a well, and if this be the case, the deal for the ground should not be closed until the well has been drilled and the supply found satisfactory. Before drilling the well, it is wise to make a survey of the surrounding property to see that the sanitary arrangements are such that contamination of the well is not probable in the future. The other water attribute, the "water as isn't," refers to necessity of locating the school on comparatively high, well drained ground, suitable for firm foundations and a dry basement. Low ground and marshy, spongy or waterlogged soils are hardly suitable for school sites from standpoints of either economy or health. The other two basic items are space and accessibility. Space is necessary for light and air, playgrounds, and room for future expansion, which should always be planned at the time the original building is laid out. Accessibility means not only location on a good road near the main artery of travel, but a position near the center of population of the territory served; at the shortest distance from the greatest number of families.

Basements should be well out of ground, with high ceilings, so they will be healthful gathering places in inclement weather and can be used for overflow classrooms in emergency. Outside walls should be dampproofed to grade, even if the site is ordinarily dry. The plumbing of a school, both in design and installation, should be of the very best. This is not only wise from a future repair expense standpoint, but good plumbing begets good care, and if we teach our children what good plumbing is, it makes for the health of not only the children themselves, but of the homes, the neighborhood and the nation. The school toilet rooms should be cleaner than the home arrangements, if possible, and the arrangements of the exposed fixtures and pipes should be neat, substantial and easily kept clean and in repair.

The Locations of Toilet Facilities. Suggestions for locating school toilet facilities in outbuildings are frequently made by those having little knowledge of matters connected with the health requirements of growing children and with difficulties of supervision. Such a location, whether connected with the school building by a corridor or not, adds greatly to the already heavy burden of proper supervision; adds to the expense of heating and ventilation in northern climates; and is a decided disadvantage from a health angle. Ease of access, cleanliness and comfort in responding to nature's requirements make for regularity and full and complete operation, forming a healthful habit which should continue for years to come. Dingy, frequently dirty, outbuildings, damp and cold in inclement weather, are not inviting and consequently are responsible for self-imposed abstinence which may, and undoubtedly often does, result in unnumbered cases of irregular habits and constipation, causing much misery and sickness in after life.

Children are naturally mischievous and are likely to break or mar things within their reach when not
under supervision; so, knowing that one in authority cannot be always in the school toilet rooms, we should accept the fact and contrive to create, as far as possible, conditions which will cause little satisfaction to those on mischief bent. This means having all our toilet room fixtures and equipment of substantial pattern, firmly fastened in place, and with as few exposed nuts, screwheads and other contrivances as possible on which a handy boy can use his jackknife. Rows of closets, urinals and basins should be set along the walls and not out in bathtubs at the center of the room, so that racing and playing tag around them will be out of the question. Fixtures and partition corners set out in the room seem to be desirable handholds and swinging posts for racing children, and many a standing partition has been torn away time after time, with recurring repair bills. Batteries of fixtures set out in the room also add to the difficulties of supervision by providing shields for those hiding from teachers passing or looking in the door. In general, it is excellent practice to lay out a school toilet room so that every portion of the room is visible from its entrance. It is also a good idea to have the entrance without doors but arranged so that the line of vision from the corridor is obscured as to any fixtures. This arrangement requires some consideration in the ventilation system so that there will always be a current of air from the corridors into the toilet rooms. Either an increased exhaust rate for the toilet room itself over the classroom rate, or definitely ventilating the corridors through the toilet rooms will take care of this.

In buildings of one story and basement it is quite customary to group all toilet facilities in the basement, or to put the boys' toilet there and the girls' toilet immediately above on the main floor, which is somewhat more economical on account of the more compact arrangement of the piping, but the best practice is undoubtedly to provide each floor with its own equipment for each sex.

**Provisions for Teachers.** Teachers' toilets should be provided, as well as slop or service sinks, on each floor. A kitchenette with a small sink in a rest room will be appreciated by the teachers. Extra drinking fountains should be in the basement playrooms, and pedestal fountains are often installed on the playgrounds and not infrequently in front of the building for use by the general public. Teachers should never be required to use the same fixtures as the pupils, but, on the other hand, good administration requires their presence in the pupils' rooms occasionally, and a way to insure this indirect supervisory effect is to locate fixtures for the teachers' use in private rooms opening from main toilet rooms so they must pass through one to get to the other, though other considerations may outweigh this.

**Walls and Floors.** Walls and floors of pupils' toilet rooms should be of non-absorbent materials with a finish not easily damaged. Buff, mottled, salt-glazed brick up to a line 7 feet from the floor has been found very satisfactory. Laid with thinly buttered joints in cement mortar without lime, these brick make a practically non-absorbent wall and one not easily scratched or marred or written on with either pencil or chalk. Ordinary cement-surfaced concrete floors are likely to be spongy and absorb moisture, giving rise to odors around the closet bases and urinals. There are a number of good composition floor materials and concrete floor hardeners on the market which can be laid with the ease of ordinary cement and troweled to a hard, glassy finish which is practically waterproof. A mastic bituminous compound has been successfully used, laid hot and ironed smooth much in the same manner as an asphalt-surfaced street pavement is laid. This material can be surface-heated and ironed smooth again if it has to be cut up or becomes worn or rough in spots.

**Partitions.** Wooden partition work for toilet room closet enclosures is unsuitable. Even with the best of finish, wood will absorb and will give off odors in time; even the window frames and sash should be metal where possible. There are any number of makes of unit metal closet partitions on the market. The best of these are of ingot iron or copper-bearing steel, all welded panels, factory enameled to resist rust, and they are sturdy and designed so they have small dust-collecting surfaces. Stock sizes include one 4 feet deep by 30 inches on centers, which makes a suitable unit for school work.

Doors, if used, should be double-swinging pairs, without bolt or latch, and those with gravity hinges are less likely to get out of order. Doors should be shorter than the partition panels, and the bottoms should be 16 inches from the floor. Some school authorities leave doors off closet stalls altogether, and still others provide them for girls and not for boys, though there seems to be no good reason for the distinction.

**Number of Fixtures.** The economical number of fixtures to provide for any given condition has been worked out through months of investigation and timing under actual conditions of use. Even bearing in mind that it is customary to recess or dismiss many classes at the same time, the average use and re-use capacity of fixtures is very great, and the final rule is very close to the old 15 to 1 rule in force in many states and cities for factories, schools and similar buildings. This more complete rule is based on modern classes with from 35 to 40 pupils, evenly divided between the sexes, and calls for the schedule of fixtures for each such classroom served:

- **Boys' toilet room:** 3/4 water closet, 1/2 urinal, 3/4 lavatory.
- **Girls' toilet:** 1/2 water closet, 1/2 urinal, 1/2 drinking fountain in the corridor. If the school is for one sex only, or if the makeup of classes may be expected to differ continually, owing to some special local condition, it is a simple matter of figures to alter the rule to fit.

In following a fixture allowance rule, judgment
should be exercised when there are an odd number of classrooms to serve, but toilet rooms should be built to fit the fixture requirements and not a number of fixtures provided to fit a room of a set size. It is important that we have a sufficient number of fixtures for proper and reasonable use, but it is just as important that we have no more fixtures than are necessary. Every unnecessary fixture adds to the cost of the building, to the amount of space unavailable for other needed uses, to the water consumption, and to the repair expenses through the years to come. Fixtures, and especially valves and faucets, should be the very best that money can buy. The difference in first cost between a good fixture and a poor fixture is at most only two or three dollars, and the first of many repairs will cost that in plumber's time alone. The good fixture will rarely need repair, and the poor fixture will frequently need attention, and a fixture that is chronically out of order and not usable might just as well not be taking up space.

Water-closets should preferably be of the type automatically operated, as children, especially the younger ones, are exceedingly careless in the matter of flushing. Attached seats must be provided, as integral seats have been tried and found to have a generally unhealthful effect, due to cold flushing water passing through the flushing rim and chilling the body resting on it. One of the largest single items in plumbing repair bills for schools is for taking up and removing obstructions from closet bowls. This can be minimized by using a full siphon jet bowl with a 2 1/4-inch or 2 3/4-inch waterway throughout, so that pencils, knives, cloths and dropped articles generally that will go into the bowl outlet will pass entirely through the trapway to the sewer without hindrance. In some cities the inspector is furnished with a wooden ball which he passes through each closet bowl before setting it, to be sure that the waterway is full size and is clear of obstructions.

There is some controversy over the proper height of the bowl, but good practice seems to point to the regular juvenile height of bowl for all grades. This bowl is 13 1/2 inches from floor to rim and, with 1 1/2 inches added for seat, it is only slightly lower than the average chair, and fits in with the claim often made by medical men that closet bowls should be lower than the usual standard height to provide a more natural and healthful position of the body during use. The seat should be of the comfortable saddle type, open at least in front. Ordinary wooden seats with either a varnish or celluloid finish have not proved very successful for school work, but there are several good composition seats with a minimum of unprotected metalwork to corrode. The solidity and strength of the hinge attachment should be carefully investigated, as well as the quality and fastening of the seat bumpers, the best of which must be replaced from time to time or the flushing rim of the bowl will be broken by slamming seats. Some bumpers cost three times as much as others and are worth it.

Flushing. The flushing should be full and powerful. Pressure flush is the only suitable system for school work, and it can be had in either of two ways, —by compression tank or by direct flush valves. Either type of valve will operate on 15 pounds pressure, but 30 to 40 is better and appears to be general. If direct flush valves are used, the diaphragm

Plan of a Typical Boys' Toilet Room
type which requires no adjustment and is easy to repair can be used to advantage. Such valves, how­ever, require larger supply pipes than are customarily used with tanks, as all the water necessary for the operation of the valve must be furnished during the flushing period of about seven seconds, whereas a tank can be allowed 30 or more seconds to fill be­ tween flushes. If pipes are too small, the velocity of flow causes an annoying singing noise, and the valve frequently develops a “hammer” at closing.

Two elements enter into the water supply of fix­tures, and in a sense they are independent of pres­sure, although uninformed people frequently attribute unsatisfactory operation simply to lack of pressure, not realizing that proper flushing depends on vol­ume at the fixture and that just as much water can be delivered by a large pipe at low pressure as by a smaller pipe at high pressure. The two elements are volume and time, and the quantity of water which can be furnished at a given point within the period of the flush is called the “rate of flow.” Assuming a five-gallon flush in seven seconds, this means a flow rate of about 40 gallons per minute for a valve closet, but if a pressure tank is used on the closet as a sort of accumulator to collect the five gallons for the short flush, it can be al­lowed 30 seconds or more to fill, at a flow rate of ten gallons per minute. Thus, other things being equal, any given size of pipe will furnish water for four times as many pressure tank closets as valve closets at the same rate of flow. To properly pro­portion closet supply mains, all factors should be taken into consideration, and sizes should be fig­ured back toward the source of supply from each closet and each group; but this is too rarely done because of the computation necessary. It is, of course, impossible to be exact without taking into consideration elevation of fixtures, friction loss for length of pipe and the number and character of bends and valves, type of meter, and initial pressure at the source; but the table included here has been worked out as satisfactory with an assumed average for friction loss, an initial pressure of 40 pounds for friction loss, an initial pressure of 40 pounds and the number and character of connections on various pipe sizes.

In estimating for urinals with flush valves, two urinals should be figured same as one water closet valve in the first table.

**Urinals.** There are two types of fixtures most suitable for schoolhouse use,—the vitreous china (not porcelain) stall urinal, and the slate stall type. In either case they should be set down into the floor construction so that the immediately adjacent floor surface grades into a waste trough part. The slate type should be used only where water is plentiful and where a continuous film of flowing water from the overflow flushing troughs can be maintained or an automatic periodic flushing device is used. The vitre­ous individual stall type should be flushed by a foot-operated flush valve set in the floor. The standard 18-inch width vitreous stall gives really too little shoulder room, even for children, if placed in battery, but if they were made in the 24-inch width, the same as biscuit porcelain, that would give more shoulder room than necessary. The medium of 21 inches on centers seems to be best for all purposes, giving sufficient but no excess shoulder room, econom­y of space and of cost. The 18-inch stalls as now made must be set 3 inches apart, with a dirt­collecting space, or the spaces must be blocked out, plastered and tiled, thus adding to the expense. Tiling these spaces makes them more sanitary than leaving them open, but not as sanitary as a vitreous unit 21 inches wide would be with its single joint. The slate stall fixture can be obtained in any of the three widths, and is a continuous fixture of practically non-absorbent material. It seems hardly necessary to mention the obsolete enameled iron trough urinal or slate slabs flushed by a perforated pipe. These are, of course, much cheaper than stall unit work, but a saving of money at the expense of sanitary conditions should never be considered.

**Floor drains** should never be installed in school toilet rooms unless they are provided with a full size vent and have a flushing rim automatically flushed from a tank on the wall two or three times a day. Without this flushing, they are catchalls for sweepings, and the water seal is rarely replen­ished and evaporates in a month or so, permitting flushing of sanitary conditions should never be considered.

Lavatories or wash basins should be of substantial pattern with as small a slab size as can be used with an adequate bowl. A small slab has little space for dust collection and offers less inducement to tired boys as a resting place. The fixture should be sup­ported on a leg or legs and have more than ordinarily strong fastenings to the wall, such as 4-inch expan­sion bolts or lag screws and lead sleeves. Extra­heavy, self-closing basin faucets should be used, so that water cannot be left running by careless pupils. The use of “pop-ups” and other such wastes should be avoided, as they are a constant challenge to the boys. Where the，“pop-ups” and other such wastes should be avoided, as they are a constant challenge to the small boy with mechanical ideas. A plug and chain frequently develops a “hammer” at closing.

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**Table:**

<table>
<thead>
<tr>
<th>Number of flush valve closets allowed on various branch supply sizes</th>
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</thead>
<tbody>
<tr>
<td>1 or 2 closets on ( \frac{1}{4} )&quot; pipe</td>
</tr>
<tr>
<td>4 to 6 &quot; 2&quot;</td>
</tr>
<tr>
<td>7 to 12 &quot; 2( \frac{1}{2} )&quot;</td>
</tr>
<tr>
<td>13 to 20 &quot; 3&quot;</td>
</tr>
<tr>
<td>21 to 45 &quot; 4&quot;</td>
</tr>
<tr>
<td>46 to 75 &quot; 5&quot;</td>
</tr>
<tr>
<td>76 to 110 &quot; 6&quot;</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of pressure tank closets on other small fixture connections on various pipe sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 2 connections on ( \frac{3}{4} )&quot; pipe</td>
</tr>
<tr>
<td>3 to 4 &quot; 1&quot;</td>
</tr>
<tr>
<td>5 to 8 &quot; 1( \frac{1}{2} )&quot;</td>
</tr>
<tr>
<td>9 to 12 &quot; 2&quot;</td>
</tr>
<tr>
<td>13 to 25 &quot; 2( \frac{1}{2} )&quot;</td>
</tr>
<tr>
<td>26 to 50 &quot; 3&quot;</td>
</tr>
<tr>
<td>51 to 80 &quot; 3( \frac{1}{2} )&quot;</td>
</tr>
</tbody>
</table>
and that rubber plugs of the cheapest kind must be bought by the gross. They are, however, much cheaper than constant repairs and replacements to mechanical wastes.

The cleanest and really the proper way to wash hands is in running water, leaving a free opening to the temperature is higher than it would be from warmed tanks, or where for some other reason the temperature is higher than it would be from wells or from properly laid mains. Drinking water of icy temperature is unhealthful, and for ordinary drinking purposes it should not be colder than 45 or 50 degrees. This subject has been given much study by mill and factory medical men, and proper control of drinking water temperature is reported as greatly reducing layoffs on account of stomach troubles induced by drinking very cold water when in a heated condition. The same considerations apply to children drinking after a strenuous play period. If it is found advisable to cool the water, it should be done by a central refrigerating plant, controlled by a thermostat, instead of by introducing ice into the water.

One difficulty with diagonal-stream fountains is their response to variations in pressure by changing the height of the stream every time pressure is lowered in the lines by flushing several fixtures. This can be avoided by passing all drinking fountain supply through a water pressure regulator and reducing the supply to them to a point where variations will not drop below the setting of the regulator. In connection with the pressure-reducing valve, a sand trap is often installed to screen out any foreign matter in the water.

*Hot water* should be supplied to all lavatories, together with liquid or powdered soap and paper towels, as children will not wash in discomfort or without soap and means of drying. The hot water supply should be of the instantaneous type, or the equipment should provide large storage capacity with a comparatively small heater, as the total use is spread over about four hours out of the 24 and nearly all during some three or four 15-minute periods. A circulating return will tend to save much water, though it will require more coal or gas to operate. In case special kindergarten toilets are wanted, siphon-jet infant-size closet bowls can be had with heights of 8½ or 9 inches, and lavatories can be set 2 feet from the floor instead of at the regular height.

*Fire Protection.* Fire standpipes, although used extensively in school buildings, are rarely considered a necessity. In some localities rates may make their installation desirable financially, but generally all modern school buildings are fireproof up to the ceiling lines of the top floors, and a judicious distribution of extinguishers, taking care that they are periodically charged, will take care of any minor fire until the arrival of fire apparatus. Teachers should not be charged with fire fighting or anything that will take their minds from their most important duty, that of getting the children out. In case the building is in a country town with little or no fire department and without a pressure water supply, several hydrants in the school grounds attached to the school water system are much to be preferred to interior standpipes. These hydrants should be 50 or more feet from the walls of the building, so that fire heat may not prevent servicing them, and the hose should be kept in an outbuilding. If the school has an auditorium with stage space for scenery, an automatic sprinkler system should be provided beneath and over the stage, in all dressing rooms, and in all stage property storage rooms. It is good practice to have the asbestos fire curtain operate on a "trigger connection," so that if there is a lack of pressure the curtain cannot be raised for a performance, and if the pressure drops dangerously low, the curtain will come down of its own accord.

*Piping.* The plumbing piping system should be of the best. The materials and workmanship should be such that the plumbing installation will last for the reasonably-to-be-expected life of the building. This does not mean the entire structural life but until the condition of the entire building and plant is such that it becomes necessary to remodel. It is safe to say that this period will be at least 30 years and may be 50. Therefore, care should be taken not to bury in floor or wall construction any material of shorter life, and to see that all valves or other parts requiring repair or replacement are left, together with their connections, in accessible positions. It pays to use a heavier grade of fittings of galvanized iron or brass pipe than would ordinarily be specified,
and to have all waste and soil pipe fittings of the long radius pattern to avoid the possibility of obstructions' building up. Probably extra-heavy cast iron soil pipe will have longer life than galvanized iron pipe. Some engineers prefer genuine galvanized wrought iron in place of the soft steel pipes of commercial grades. Brass pipe answers the need for long life water pipe where it is concealed, but galvanized iron, of a larger size to take care of inside corrosion, may last if it is painted and given a protective wrapping. Pure copper tubing is used to some extent, is much cheaper than iron pipe gauge brass pipe, and it is flexible and easily worked.

All water piping, whether concealed or exposed, should be covered with asbestos or hair felt covering. This protects the pipe from corrosion through contact with building materials such as mortars and concrete, minimizes loss of heat in hot water piping, and prevents condensation on the cold water lines. It also prevents, to some extent, noises due to pipe vibrations, though it is good practice to install shock absorbers at strategic points to take care of water hammer if it does develop. Each main water line in the basement should be painted its distinctive color, and all valves should be tagged. The plumbing system should be adequately vented, the fixture wastes having individual vents or being connected on a circuit or loop vent in accordance with modern practice. If the state, city or town has no plumbing code, the "Hoover Code" requirements should be strictly adhered to.

Special Pipe. Wastes from chemical and physical laboratory sinks should never be connected to the general plumbing system of the building, and they should be run exposed for easy inspection and repair unless the waste lines are constructed of pipe proof against the commonly used acids. Special pipe for acid work can be had in several materials, such as a composition of hard rubber, stoneware, china, lead-lined iron, and cast iron with a high silicon content. They are all hard to work, and the fittings of some are cumbersome, but the silicon iron, being so similar to the cast iron soil pipe used elsewhere in the system, probably will be most satisfactory. In using this, or any acid-resisting pipe, joints are weak points, and special asbestos jointing material must be used.

Valves. Too much stress cannot be laid on quality of valves. They vary widely in price, but the best will be found much cheaper in the end. Globe valves should be used sparingly on account of their resistance to flow which is about 20 times as much as for the same size gate valve under equal conditions of pressure and rate of flow. It is best to select the make of valve to be used and have the same make throughout the work. All valves in rooms to which pupils have access should be of the lock shield, removable handle type, which cannot be meddled with.

**Pumps and Tanks.** If a pressure water supply is not available, then a pumping system and an elevated tank may be used, but as satisfactory operation of valve closets depends on a head of 35 or 40 feet above the topmost fixtures, a pressure tank layout will be found more serviceable and less costly. A proper size tank would hold not less than 400 gallons per classroom in combined air and water. The tank (or tanks) may be heavily coated with protective paint and buried in the ground with just the head and connections exposed in the basement. Gauge glasses as well as pressure gauges should be provided, and a dependable relief valve is a necessity whether there is one on the pump or not. Good practice is to have a separate air pump instead of relying on the snifter valve usually furnished on the water pump, as it places better control in the hands of the operator. Automatic intakes on pumps are always to be used on wells and pump heads, and jacks are noisy and the monotony of their pound has a bad effect on school work. If deep well work is necessary, an air lift system will be found best, although more expensive.

**Sewage Disposal.** In the absence of a public sewer system, a sewage-disposal plant is a necessity. A leeching cesspool is an abomination and should never be considered, even if the law is loose enough to permit it. What is usually called a septic tank will answer for the preliminary treatment of reducing the sewage to a liquid form, but even in the design of this there is the difficulty that the quantity of sewage to be treated varies greatly. The plant must normally work five days and be idle two, and there are several short and one long vacation, and stale sewage will not respond readily to secondary or purifying treatment. This intermittent use also tends to sludge up the tanks excessively, but as the tank must be desludged each fall anyway, this condition only adds to the size.

A two- or three-part concrete tank of rectangular shape is generally used, although a much smaller unit built on the Imhof principle will occupy less space and possibly will cost less to build. The Imhof pattern has the advantage of quickly clearing of stale sewage on occasion, the mat area is small, and removal of sludge is easier.
SCHOOL FINANCING AND THE ARCHITECT

BY
C. STANLEY TAYLOR

A T first thought it might seem that the architect would have no particular interest in the question of financing school building projects.

The reason that the architect's relation to the financing of school buildings is becoming of paramount importance is because the nature of such financing invariably establishes an almost absolute cost limit or budget for the building operation. It is quite unnecessary to go into details regarding the types of school bonds or the methods of taxation. The important point for the architect to consider is that a bond issue, a special tax, or an endowment, prescribes a definite sum of money which should not be exceeded by the cost of the land, building and equipment. Last year an extensive survey was made by the Better Schools League, Inc., of Chicago. So many valuable facts were developed in the course of this survey that it is drawn upon freely in the development of this article.

Costs and Appropriations. The Better Schools League survey brought out some very interesting information in relation to the question of construction and equipment costs exceeding bond issues or appropriated funds. In 350 cities which erected school buildings within the past five years, 22 per cent of them overspent the bond issues or appropriations. The results of incurring building and equipment costs which exceed appropriations are always unfortunate, and in many cases the architect is directly charged with the responsibility. In the first place, if there is an excess cost, the community is forced to issue warrants bearing high rates of interest. In many communities this practice is not legal, and the only thing that can be done where the construction cost is excessive is to curtail definitely the finishing and equipping of the building. Old equipment may be substituted for new, and in every way the final structure will be inferior, according to present-day standards. This situation may also lead to instructing important extra-curricular activities,—music, art, industrial arts, gymnasium and playground activities. Under these conditions also it becomes impossible to develop the school as a community center and to provide the various facilities necessary to contribute to community life. It becomes quite evident, then, that the architect's relation to financing has much to do with developing a building which will unquestionably come within the construction budget. The fact is, however, that this relationship should logically begin at the earliest stage, when the project of a new school building is first contemplated and before any bond issue or appropriation is established. An architect should be called upon at this stage to investigate the school requirements and with rough preliminary plans to indicate to city officials or the school board how much money is really necessary for the building and its equipment.

The Fixed Budget. This question of developing plans within fixed budget limitations offers in itself a series of problems which must be solved in a practical manner by the architect. The first temptation, of course, is to establish construction and equipment cost savings through the use of less expensive materials, and perhaps through simplified planning. This is a logical way to bring down the cost of a building of any kind, but at the same time it is a very dangerous procedure unless practical minimum standards are set. It must be remembered that school buildings are built to serve the community for a great many years and in the most efficient possible manner.

The information which follows is presented primarily as a guide to the architect who undertakes school work. It gives some very definite information as to the cost of the construction of schools of various kinds and also shows at least one recommended method of establishing the related budget of equipment cost as compared with the total building cost. The data have been taken from last year's survey by the Better Schools League, Inc.

Ratios of Building to Equipment Costs. General experience with the school equipment budget indicates that it should be established as an entirely separate fund upon which the building cost itself should not encroach. Reports received by the Better Schools League from 350 cities which have erected school buildings since the year 1923 showed a very consistent ratio of the percentage of the bond issue which should go into the building proper and that which should go into equipment. The experience of this group provides a basic standard of average practice. The summary for the different types of school buildings is indicated here. It may be noted that school buildings throughout are classified according to the grades housed in the structures. Thus, grades 1 to 8 represent the average elementary school; grades 1 to 9 represent elementary and junior high school combined; grades 1 to 12 represent elementary and high school combined; 7 to 9 junior high school; 7 to 12 junior and senior high school; 9 to 12 regular high school; and 10 to 12 senior high school. The term "upper 50 per cent" is also used, indicating the finer standards of modern construction and equipment, so that the general figures given represent average practice, but those labeled "upper 50 per cent" represent the practice of the better-than-average group.

According to analyses in 350 cities, in school buildings housing grades 1 to 6, the average equipment cost was 8.2 per cent of the bond issue or appropriated funds. The average of the upper 50 per cent, classified on the basis of per cent of bond issue
going into equipment, was 11.2 per cent. In school buildings housing grades 1 to 8 the equipment cost was 10 per cent of the bond issue or appropriated funds. The average of the upper 50 per cent, classified on the basis of percent of bond issue going into equipment, was 13.7 per cent.

In school buildings housing grades 1 to 9 (elementary and junior high school combined) the equipment cost was 13.6 per cent of the bond issue or appropriated funds. The average of the upper 50 per cent, classified on the basis of percent of bond issue going into equipment, was 18.3 per cent. In school buildings housing grades 7 to 9 (junior high school) the equipment cost was 10 per cent of the bond issue or appropriated funds. The average of the upper 50 per cent, classified on the basis of percent of the bond issue going into equipment, was 18.3 per cent. In buildings housing grades 7 to 9 (junior high school) the equipment cost was 10 per cent of the bond issue or appropriated funds. The average of the upper 50 per cent, classified on the basis of percent of bond issue going into equipment, was 12.5 per cent. In school buildings housing grades 7 to 12 (junior and senior high schools combined) the equipment cost was 12.2 per cent of the bond issue or appropriated funds. The average of the upper 50 per cent, classified on the basis of percent of the bond issue going into equipment, was 18.5 per cent. In buildings housing grades 10 to 12 (senior high school) the equipment cost was 16.6 per cent of the bond issue or appropriated funds. The average of the upper 50 per cent, classified on the basis of percent of the bond issue going into equipment, was 22.6 per cent.

On the basis of these averages, a table of budgeting,—assuming the building and equipment cost $300,000.00,—would be:

<table>
<thead>
<tr>
<th>Grades</th>
<th>To House</th>
<th>Cost of Equipment</th>
<th>Cost of Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-6</td>
<td>$24,600</td>
<td>$275,400</td>
<td></td>
</tr>
<tr>
<td>1-9</td>
<td>30,000</td>
<td>270,000</td>
<td></td>
</tr>
<tr>
<td>1-12</td>
<td>42,000</td>
<td>258,000</td>
<td></td>
</tr>
<tr>
<td>7-9</td>
<td>30,000</td>
<td>270,000</td>
<td></td>
</tr>
<tr>
<td>7-12</td>
<td>36,600</td>
<td>263,400</td>
<td></td>
</tr>
<tr>
<td>9-12</td>
<td>45,000</td>
<td>255,000</td>
<td></td>
</tr>
<tr>
<td>10-12</td>
<td>49,800</td>
<td>250,200</td>
<td></td>
</tr>
</tbody>
</table>

It is manifestly difficult to lay down a definite and established ratio between the cost of the building and the cost of equipment. The average for the junior high school is low in comparison with others, possibly because it is a new institution, and its needs therefore, not so well standardized. The averages given here show the general trend and afford local school officials an opportunity to check their own school costs against the general averages.

For those who are interested in knowing what the "upper 50 per cent" or better than average groups are doing, this table indicates the allocation of the total budget for a school building project,—assuming again the cost of building and equipment to be $300,000.

**AVERAGES FOR "UPPER 50 PER CENT"**

**Survey of Actual Costs.** Returning again to the question of school building costs, the most reliable data was received by the Better Schools League, Inc., 53 West Jackson Boulevard, Chicago, in the course of their extensive cost investigation. In this survey will be found a detailed list of actual school building projects, giving in all cases the essential data, including cost per pupil and in many cases the actual cost per cubic foot. Of the various buildings on which costs are given, 228 are of fire-resisting construction; 94 are of the slow-burning type of construction; and 5 have practically no structural safeguards against fire. The tabulations give in the first column the type of school described by grades housed in the structure. The meaning of these various grades has already been presented in preceding paragraphs. The second column gives the year of construction; the third gives the maximum pupil capacity; the fourth gives the cost per pupil; and the fifth gives the cubic foot cost in cases where costs are available. These figures are conveniently divided into various states. They will unquestionably serve as a general basis for comparative cost estimating. It must be realized, of course, that cubic foot cost data have definite variations and limitations, and that the same structure in one locality may cost more or less than in another. The building that costs $300 per pupil may provide twice as much in the way of facilities of an auditorium, gymnasium, laboratories, etc., as the structure costing $150 per pupil, so that it is not safe to assume that the school built at lower cost is necessarily the most efficiently designed. The opposite may be the case.

**Environ's Note—**The full tabulation of school building costs, arranged according to the type of school, the year constructed, the pupil capacity, the cost per pupil and the cost per cubic foot, is published in a booklet entitled, "School Construction Costs and Equipment Budget." This booklet, which is described by Mr. Taylor, is published by The Better Schools League, Inc., 53 West Jackson Boulevard, Chicago, and is the result of an investigation which covered reports from 350 cities which have erected school buildings within the past five years.
DURING the year 1905 and subsequent years, school buildings, when finances made it possible, have been constructed of fire-resisting materials, using the wall-bearing type of construction, which in more recent years has made way for the column-bearing type,—a more economical and practical form of construction. This change in design has been greatly augmented by the great number of school buildings that have been destroyed by fire. Statistics show, even in this modern age when everything is being done to preserve human life, that a great number of school buildings of all sizes throughout the country are still being constructed of non-fire-resisting materials and that on every day in the year, approximately five such buildings are burned to the ground. This is not confined to buildings erected during the early part of our educational development, but includes some constructed during recent years. The desire to reduce fire losses to the minimum, together with new standards of higher education and laws enacted by the legislatures of the different states, has resulted in the development of the modern school building.

Costs. Some elementary schools completed during the latter part of 1927 in one of the large cities at a cost of approximately $543,000 each were designed of concrete with full column-bearing type construction and had in general 35 class units, including shops, recreation rooms, auditoriums, doctors' rooms and boys' and girls' interior toilets on each floor. Buildings are now completed in their entirety within 12 months from dates of awards, which would not have been possible had wall-bearing construction been used. A senior high school completed during the early part of 1927 at a cost of $2,170,191 of construction similar to that of the elementary schools, included over 100 class units, among which were units for the study of chemistry, physics, art, mechanical drawing, home economics, physical training, manual training, music, botany and others too numerous to mention. Within this building are also to be found a large auditorium, up-to-date administrative offices, toilets and rest rooms.

The constant change in ideas for the educational requirements of the child, together with new building laws, has kept the designers of school buildings on the alert in order to keep pace with the latest developments. As a result, many new details have been introduced in construction and design that would not otherwise have occurred. It is interesting to note the mounting cost per cubic foot of space as the educational system develops, with a simultaneous elaboration and beautification of the exteriors of the buildings. Much study has been given to every part of the building in order that the cost of installation might be reduced to a minimum consistent with good design.

Economy of Space. There has been a great advance in what is known as concrete column construction, using spandrel beams to support exterior and interior walls. This type of construction provides saving in space, economy in construction and rigidity and rapidity of erection over the former wall-bearing type. The skeleton-frame type of construction allows a reduction in the gross area as well as the total height of building. This is very evident by referring to the illustration of "Comparative Types" which shows three systems of concrete construction. In the use of 13-inch curtain walls and 4-inch tile partitions one can readily visualize the saving in total area, which is often as much as 3 per cent. By reason of the shallow floor construction and the omission of the large factory-like windows sometimes placed in school buildings, about 5 or 6 feet may be saved in the total height of a three-story building, which may permit a total reduction in the cubic of the building of approximately 10 per cent.

![Diagram of Comparative Types of Concrete Construction](image-url)
Typical Junior High School, Completed 1927. Cost Per Cubic Foot, 43 Cents. Cost Per Pupil, $608. Pupil Capacity, 2040

This reduction in culage, however, is not so evident in the cost per cubic foot as in the total cost of the building and the cost per pupil. This theory is proved by the example of a school recently constructed without an auditorium, where the per cubic foot cost was 42 cents, with the per-pupil cost as low as $253. Here the plan was rectangular and had no waste areas. On the other hand, in another building, having an auditorium, the cubic foot cost was 43 cents, while the cost per pupil was $345. Thus, while the increase in the per-cubic-foot cost due to the inclusion of the auditorium is but \( \frac{1}{2} \) per cent, the increase per-pupil cost is more than 36 per cent.

Rapidity of Construction. Rapidity in construction is an important factor in the building of schools, and this is best accomplished when all trades can proceed independently of one another and without interference of any kind. This is better accomplished with the skeleton form of construction than with the wall-bearing, for the reason that floor after floor can proceed without waiting for bricklayers and other sub-contractors to get on the site. The solid concrete floors and stairs become a protection to workmen against weather and accidents, and facilitate the movement of materials and labor as soon as this portion of the work is completed. School buildings with a culage of over 1,000,000 cubic feet have been completed and fully equipped within a period of from nine to ten months after the work was started. The rapidity of construction resulting from the use of this type is closely allied with economy in construction, so that owner and contractor are always
the principal beneficiaries, as indeed they should be.

**Rigidity of Construction.** One of the most important qualities in the use of concrete is the rigidity that is secured by the skeleton type of construction. It is very important that the vibrations caused by children marching or drilling should not be transmitted to the classrooms, and that the noise and motion of the gymnasium should not in any way disturb the auditorium exercises. The rigidity of the concrete skeleton frame building gives assurance and satisfaction in a heavy wind storm such as have been experienced recently in many parts of the country. In connection with these wind storms, it will be noticed that wherever loss of life has occurred from a collapse, the building was of the wall-bearing type.

**Economy of Construction.** Since the adoption of the full skeleton type of construction, many buildings have been erected of the reinforced concrete skeleton type. Using this, it has been possible to complete and fully equip $500,000 buildings in ten months, when it once took twice that time. Study and research have made it possible to standardize certain drawings and details, with the result that within 24 hours after a contract is awarded practically 80 per cent of the details required for the building can be issued to contractors. In this way there is no wasteful and expensive delay, and the contractor is able to reduce his own overhead charges.

**Details of Construction.** The details of construction here shown may be considered typical for this kind of building. In general, classrooms are 30 feet long in the clear, so that the spacing of columns is 15 feet, 2 inches. The floor and roof construction is formed of 5 3/4-inch wide concrete joists (usually 8 3/4 inches deep), 26 inches on centers, with slabs 2 1/2 inches thick. This floor, known as “composite” construction, is framed to a large girder 16 inches wide by 26 inches deep, having a span of 23 feet, with a wide tee, which runs from column to column across the width of the room (Diagram page 474). The slabs and joists, in the schools just mentioned, are “formed up” by the use of No. 12 gauge removable steel forms, which may be removed two to four days after the concrete is placed, providing the supports under the joists are left in place. This permits the continuous use of the forms, so that a comparatively small quantity will be sufficient for the entire building. There are various other satisfactory types of concrete floor construction, such as terra cotta or light hollow concrete blocks spaced so as to form the rib beams, flat slab construction reinforced in various ways, etc. The finished ceilings of the classrooms, corridors, and other rooms are formed by expanded metal lath suspended beneath the soffits.
of these joists and plastered with the usual three-coat work. The ceilings of the upper stories are formed in a similar manner, supported on channels or angles which are suspended several feet below the roof construction. The space between the roof and the ceiling below is useful for the steam pipes and ventilating ducts which are so necessary in large school buildings. (See illustration “Comparative Types,” below.) All exterior walls are of face-brick veneer with a backing of a hollow tile or common brick supported at each floor on concrete spandrel beams, which are framed monolithically with the floor, girder and column construction. An important feature of the construction is the all-concrete stairways which are poured with the floor construction, providing safe and easy access to all floors.

It is almost impossible to imagine what changes will occur in school buildings which may be erected during the next 100 years, considering the great changes that have developed during the past hundred. Will they be huge structures, three and four times the sizes of the present buildings, or will education, like all other enterprises and developments, reach a “saturation” point? The writer believes that there will come a time when the mechanical activities will be removed to special trade schools, and that the new education in these buildings will revert to that of the “three R’s” of a more advanced standard.
SPECIFICATIONS FOR THE SCHOOL BUILDING

BY

CHARLES E. KRAHMER

OF THE OFFICE OF GUILBERT & BETELLE, ARCHITECTS

THE "Tentative Contract Forms" submitted by the Interdepartmental Board of Contracts and Adjustment of the Bureau of the Budget, U. S. Government, contains this excellent definition of public and private contracts:

"1. All public contracts are made by agents with limited authority. Their authority is governed and controlled by the laws under which they are authorized to act.

"2. It is a well established public policy that all public contracts shall be let after open and free competition to the lowest responsible bidder, and that, in order to accomplish this result and have competition based on uniform terms, the government, states, counties and municipalities must dictate the terms and conditions that must be met by the bidder.

"3. In order to carry out this public policy it is necessary that the contracts shall be carried out and performed in substantial compliance with the terms and conditions under which they are let. No officer of the government, or of a state, county or municipality, has the right to vary the terms or waive the rights accruing under such contract. In private business, however, the individual awarding the contract can do what he pleases with his own money or his own property, and he can select his own contractor upon his own terms. He is free to order any changes he may desire to have made in the contract and to make any kind of settlement he can arrange with the contractor after performance has been completed."

A contract for a public school is a public contract, subject to the restrictions quoted. There are some municipalities and school districts where a public school contract may be legally handled as a private contract. In these cases it is generally considered for the best interests of the public to handle them essentially as described for public contracts.

A close contact with public contracts over a period of years reveals the fact that the element of "good will" is absent in this class of work, and there appears to be a good reason for this condition of affairs. The lowest responsible bidder is an elastic term, which includes generally all not in receivership or jail. This state of affairs is due largely to the surety companies, which seem willing to furnish bonds to anyone able to pay their fees. When a surety company guarantees the responsibility of the contractor, the school board is in effect denied the right to judgment which the law intended. A public contract is awarded as the result of a "free for all" upon a strictly price basis, and the successful bidder generally feels that the contract was awarded without regard to ability, character, integrity or financial responsibility, and, therefore, he is entitled to take advantage of all of the "breaks," errors, misinterpretations and omissions, and will create as many of these to further his own interests as possible. The specification writer should be thoroughly familiar with the effect of public bidding and the lack of "good will," and he should erect a defense against the evils resulting from open bidding and the lack of "good will." In order to effectively carry out the policy and conditions defined for public contracts, it is necessary to include in the specifications requirements and conditions peculiar to this class of work.

An attempt has been made in this article to restrict the discussion to those questions which require special treatment in public contracts, and no attempt will be made to cover questions which are encountered in specifications for the average work.

Advertisement: The advertisement is generally included as part of the contract documents and should, therefore, be prepared by the architect. The advertisement is the concrete expression of "open bidding" and is required to insure such bidding. Certain municipalities and school districts have requirements which differ from others, and the specification writer should consult the secretary of the school board before preparing it. The advertisement should state briefly when and where the bids will be received, the character and size of the project, the number of contracts, the deposit required to guarantee the bid, and whether it will be a certified check, bid bond or cash; also where plans can be obtained for estimating purposes and the deposit required for them. The advertisement should be included as part of the specifications and a copy turned over to the secretary of the school board for insertion in the papers. When this detail is handled by the architect, he should look up the law, as it varies not only in different states, but also in different municipalities and school districts.

Proposal Form. In order to carry out the policy of dictating all of the requirements and conditions that must be met by the bidder, and to insure the bids being received on exactly the same basis, the proposal form is always included. The proposed form should be prepared by the specification writer and is either included in the specifications or as a loose form with the specifications. The proposal form simplifies the public reading of bids and becomes part and parcel of the contract documents. The proposal form should be made out in complete detail, so that it will only be necessary for the bidder to fill in the amounts and sign it. When alternative estimates and separate estimates are required, the exact wording of each should be on the proposal form, so that it will be necessary to fill in only the amount. The courts have ruled that optional alternative bids which deal with a system or method
different than that specified are illegal, due to the fact that the other bidders did not have the opportunity to estimate upon the same basis. For this reason proposal forms which request the bidder to name the time of completion have been held illegal because all bids were not on the same basis.

Deposit Guaranteeing the Bid. In order to prevent fraud in public work, a deposit is required with the bid guaranteeing that the bidder will execute the contract if it is awarded to him. The deposit may be cash, certified check or bid bond, and the amount required will generally vary from 2 to 10 per cent of the amount of the bid, depending upon the amount of money involved. A bid bond is furnished by a surety company for a nominal fee as an accommodation, and as such they expect to receive the contract surety bond if the bidder be awarded the contract.

Some school boards will not approve some surety companies, and in order to prevent the necessity of disapproving a surety company after it has guaranteed the bid of a successful bidder, they refuse to accept bid bonds as deposits and demand certified checks or cash. To prevent issuing certified checks upon weak banks, some school boards require that the certified check be made upon a member bank of the Federal Reserve System, as a bank must qualify before being accepted as a member. It is usual to require all bids to hold good for 30 days after their receipt, and to require the retaining of the deposits of the three low bidders on each class of work until the contract is executed. As the deposit is frequently 5 per cent of the bid, this means that this amount is deposited without interest with the school board for this period of time. Some school boards do not request funds for building purposes from the public or board of school estimate until the bids are received, and it is manifestly unfair to tie up the liquid funds of an unsuccessful bidder for 30 or 40 days without interest.

Surety Bond. A bond guaranteeing the performance of the contract is required from the successful bidder and is a legal requirement of all public contracts. Personal bonds are legally acceptable in most states, but owing to the liability of the individual members of the school board, if the contractor should default and the security prove worthless, this class of bonds is rarely accepted. Practically all bonds are executed by companies which make a business of this class of risks. The fees for surety bonds are generally fixed by law, and the surety companies are generally licensed by the state before they can do business in that state. They are also required to deposit a percentage of their capital in the state treasury, the amount of the deposit being based upon the amount of business done. Some states legally define the liabilities which the surety company must assume, irrespective of the particular bond form it may have executed. One may often feel secure in the knowledge that he has protected the owner, subcontractor and materialman, by a cleverly worded and legally executed bond form, but may learn later that the state law has limited the liabilities of the bonding company to such an extent as to make it practically valueless. In New York, the surety bond protects not only the owner, but the sub-contractors and materialmen. This is as it should be in building construction, owing to the fact that the contractor in this class of work is in effect a broker, who can easily shift his liabilities to the shoulders of the sub-contractors and materialmen, and let them "hold the bag." Such a condition of affairs exists in the state of New York, and it encourages fraud. The surety companies in New York are responsible to the owner only. The general contractor can finance a project from the sub-contractors' funds, collect at completion, and as long as he does not default to the owner the surety companies are not involved.

Qualifying as a Responsible Bidder. In a creditable attempt to take the definition of a responsible bidder out of the hands of the surety companies and to correct some of the evils of public bidding, the Joint Conference on Construction Practices, at Washington, has compiled standard questionnaires and financial statements which when executed should form a good basis on which to establish the proposed bidder's responsibility. The forms consist of an experience questionnaire, plan questionnaire and financial statement, and appear to be a step in the right direction.

General Conditions

Liquidated Damages. The General Conditions for a school building will vary from that used for a private project, due to the fact that all of the conditions and requirements must be decided beforehand and definitely specified, with nothing left to future negotiation. For example, the time of completion should always be given, so that all bids will be received on exactly the same basis. The amount of liquidated damages should be given, with detailed conditions under which the time will be extended. If the operation is awarded under different contracts the liquidated damages are more difficult to collect, but even under these conditions the amount has been collected. The amount of liquidated damages that the school board will stand is not in direct relation to the amount of the contract price of the building. Should the time of completion coincide with the beginning of the fall school term, the liquidated damages should be greater than if the time of completion were at the beginning of the summer vacation period. If a school addition or alteration is contracted for and if it affects the operation of the present building, the amount of liquidated damages incurred would be proportionally greater than if the building were a complete unit in itself. These facts should be considered when establishing the amount of liquidated damages. Liquidated damages for non-completion of the work on time should be required for all public contracts.

A "pitfall" in public work is the inclusion of cash
allowances in the specifications, such as is frequently done in private work. This should never be done, for the reason that it turns over to the architect a definite sum of the public's money to spend without competition, and while this procedure may be consistent with the best interests of the building, it is not good public policy, and I seriously question if it is legal. The architect should reserve the right to approve the sub-contractor under all conditions, for it is through the "good will" of the sub-contractors and the materialmen that little difficulties are ironed out during construction.

"Or Equal." This is not the place to debate "or equal." The principle of open and free bidding in public work forces the use of "or equal" throughout school specifications. It is of the utmost importance that the architect be the judge of "or equal." A forcible paragraph should be included in the General Conditions to the effect that the exact brand specified must be used, and where substitutions are desired they must be submitted to the architect for approval, which approval must be given in writing through the general contractor. This provision keeps the control and selection of material under the architect's control, where they rightly belong. It also, if rigidly enforced, discourages the use of substitutions, as the sub-contractor is required to have the general contractor make the requests, and this operates as a restraint in many cases. Another method of handling the question of "or equal" is to require the exact brand of material specified with the provision that all substitutions must be submitted before the receipt of the bids, and that where a substitution is granted, the substitution will be included in a bulletin sent to all bidders upon the work, after the receipt of the bids no substitution being allowed. This requirement, which is in line with legal opinion, is, however, pretty rigid, and it is questionable whether it is in harmony with the best interests of the public. Another method of handling the question is to require all bidders to submit with their estimates the substitutions that they desire to make with the prices, more or less, which in effect really makes these alternative estimates. A statement is generally included to the effect that after the award of the contract no substitutions will be considered other than those decided from the list furnished with the bid.

The method of procedure in constructing the building should be given attention, particularly if the building is an addition. In these cases it is usual to require that no workmen be allowed in the existing building while the school is in session, and that the school shall be kept in operation uninterruptedly at all times. It also is general to require dust-proof and noise-proof partitions to be constructed where alterations are being performed in the present building, and to require that the contractor work out a schedule of procedure with the architect and school authorities.

General Contractor's Work. A section should be included in all school specifications covering the amount of work which must be done by the general contractor. It is important for sub-contractors and materialmen to have decided for themselves in advance questions as to who will furnish the water, heat, light, watchmen, hoists, scaffolding and toilet facilities, during construction. They are also interested in knowing whether these will be furnished free or whether the general contractor will charge them a pro-rata fee for their use. The general contractor should provide any temporary dust-proof partitions required in an existing building where alterations are being made. In addition to the services named already, he should also provide temporary fences, cutting off the area under construction from the other school property.

Sub-Contractors. Within the past decade a most unusual development has taken place within the building trades. This consists of the splitting up of the basic trades and the changing of their status from that of employees to sub-contractors. This movement is in line with the present age of specialization and standardization, and is in harmony with our present social structure. The architect and the contractor have not been alert and are slow in planning to meet this change. A decade ago an owner selected an architect who gathered around himself general contractors who were thoroughly familiar with the class of work desired by the architect. Specifications as we now know them were unheard of and unnecessary, due to the fact that the general contractor employed the mason, carpenter, painter, etc., on his own pay roll, and selected and trained them to do but one class of work, irrespective of what the specifications required. Now that the trades have organized into sub-contractors and that these sub-contractors have associations, we find them demanding definite and specific specifications on the work they are to furnish, so that they will feel sure their competitors will be required to furnish the exact article on which they estimated. This is particularly true of public work. It is no longer a question as to whether a certain material is good enough, but whether it is of the exact grade specified, in order to keep up the morale of the sub-contractors estimating upon the work. They soon find out whether their competitor is taking an "oat out of the bag" by furnishing one grade lower. If they find that this condition obtains, one may be sure they will go one step further than their competitors. It is for this reason that specifications in our modern methods of building should be very explicit and very complete.

Special Problems in Construction and Materials. A school building will not be sold, rented or leased, in the natural course of events, but must be kept and maintained by the owner until it becomes obsolete and is demolished. If the building be physically defective, requiring constant maintenance, it will not reflect credit upon the architect. Another point to consider is that the school will be in care of a janitor, who may be a political appointee who will give the
building the most elementary maintenance, if any. The materials entering into a school building must not only be "fool-proof" but "abuse-proof." This creates several problems which are peculiar to school buildings: first,—the building will receive practically no careful maintenance service; second,—it will receive the hardest kind of wear and tear from minors at an age when destructiveness is most prevalent; third,—the building will never be sold, but must be carried by the owner. If there is any class of work where good, sound building construction should be practiced, it is in a school building. These suggestions should be given special attention.

Systems of Waterproofing and Damp Proofing. Water is most difficult to contend with, and the toughest enemy to conquer. It causes trouble in three major portions of a building: 1. Foundations and Basement. 2. Exterior Walls. 3. Roofs.

There are three basic systems of waterproofing the foundations which I have used to some extent,—waterproofed concrete, membrane system and the pulverized iron system.

Integral System. A successful integral waterproofing system usually results from the use of a combination of labor and compound in the proportion of 90 per cent labor and 10 per cent compound. The "human element" enters into this class of work to a great extent, and when "good will" is absent the problem is greatly complicated. The architect sometimes takes the claims of the manufacturer on their face values, incorporates them in his specifications and asks the contractor to guarantee them. The manufacturer of the compound may claim that the reason one did not get the result he promised is because the contractor did not "follow the printed instructions." The contractor does not see why he should be required to guarantee the results claimed for a secret compound. My theory is that the manufacturer who developed the product knows what it is and will do, and is the one who should assume the responsibility for the success of integral waterproofing. To put this theory to practical application, the specifications require the manufacturer to furnish the material and supervise the installation of all concrete and mortar where his material is called for to produce a waterproof result. For this supervision he usually charges the general contractor about $20 per day, plus expenses. As the value of integral waterproofing depends on the kind of concrete produced, one is assured in this way that excellent concrete will result and no excess water will be used, which result is worth the supervision fee charged. In such a case the manufacturer guarantees and furnishes the owner a maintenance bond, co-executed by himself and an approved surety company, that the work will be water-tight.

Membrane System. When the problem of waterproofing is very serious, I generally turn (rightly or wrongly) to the use of a membrane system of waterproofing consisting of alternate layers of hot asphalt and cotton saturated with asphalt, though other satisfactory systems of membrane waterproofing use rag felt, asbestos felt and burlap for the reinforcing agent, and asphalt or pitch of various consistencies and grades for the waterproofing element. The best of waterproofing can be analyzed as 25 per cent materials and 75 per cent labor. A good waterproofer can produce better work with poor materials than a poor waterproofer can with the best of materials. My belief is that the best assurance for successful membrane waterproofing is the requirement that it shall be done by a specializing waterproofing contractor. Another requirement to assure success is to specify the materials of a high grade company which will follow through and look after the work in a general way so as to make it successful. Membrane waterproofing should be guaranteed directly to the owner by the waterproofer, which guarantee should be backed by a maintenance bond for about five years and co-executed by the waterproofer.

Pulverized Iron Systems of Waterproofing. This system is sometimes used when it is questionable whether a waterproofing system is necessary or not, because it is the only system which I will use that can be logically applied to the interior of the foundation walls. For this reason, when in doubt, a separate price is requested on work of this type with the reservation that the right to accept the bid will run for the life of the contract. This will allow the saving of the cost of the waterproofing in the event that it should develop that no waterproofing is required. I have found this an excellent method when in doubt, and have frequently saved the entire cost of the waterproofing.

The method of waterproofing by this system is generally this: Finely ground pulverized pure iron combined with chemicals is mixed with water and brushed into the pores of the masonry, applications being made until the desired oxidation results, after which a heavy slush coat of the compound sand and cement is applied, and finally a neat cement wash is brushed over the waterproofing. The pulverized iron is oxidized by means of a chemical corroding agent and water. The result is a plating of corroded iron over the walls and bottom, of sufficient strength to withstand any hydrostatic pressure the structure is capable of withstanding. One of the dangers of this system is that the waterproofer must estimate the amount of application that may be necessary to withstand any hydrostatic pressure the structure is capable of withstanding. One of the dangers of this system is that the waterproofer must estimate the amount of application that may be necessary to withstand the most severe conditions, which generally occur during the spring thaws. The advantage of this system is that this work is being done at the present time by experienced waterproofers. This work should be guaranteed and bonded as suggested for the membrane system.

Damp Proofing Exterior Walls. Here is a quotation from circular of The Bureau of Standards No. 151, being the report of The Bureau of Standards Plastering Conference: "There are certain localities in the United States where the climate is uniformly hot and dry. (In the preceding sentence particular emphasis is to be placed on the word and.) With the
exception of in such localities, it is recommended that all exterior masonry walls be furred." This quotation is preceded by an authoritative and complete analysis of all the conditions of the problem, which warrants the conclusion reached. Poor workmanship and materials are responsible for most of the troubles encountered with water soaking through exterior walls. The present styles of architectural design have a bearing on the question, due to the lack of sill courses, water tables and cornice protection. Dampproofed exterior walls can be obtained if these precautions are taken.—Always fur plastered exterior walls. Never use thin back-up tile, clay or concrete. In severe cases parge the back of the exterior wall with waterproofed cement mortar before furring.

In connection with furred walls, the cheaper building can be furred with 1 x 2-inch spruce spaced 12 inches on centers and covered with metal lath and plaster. Wood furring should not be used for the better class of buildings or for buildings at the seashore where considerable dampness occurs. In these cases the inside of the exterior walls should be coated with an asphalt compound and then furred with split furring tile; the asphalt should continue out on the floors, ceilings and walls for a distance of about 3 feet. When the conditions are severe, such as at the seashore, it is desirable to parge the inside of the wall with a coat of 1:2 waterproofed cement mortar before the asphalt compound and furring are applied. The parging should continue out on the rough concrete floor slab and around the windows and out on the ceiling a distance of about 3 feet. Due to the fact that all face bricks are or should be laid up from outside scaffolds, and that face bricks are selected and laid for architectural effect, it is impractical to thoroughly slush and build up a pressure so as to force itself through the joints of face brick. The mortar is deposited around the edges of the brick with the point of a trowel and the brick bedded, the mortar extending back from the face of brick about \( \frac{1}{2} \) inch. When tile backing is used it is practically impossible to thoroughly slush and fill the joint between the face brick and the back-up tile, with the result that the water enters through the brick joints and soon filters and percolates through the joints of back-up tile, and in some cases builds up a pressure so as to force itself through the asphalt coating, window sills, floor slab, etc.

**Roofs.** Considering the lack of maintenance it generally receives, a good roof is of the utmost importance. For flat roof surfaces of large areas, the choice falls between a pitch slag and felt, or an asphalt and felt roof. Both types give excellent service if care is used in the selection of material and of the sub-contractor using it. On school roofs there are usually ventilators, skylights and scuttles. The composition is laid immediately after the roof slab has been cast. There results a considerable amount of traffic over the roof before the workmen are through. This damages the roof to a considerable extent and in a way that it is difficult to estimate. An improvement over the ordinary method of laying composition roofs is to apply the first three plies and then have the mechanics leave the work. When the parapet walls are completed, copings set, ventilators applied and all of the other work on the roof is completed, the roofer returns and repairs the damage to the base coats, and applies the final plies of the composition roofing. All flashings for a school roof should be of the most durable materials obtainable. The parapet walls should be flashed their full height. The best method of flashing a parapet wall is to use a lead cap flashing, as it seats well on a masonry wall. This cap flashing should be installed under the coping to form a drip on the outside, and should be continued through the wall and down the inside approximately 6 inches, with a \( \frac{1}{2} \)-inch lap. The base flashings should be of copper and locked to the lead cap flashing. An examination of parapet walls in a considerable number of schools discloses the necessity of thoroughly flashing the entire back of the parapet wall and indicates that all parapet walls should be 12 inches thick.

**Stair Halls.** Stair halls receive a tremendous amount of traffic and abuse. The reason is that the classes are constantly changing. This traffic is of the most destructive nature, and the materials should be selected to withstand it. The stairs are often of steel, strong enough to support a live load of 150 pounds a square foot. A balustrade is often provided about 5 feet high to prevent the pupils from pushing one another over the rail. Among the best stair treads are slate, soapstone, bluestone, terrazzo or cast iron with an abrasive element non-slip tile etc. Bluestone, which is extremely hard, comes about 2 inches thick, and wears non-slip. The platforms should be of the same materials as the treads. The walls of the stair halls should be wainscoted to a height of 5 feet or more with a material that will stand abuse and pencil marks. The best materials for this purpose seem to be glazed brick or salt glazed brick. The walls above the wainscot are generally plastered. A light colored impervious brick may be used above the glazed brick wainscot.

**Corridors.** School corridors receive the same traffic as the stair halls and should have materials to withstand the resulting wear. As noise is a disturbing element in the corridors, every effort should be made to minimize it. The materials most used for floors to accomplish this are either cork tile, linoleum tile, linoleum, rubber tile or mastic floors. Much might be said about each. Considering price, appearance, durability and value received, I consider plain brown battleship linoleum the best material for school corridors, providing it is properly laid and maintained. Terrazzo has been used with considerable success for corridor floors, but it is not very quiet. Terrazzo should be made non-slip by the addition of an aggregate which is sprinkled over the surface, displacing about 40 per cent of the marble chips. Mastic tile, cork tile and rubber tile have been used with varied degrees of success. Rubber
tile, linoleum and linoleum tile are secured to the floor with the same kind of cement. Moisture attacks the cement used in laying these floors. For this reason these materials should not be used where the floor foundations are on earth, despite the fact that the basement may be waterproof. In these cases terrazzo or mastic floors have proved successful. The walls in corridors should withstand abuse, and the materials selected are generally those used for the stair halls. In cases where the appearance of a brick wall is objected to, a colored ornamental architectural terra cotta cap may be used above the brick wainscots to produce a pleasing effect.

Classrooms. Wood is often considered the best material for classroom floors, considering ease, underfoot quiet and ability to secure desks. The choice seems to lie between yellow pine and maple. Yellow pine should at least be specified as dense heart rift “B and better” grade. No inferior grade should be used, for the reason that the mopping of a yellow pine floor wears at the sap streaks and causes the floor to splinter at the edges. This is particularly true for sap rift flooring. The advantage of pine flooring is that it can be sanded finely, lays perfectly straight and true, does not warp or twist to any appreciable extent, and comes in long lengths. Maple flooring should be graded as No. 1, formerly known as “clear” grade. This flooring comes in standard lengths of even feet, and when it is used the sleepers should be spaced not more than 12 inches on centers so that a bearing can be had on at least two surfaces. It is always preferable, where funds permit, to use under-flooring where maple floors are used. The wood floors should be finished with a sanding machine run diagonally across the floor to prevent cupping, and to assure perfectly level surfaces. The floors should then be treated with an oil or a floor preparation which holds paraffin in suspension. Walls and ceilings of the classrooms should be plastered. The lower portion of the classroom walls to the height of the chalk rail is often covered with a heavy woven canvas to prevent the children from damaging the plastered wall. Wood makes the best classroom trim. Oak, chestnut and yellow pine have been used with considerable success. The pupils’ desks and seats are wood, teachers’ desks and chairs are wood, cabinets as a rule are wood, and it is always well to recall the wood treatment in the blackboard trim, door and window trim. There are many composition blackboards, some of which seem to have merit. Natural slate is an old standby and has been used with much success, and is usually my preference, although there are some cases where water turns the slate to a gray color very quickly. Cork bulletin boards are generally installed in connection with blackboards, and in a good many cases a cork strip is placed over blackboards so that standard size illustration sheets can be installed for exhibition or decorative purposes.

Classroom windows can be made in a variety of types and sizes, but preference seems to be for double-hung wood windows and certain patented windows. Windows should be shaded at the center with the shades drawing up and down so that light can be had at the far side of the classroom, which would not occur if the shades were pulled from the top down in all cases.

Toilets. Floors in toilet rooms are generally of either tile or terrazzo. Terrazzo is the cheaper of the two, but is not as sanitary as ceramic tile. The wainscots are usually either tile-glazed brick, glass or Keene cement. Tile is the material most widely used, although structural glass in ashlar form is growing in popularity due to the new methods of, economy in the production of structural glass. Toilet partitions are generally wood, slate, soapstone, metal or marble. Wood should not be used, except where economy is of the utmost importance, as it is practically impossible to keep the doors in place. The pupils swing on them and soon tear them off the butts. Slate and soapstone, while very sanitary, do not make a very desirable impression, due to the fact that they are oiled during the vacation period and become black and greasy in color. The doors of the compartments are often of wood and it is so difficult to keep the doors on these partitions that some school boards omit the doors entirely. Marble, while desirable, is rarely used owing to its cost, although in normal school buildings of the better class its use is legitimate. The most practical partition in my opinion seems to be the standard steel partition with metal doors, such as is used in the better class of factory buildings. These partitions stand abuse, and it is rare to find a door off the hinges.

Gymnasiums. Gymnasiums should have double floors. The finished floor should be 1 1/2 inches clear grade maple with all lengths under 4 feet culled out and not used. The double floor allows for the insertion of the flush sockets which are required for gymnasium apparatus. The walls of the gymnasium should usually be buff brick, with a salt glazed brick wainscot about 8 feet high and laid with tight joints. Windows consisting of large banks of pivoted sash operated by sash-operating devices, with the interior protected by a wire guard, flush with the brick wall, make an ideal arrangement. A base of 3/8-inch steel plate about 6 inches high is generally installed around the walls and grouted solidly with Portland cement. This base prevents the gouging out of the brickwork by forcibly shoving the horses, parallel bars and other apparatus against the wall. The ceiling should be of Keene cement and the lighting fixtures should be recessed flush. Where clocks and bells are required, a recess should be provided for them, and they should be flush with the wall and covered with a wire guard. Pipe hangers with clamps should be installed in the ceiling, so that pipe beams can be installed by the gymnasium equipment contractor. If these pipe hangers are of more than 1 foot in length, they should be braced against side swaying.
This Kohler Efficiency Sink (No. K1550) is one of a complete line of new models, providing various combinations and ranging in length from 36 to 78 inches.

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_A sample valve was tested 150,000 operations without any appreciable wear._

_All water drains out of the flush valve body so that in places such as school buildings where the fires may be banked over the week-end, valves will not be damaged by frost._

The tank may be concealed back of the wall if so desired.
The simplicity of the *VOGEL* NUMBER TEN flush valve will appeal to anyone of a mechanical turn of mind.

When the closet seat is depressed the supply valve packing is drawn down from the top supply valve seat, and the flush valve packing is brought into contact with the flush valve seat, allowing water to enter the tank through the flush pipe. Upon the pressure of water and air in tank becoming equalized with the service pressure, no more water enters the fixture. This water is held in readiness for the release of the seat.

When the seat is released the rod which carries both supply and flush valve packings is forced upward, closing the water supply at the inverted supply valve seat in the swivel at the top. The flush valve, by the same movement, is opened and a strong flush of water from tank to bowl ensues.

By depressing the closet seat the supply coupling at top may be easily removed. Then by raising the closet seat to upright position the valve stem carrying both supply and flush valve packings may be easily lifted out.

The flush valve closes with the water pressure insuring easy closing.

This outfit eliminates waste of water.

*VOGEL* NUMBER TEN Closet Roughs: wall to center of waste outlet, 16 in. Can rough-in, 12½ in. by offsetting flush pipe.

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CLEVELAND—Union Trust Bldg.
DALLAS—Magnolia Bldg.
DENVER—Continental Oil Bldg.
DETROIT—First National Bank Bldg.
KANSAS CITY, MO.—Commerce Bldg.
MINNEAPOLIS—Andrus Bldg.
NEW ORLEANS—Hibernia Bank Bldg.
NEW YORK—20 Church St., Hudson Terminal Bldg.
PHILADELPHIA—Franklin Trust Bldg.
PITTSBURGH—Oliver Bldg.
SAN FRANCISCO—Sharon Bldg.
SEATTLE—Central Bldg.
ST. LOUIS—Mo. State Life Bldg.
YOUNGSTOWN—Stambaugh Bldg.

LONDON REPRESENTATIVE—The Youngstown Steel Products Co., Dashwood House, Old Broad Street, London, E. C., England

Youngstown-Buckeye Conduit
Recent years have brought a marked improvement in our grade and high school buildings. In the march of progress in buildings generally, the high school has undergone practically a complete change in both architectural design and interior plan.

From the modest "school house" of yesterday has come the "institution" of today. Beautiful in outward appearance—efficiently planned within—the modern school building reflects the trend of modern thought in meeting today's needs and anticipating tomorrow's requirements.

In keeping with architectural achievement, engineering skill has been diligently applied—the hand of genius is seen in the specifications for various materials used. Behind the walls and beneath the floors is one of the most important of these materials—a vast net work of pipe lines. There could be no substitute for quality here. Efficient service and long life were factors carefully considered and only pipe which bore unmistakably a reputation for proven quality received consideration.

It is significant that in many of America's modern school buildings "NATIONAL" Pipe has been generously used.

The Taylor Allderdice High School in Pittsburgh illustrated above is one of the many schools throughout the country in which "NATIONAL" Pipe has been installed.

NATIONAL TUBE COMPANY
Frick Building, Pittsburgh, Pa.
DISTRICT SALES OFFICES IN THE LARGER CITIES
How Architect Hinsdale Provided for Rust-Fire*

WHEN Architect Reynold Hinsdale designed the Park Lane Villa Apartments he realized that rust-fire was one of his biggest problems. So he chose ARMCO Ingot Iron, for cornices as well as for the heating and ventilating system.

Thus, he assured his clients little or no replacement expenditures throughout the probable life of the building.

Perhaps you have in mind an assignment that needs better-than-average sheet metal equipment . . . at reasonable cost. Just the time, then, to call in one of our district consultants—experts in architectural applications of sheet metal. Get in touch with the office nearest you for this service. No charge nor obligation.

The American Rolling Mill Company
Executive Offices, Middletown, Ohio
Export: The ARMCO International Corporation
Cable Address—ARMCO, Middletown (O.)

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<thead>
<tr>
<th>District Offices</th>
<th>Chicago</th>
<th>Cincinnati</th>
<th>Cleveland</th>
<th>Detroit</th>
<th>Philadelphia</th>
<th>Pittsburgh</th>
<th>New York</th>
<th>San Francisco</th>
<th>St. Louis</th>
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*RUST-FIRE is retarded. The only difference between rusting and burning is time—both are oxidation. You can feel and see the fire produced by rapid burning. But when metal rusts, the process is too slow to see. Rust is the "ash" of this fire.
October, Twenty-nine, Nineteen-twenty-seven.

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After my consulting engineer and I had investigated the different materials available for acid waste lines we decided to specify Duriron for this purpose.

By using Duriron we have been able to locate laboratories in any part of the building, conceal the piping in the floors and walls where necessary and have had no trouble about the replacement of piping.

The initial cost of Duriron may be more but, "The recollection of quality remains long after the price has been forgotten."

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Architect.

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Duriron is produced only by
The DURIRON COMPANY
Dayton, Ohio
PURE CLEAN... HOT WATER FOR NEGLECTIBLE COST

MAKE the one necessary fire of the heating boiler serve two purposes—to also heat water for domestic use.

NOT a drop of the warmed water can touch iron, since it flows continuously thru the copper coil and patented ground-joint brass connections. The use of troublesome gaskets is thus eliminated. Specify the genuine Excelso Heater by name.

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THE Watrous flush valve is the only design that makes proper provision for adapting the quantity of water consumed to the needs of any bowl with which it is used. The result is maximum flushing efficiency and economy in water consumption.

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By merely turning the screw A (see sketch), the valve is adjusted to the requirements of the bowl. It is not necessary to turn off the water, or remove any of the working parts of the valve to make this adjustment.

The adjustment, once made, remains permanent.

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Every time the valve is flushed, the plunger (B) is raised off its seat (C), leaving an opening through which grains of sand, etc., can be washed out of the port. No type of flush valve, without this or a similar safeguard, is immune from obstruction.

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The feature just described—control of the quantity of water supplied to the bowl—should not be confused with regulation for varying degrees of pressure. The Watrous Valve requires no regulation, from highest pressure down to approximately 5 lbs.

Watrous fixtures are furnished with exposed parts chromium plated, if desired. Write for details

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carried that number of sightseers up and down during 1927

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Distributed Through Representative Glass Jobbers and Used by Sash and Door Manufacturers Everywhere.
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MISSISSIPPI GLASS COMPANY
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A new way to add HEALTH VALUE to DESIGN with VITA GLASS!

Vita Glass panes... admit health-giving ultra-violet rays of sunlight... increase utility... give more light... supplement service you already offer with your design.

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Then this amazing glass was invented. Every demand was complied with. Vita Glass admits, in volume, the vital health rays of sunlight. It brings out-of-doors into homes and offices.

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It brings health... increased efficiency. Embodied in architectural designs, it gives the designs additional value...

Read what it is.

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When a Barrett Specification Roof is laid, a Surety Bond is issued guaranteeing the building owner against repair or maintenance expense for the next twenty years*—until 1948.

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* The Barrett Company also offers a Specification Type "A" Roof which is bonded for 10 years. This type of roof is adaptable to a certain class of buildings. The same high-grade materials are used, the only difference being in the quantities applied.

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Throughout the United States and Canada a limited number of roofing contractors have been approved by Barrett to lay the Barrett Specification Bonded Roof. These men have earned a reputation for doing efficient work—a name for absolute dependability.

Good workmanship is a big part of any good roof. Good workmanship is a certainty when you provide for a Barrett Specification Roof.

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STANDING SEAM  BATTEN SEAM

The lowest cost permanent metal roofing
Eliminates all expense for Upkeep and Repair

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The Kernerator, chimney-fed incinerator has solved the problem of waste disposal in many of the country’s best known schools, academies and seminaries, both large and small.

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1. Overcomes the chief cause of 75% school fires through trash piles in the basement.
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This lamp floods every drop of water that passes through the R-U-V Sterilizer with intense ultra violet light. Every disease germ is killed.

And when R-U-V is used with a special filter, it not only kills germs but also removes all unpleasant chemical tastes that may have been introduced by treatment plants.

R-U-V operation is as simple as turning on or off an electric light.

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- 9 Public School Pools, Kansas City, Mo.
- University of Chicago, Chicago, Ill.
- Culver Military Academy, Culver, Indiana
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Ultra Violet Ray Water Sterilization

James B. Clow & Sons
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More Than 4000 American Educational Buildings are equipped with Clow Plumbing. And, in them more than 105,000 Clow-Madden Automatic Clos-ets are on duty. There are two reasons why—Clow-Madden Automatics guard health, and Clow-Madden Automatics guard costs. They flush automatically after each occupation. Every Clow-Madden Automatic means a quarter-century of toilet room hygiene. Many Clow-Madden Automatics have served for 30 years—some for nearly 40.

CLOW AUTOMATIC

Never, Never Forgets — Forty-eight Styles, Heights and Types to Meet Your Requirements
Crosses on map show approximate location of educational buildings equipped with Clow Plumbing. Map by courtesy of Rand McNally & Co.

The Clow-Madden Valve is simply built. Having no complicated parts to wear out or break, it practically never needs replacing. The Madden Valve uses gallons less per flush. And it never, never fails to flush.

All Clow school plumbing is designed by engineers who know the wear and tear that school plumbing must stand. That Clow stands up is plainly illustrated by the fact that it has been chosen for more than 4000 American educational buildings.

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By including built-in Standard Conveying Systems, engineers and architects have made it possible to condense material-handling operations thereby saving the manufacturing floor space and lessening man-hours per handling job.

Standard Conveyor Counselors have some very interesting and instructive data on material-handling as experienced by various large manufacturers.
Selected List of Manufacturers' Publications

FOR THE SERVICE OF ARCHITECTS, ENGINEERS, DECORATORS, AND CONTRACTORS

The publications listed in these columns are the most important of those issued by leading manufacturers identified with the building industry. They may be had without charge, unless otherwise noted, by applying on your business stationery to The Architectural Forum, 383 Madison Ave., New York, or the manufacturer direct, in which case kindly mention this publication.

ACOUSTICS

R. Zimmern & Co., 40 Court St., Boston.
Akoastolith Plaster. Brochure, 6 pp., 10 x 12½ in. Important data on a valuable material.

U. S. Gypsum Co., 200 W. Monroe St., Chicago, Ill.
A Scientific Solution of an Old Architectural Problem. Folder 6 pp., 8½ x 11 in. Describes Salinite Acoustic Plaster.

ASH HOISTS—ELECTRIC AND HAND POWER

Gillis & Grohogan, 535 West Broadway, New York, N. Y.
Concrete Handling. 8 pp., 8½ x 11 in. Illustrated. Electric and hand-power models; watertight sidewalk doors; automatic opening, closing, and locking devices.

BASEMENT WINDOWS

Buildings, Steel Products for Brick

Gillis & Geohegan, 535 West Broadway, New York, N. Y.
R. GuasUvino Co., 40 Court St., Boston
Carney Company, The, Mankato, Minn.
Kosmos Portland Cement Company, Louisville, Ky.
Louisville Cement Co., 315 Guthrie St., Louisville, Ky.

Gillis & Geohegan, 535 West Broadway, New York, N. Y.
A Scientific Solution of an Old Architectural Problem. Folder 6 pp., 8½ x 11 in. Illustrated. Electric and hand-power models; watertight sidewalk doors; automatic opening, closing, and locking devices.

Gillis & Geohegan, 535 West Broadway, New York, N. Y.
A Scientific Solution of an Old Architectural Problem. Folder 6 pp., 8½ x 11 in. Illustrated. Electric and hand-power models; watertight sidewalk doors; automatic opening, closing, and locking devices.

BAC Prediction of an Old Architectural Problem. Folder 6 pp., 8½ x 11 in. Illustrated. Electric and hand-power models; watertight sidewalk doors; automatic opening, closing, and locking devices.

BATHROOM FITTINGS

Onlinson for Fine Buildings. Folder, 8 pp., 3½ x 6 in. Illustrated. Details with full-paper fittings of metal and porcelain.

Architects' File Card. 8½ x 11 in. Illustrated. Filing card on metal and paper towel cabinets.


Catalog and price list of fixtures and cabinets.

BRICK

American Face Brick Association, 1751 Peckles Life Building, Chicago, Ill.
Brochures. 48 pages, size 7½ x 11 in., an attractive and useful volume on the history and use of brick in Italy from ancient to modern times, profusely illustrated with 69 line drawings, 300 half-tones, and 20 colored plates, with a map of modern and XII century Italy. Bound in linen. Will be sent postpaid upon receipt of $6.00. Half Moroco, $7.00.

Industrial Buildings and Housing. Bound Volume, 132 pp., 8½ x 11 in. Profusely Illustrated. Deals with the planning of factories and employees' housing in detail. Suggestions are given on ventilation of high-ceiling buildings, etc. Price $3.

Common Brick Mfrs., Assn. of America, 231 North Guarantee Blvd., Cleveland.
Brick How to Build and Estimate. Brochure, 96 pp., 8½ x 11 ins. Illustrated. Complete data on use of brick.


Skirted Brickwork. Brochure, 15 pp., 8½ x 11 ins. Illustrated. Tells how to secure interesting effects with common brick.


CEMENT—Continued

Tennessee-Oklahoma Cement Corp., 332 East 46th St., New York.
Celluloid Measuring Scale for Concrete and Lumber, 4½ x 6½ ins. Useful for securing accurate comparisons of aggregate and cement; also for measuring lumber of different sizes.

CONCRETE BUILDING MATERIALS

Celite Products Co., 1230 South Hope St., Los Angeles.
Better Concrete; Engineering Service Bulletin X-325. Booklet, 16 pp., 8½ x 11 ins. Illustrated. On use of Celite to secure workability in concrete, to prevent segregation and to secure water-tightness.


Concrete Surface Corporation, 34 Madison Ave., New York.
Bonding Surfaces on Concrete. Booklet, 12 pp., 8½ x 11 in. Illustrated. Deals with an important detail of building.

Dowel Anchor Set Co., 149 West Ohio St., Chicago.
Dowel Masonry Anchoring System. Folder, 4 pp., 8½ x 11 ins. Illustrated. Data on a system of anchoring masonry to concrete.

National Building Units Corporation, 100 Arch St., Philadelphia.

Sound Absorption of Cinder Concrete Building Units. Booklet, 8 pp., 8 x 11 ins. Illustrated. Results of tests of absorption and transmission of sound throw Cinder concrete blocks.

Philadelphia, CINDER Concrete Building Units. Brochure, 36 pp., 8½ x 10½ ins. Illustrated. Full data on an important building material.

Kosmos Portland Cement Company, Louisville, Ky.
High Early Strength Concrete, Using Standard Kosmos Portland Cement. Folder, 1 pp., 8½ x 11 in. Complete data on securing high strength concrete in short time.

CONCRETE COLORING

The Master Builders Co., 2016 Euclid Ave., Cleveland.
Color Mix, Colored, Hardened Concrete Floors (Integral). Brochure, 16 pp., 8½ x 11 ins. Illustrated. Data on coloring for floors.

Dychrome, Concrete Surface Hardener in Colors. Folder, 4 pp., 8 x 11 in. Illustrated. Data on a new treatment.

CONSTRUCTION, FIREPROOF

Master Builders Co., Cleveland, Ohio.
Color Mix, Colored, Hardened Concrete Floors (Integral). Brochure, 16 pp., 8½ x 11 ins. Illustrated. Data on coloring for floors.

Northwestern Expanded Metal Co., 1234 Old Colonial Building, Chicago, Ill.
Northwestern Expanded Metal Products. Booklet, 8½ x 10½ in. 16 pp. Fully illustrated, and describes different products of this company, such as Kno-burn metal mesh, 20th Century Corrugated, Pistor-Sava and Longspan space channels, etc. A. I. A. Sample Book. Bound volume, 8½ x 11 ins., contains actual samples of several materials and complete data regarding their use.

DAMPPROOFING

Philip Carey Co., Lockland, Cincinnati, Ohio.
Architect's Specifications for Carey Built-Up Roofing. Booklet, 8 a 20½ in. 24 pp. Illustrated. Complete data to aid in specifying the different types of built-up roofing to suit the kind of roof construction to be covered.

Carey Built-Up Roofing for Modern School Buildings. Booklet, 8 x 10½ in. 25 pp. Illustrated. A study of school buildings of a number of different kinds and the roofing materials adapted for each.

Genfire Steel Company, Youngstown, Ohio.
Washing of the Production of Different Types of Built-Up Roofing to Suit the Kind of Roof Construction to be Covered.

Specification Sheet, 8½ x 11 in. Descriptions and specifications of materials for damp-proofing, interior and exterior surfaces.

The Vortex Mfg. Co., Cleveland, Ohio.
Par-Lock Specification "Form T" for dampproofing. Information and specifications for materials used in building with concrete.

Speciation Sheet, 8½ x 11 in. Descriptions and specifications of materials for damp-proofing, interior and exterior surfaces.

SELECTED LIST OF MANUFACTURERS’ DoORS AND TRIM, METAL

The American Brass Company, Waterbury, Conn. A complete line of architectural hardware, designed to meet every condition of service. Illustrated.


FIREPROOFING—See also Construction, Fireproof


North Western Expanded Metal Co., 407 South Dearborn St., Chicago. Illustrated.

A. I. A. Sample Book. Bound volume, 8½ x 11 ins. Contains actual samples of several materials and complete data regarding their use.

FLOOR HARDENERS (CHEMICAL)


Selections from the page:

**ELEVATORS**


"The House of a Hundred Comforts." Booklet, 40 pp., 8½ x 10½ ins. Illustrated. Dews on importance of adequate wiring.


Modern Electrical Equipment for Buildings. Booklet, 80 pp., 8½ x 10½ ins. Illustrated. Deals with the right type of reflector or other lighting equipment. Illustrated.


**DUMBWAITERS**


**DOORS AND TRIM, METAL**


**ELECTRICAL EQUIPMENT**


Benjamin Electric Mfg. Co., 120 So. Saragamo St., Chicago. Electric Power for Buildings. Brochure, 16 pp., 8½ x 11 ins. Illustrated. "Enables one to select at a glance the right type of reflector or other lighting equipment."


**FLOORING**


Linoleum for Home Floors. Brochure, 7½ x 10½ ins. 27 pp. and colored endcaps of floor installations.


**BEAUTY; POWER; SILENCE; Westinghouse Electric Appliances (Catalog 44-A). 32 pp., 8½ x 11 ins. Illustrated. Important details of machines, motors and controllers for these types.

Benjamin-Gearard Gearless Traction Elevators of All Types. Descriptive leaflets, 8½ x 11 ins. Illustrated. Full details of machines, motors and controllers for these types.

Otis Gears and Gearless Traction Elevators of All Types. Descriptive leaflets, 8½ x 11 ins. Illustrated. Full details of machines, motors and controllers for these types.

Elevator Book, 8½ x 11 ins. Illustrated. Describes use of escalators in subways, department stores, theaters and industrial buildings. Also includes elevators and dock elevators.

North Western Expanded Metal Co., 407 South Dearborn St., Chicago. Illustrated.

Bloxonend Flooring. Booklet, 8½ x 11½ ins. Illustrated. Full data on Bloxonend in concrete, wood or steel construction, and advantages over loose wood blocks.

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This Jennings Sewage Ejector is supplied in capacities up to 1500 g.p.m. Heads up to 50 ft. For pumping unscreened sewage or drainage from basements below the street sewer level, handling crude sewage from low level districts, pumping effluent, sludge and other heavy liquids.

Write for Bulletin No. 67.

NASH ENGINEERING COMPANY
11 Wilson Road
So. Norwalk, Conn.

Jennings Pumps
SELECTED LIST OF MANUFACTURERS' PUBLICATIONS—Continued from page 186

HEATING EQUIPMENT

American Radiator Company, The, 40 West 40th St., N. Y. C.
Ideal Water Tube Boiler. Catalog 575 x 816 in. 16 pp. Illustrated in 4 colors. Data on a complete line of Heating Boilers of the Water Tube type.
Ideal Smokeless Boilers. Catalog 794 x 1014 in. 32 pp. Illustrated in 4 colors. Fully explains a boiler free from the objection of causing smoke.
Ideal Boiler for Oil Burning. Catalog 596 x 816 in. 16 pp. Illustrated in 4 colors. Describing a line of Heating Boilers especially adapted to use with Oil Burners.
Ideal Arcola Radiator Warmth. Brochure 596 x 714 in. Illustrated. Describes the heating apparatus for small residences, stores, and offices.

James B. Claw & Sons, 256 South Third St., Chicago, Claw Gavran Ventilated Heating System. Brochure, 24 pp., 8 1/2 x 11 in. Illustrated. Deals with a valuable form of heating equipment for using gas.
C. A. Dunham Company, 450 East Ohio Street, Chicago, Ill.
Residence Oil Burning Equipment. Brochure, 24 pp., 5 1/2 x 11 in. Illustrated. Describes heating apparatus for garages and parking garages, and describes the d'Humy Motoramp system of heating.

E desi
- Flowing Water Heater. Catalog 596 x 816 in. 16 pp. Illustrated. A brochure on a space-saving radiator of beauty and high efficiency.
Ideal Boilers for Oil Burning. Catalog 596 x 816 in. 16 pp. Illustrated. A brochure on a space-saving radiator of beauty and high efficiency.
Ideal Arcola Radiator Warmth. Brochure 596 x 714 in. Illustrated. Describes the heating apparatus for small residences, stores, and offices.

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The Ahwahnee
Charming New Hotel in Yosemite National Park, California

ARCHITECTS
GILBERT STANLEY UNDERWOOD
LOS ANGELES

BUILDERS
JEPSE & MELSTON CO.
SAN FRANCISCO

Maintains even heat against wide outside variations with No. 942

Sylphon TRADE MARK
Temperature Regulators

Nestling at the foot of talus slopes, the new million-dollar Ahwahnee, of superb architecture and Indian motif decoration, looks down the grand Yosemite Valley. From it one sees Half Dome, Glacier and the Falls. The temperature of its large dining-room, seating 500 guests, is controlled by a Sylphon Temperature Regulator, No. 942, installed in conjunction with Air-Fin air heaters. "Giving complete satisfaction," writes Roy C. Baker, chief engineer, of the Yosemite and Curry Company.

We will be pleased to send you complete details of Sylphon applications and our engineers will gladly assist in solving any particular temperature control problem. No obligation on your part. Just mail the coupon or write if you prefer.

THE FULTON SYLPHON COMPANY, Knoxville, Tennessee, U.S.A.

Sales Offices: NEW YORK DETROIT CHICAGO PHILADELPHIA BOSTON AND ALL PRINCIPAL CITIES IN U. S.
SELECTED LIST OF MANUFACTURERS' PUBLICATIONS—Continued from page 190

HEATING EQUIPMENT—Continued
Petro Mechanical Oil Burner & Air Register. Booklet, 13 pp., 8 1/2 x 11 in. Illustrated. Describes the use of insulation for structural purposes.

Asbestos-Cement Co., 111 West Washington St., Chicago, Ill. Booklet, 12 pp., 8 1/2 x 11 in. Illustrated. Describes the use of insulation for structural purposes.


Trane Co., The, La Crosse, Wis. Bulletin 20, 8 pp., 8 1/2 x 11 in. Covers the complete line of Trane Heating Specialties, including Trane Blowing Traps, and Trane Bellows Packless Valves.

HOSPITAL EQUIPMENT

The Insulation of Boilers. Booklet, 8 pp., 8 1/2 x 11 in. Illustrated. On insulating boiler walls, breechings, and stacks to reduce amount of radiation.

Heat Insulation Specifications and Blue Prints. Booklet, 20 pp., 8 1/2 x 11 in. Illustrated. On approved types of insulation.


Philip Carey Co., The, Cincinnati, Ohio. Celotex and Magnaflora Catalogs. Catalog, 6 x 9 in. 72 pp. Illustrated.


JOISTS


Truscon Steel Co., Youngstown, Ohio Truscon Steel Joists; Booklet, 9 1/2 x 11 in., 16 pp. Illustrated. Gives types of equipment in which Monel Metal is used, with service data and sources of equipment.


Heat Insulation for Houses." Booklet, 64 pp., 9 x 11 1/4 in. Illustrated. Authoritative information on thermal insulation with complete specifications for all types of buildings.

Philip Carey Co., The, Cincinnati, Ohio. Celotex and Magnaflora Catalogs. Catalog, 6 x 9 in. 72 pp. Illustrated.


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Where Long Life is Essential

In five of the units of the Medical Center of New York—the Private Patients' Building, the Outgoing Patients' Building, the Main Hospital Building, the College of Physicians and Surgeons, and the Power House—Armstrong's Cork Covering has been used on all pipe lines and cooling tanks of the refrigerated drinking water system.

Armstrong's Cork Covering is air-, moisture- and frost-proof, and, properly applied, it will last the life of the pipe. Being cellular, not fibrous, in structure, it is non-absorbent and has no capillarity. Hence, its efficiency is constant and will not decrease as time goes on. Pipes insulated with Armstrong's Cork Covering may safely be enclosed in walls and chases without danger of discoloration of walls from condensation of moisture.

Armstrong Engineers, with many years' experience in the insulation of cold lines, are at the service of architects for consultation, advice and assistance in the designing of drinking water systems. Branch offices are located in all principal cities. Armstrong Cork & Insulation Company, 132 Twenty-fourth St., Pittsburgh, Pa.; McGill Building, Montreal, Que.; 11 Brant St., Toronto, Ont., 2.

Armstrong's NONPAREIL Cork Covering

Send for this Book
"Refrigerated Drinking Water for Mills, Public Buildings, Hotels, Office Buildings"—the only authentic publication on the subject.
SELECTED LIST OF MANUFACTURERS’ PUBLICATIONS—Continued from page 192

LAUNDRY MACHINERY

Art Metal Construction Co., Norwalk, Connecticut. Discusses the latest developments in laundry machinery. 8 pp., 5 x 11 in. Expanded text on the importance of modern laundry equipment.

LIBRARY EQUIPMENT


MATERIALS


METALS

The International Nickel Company, 64 Wall St., New York, N.Y. The Chosen of a Metal. Booklet, 6 x 9 in. 150 pp. Illustrated. A comprehensive guide to the properties and uses of nickel.

MORTAR COLORS

Clinton Metallic Paint Co., Clinton, N.Y. Clinton Mortar Colors. Folder, 8 x 11 in. 4 pp. Illustrated. Shows the full range of colors in a complete line of mortars.

PAINTS, STAINS, VARNISHES AND WOOD FINISHES


ORNAMENTAL PLASTER


PUBLICATIONS—CONTINUED

ARCHITECTURE

The American Architect, 111 Broadway, New York, N.Y. Next to Daylight Brochure, 16 pp., 4 x 8½ in. Illustrated. Deals with the latest in architectural lighting solutions.

BUILDER

The Pergola Catalog. 7½ x 11 in. 240 pp. Illustrated. This is an Architectural and Decorative Ornament Catalog. Includes over 300 designs of standards, lanterns and brackets of bronze or cast iron.

CIRCULARS


CIRCULARS—CONTINUED

How to Keep Your House Young. Illustrated brochure, 23 pp., 8 x 11 in. 20 pp. Illustrated. A highly technical subject treated in a simple, understandable manner.

CIRCULARS—CONTINUED


CIRCULARS—CONTINUED


CIRCULARS—CONTINUED


CIRCULARS—CONTINUED

How to Keep Your House Young. Illustrated brochure, 23 pp., 7 x 8½ in. A useful work on the upkeep of residences.


PAPER


PARTITIONS

Circle A Products Corporation, New Castle, Ind. Circle A Partition Co., New and Movable. Brochure. Illustrated. 8½ x 11 in. 32 pp. Full data regarding an important line of partitions, along with erection instructions for partitions of three different types.

HAUSSERMAN COMPANY

E. F. Cleveland, Ohio. Haußerman Design and Color Partitions. Various folders, 8½ x 11 in. Illustrated. Give full data on different types of steel partitions, together with details, color chart, and specifications.

IMPROVED OFFICE PARTITION COMPANY


INSTRUCTIONS FOR ERECTING TELESKO PARTITIONS

Detailed Instructions for erecting Telesko Partitions. Booklet. 24 pp., 8½ x 11 in. Illustrated. Complete instructions, with cuts and drawings, showing how easily Telesko Partition can be erected.

OFFICE PARTITION COMPANY

23 Grand St., Elmhurst, L.I. Telescopic Partition. Catalog, 8½ x 11 in. 14 pp. Illustrated. Shows typical offices laid off with Telescopic partitions, cuts of finished partition units in various woods.

RICHARDS-WILSON MFG. CO.

Aurora, Ill. Paragon Partitions. Various folders, 8½ x 11 in. Illustrated. Give full data on different types of steel partitions, together with details, color chart, and specifications.

YORK ROOFER TILE CO.


PAINTS


TRUSCON STEEL COMPANY

Youngstown, Ohio. Truscon Catalog. 8½ x 11 in. 64 pp. Illustrated. Contains detailed instructions of all items of Truscon woodwork, for the use of architects.

WROUGHT IRON COMPANY


ART METAL CONSTRUCTION CO.

Jamestown, N.Y. Art Metal Construction Co., Jamestown, N.Y. Illustrated catalog of fine metalwork. 160 pp., 8½ x 11 in. Illustrated. Discusses the most advanced techniques in metalwork.
Again these Carney claims prove practical

When an architect specifies Carney Cement for his masonry, we promise two things—a bonding quality that has no superior, and masonry and mortar costs that cannot be equaled by any other good material. These statements have been tested time after time on literally hundreds of the nation’s outstanding projects, for nearly a half century—always bearing out these claims.

Carney Cement surpasses in bonding quality and plasticity because it is ground from a deposit found only in the vicinity of Mankato, in which these attributes are more strongly marked than in any other stone.

THE CARNEY COMPANY
DISTRICT SALES OFFICES: CLEVELAND, CHICAGO, DETROIT, ST. LOUIS, MINNEAPOLIS
Cement Makers Since 1883

CARNEY CEMENT
for Brick and Tile Mortar
Specifications
1 part Carney Cement to 3 or 4 parts sand, depending upon quality of sand.
SELECTED LIST OF MANUFACTURERS'

PIPE

American Brass Company, Waterbury, Conn.

Chicago P.L. Brass and copper pipe, shows typical installations of brass pipe, and gives general discussion of the corrosive action of water on iron, steel, and brass pipe.

American Rolling Mill Company, Middletown, Ohio.

Clow & Sons, James B., 548 S. Franklin St., Chicago, Ill.
Catalogue No. 25. 8% x 11 in. 80 pp. Illustrated. Shows a full line of steam, gas and water works supplies.

Cohoes Rolling Mill Company, Cohoes, N. Y.
Catalogue No. 5. 8% x 11 in. 5 7/8 x 7 7/8 in. Data on wrought iron pipe.

Duriron Company, Inc., Dayton, Ohio.
Duriron Acid, Alkali, Rust-proof Drain Pipe and Fittings. Booklet. 20 pp. 8% x 11 in. Illustrated. Important data on a valuable line of pipe.

National Tube Co., Frick Building, Pittsburgh, Pa.
"Data on Sani-White and San-Black Hot Water Pipe, 85 9/16 x 11 in. 24 pp. Illustrated. In this bulletin is summed up the shows roughing-in measurements, etc."

The text material consists of seven investigations by authorities on this subject. "National" Bulletin No. 3. The Protection of Pipe Against Internal Corrosion, 85 9/16 x 11 in. 20 pp. Illustrated. Discusses various causes of corrosion, and details are given of the deactivating and desalinating systems for eliminating or retarding corrosion in hot water supply lines.

"National" Bulletin No. 25. "National" Pipe in Large Buildings. 85 9/16 x 11 in. 88 pp. This bulletin contains 94 illustrations of prominent buildings of all types, containing "National" Pipe, and considerable engineering data of value to architects, engineers, etc.

Modern Welded Pipe. Book of 88 pp. 8% x 11 in., profusely illustrated with halftone and line engravings of the important operations in the manufacture of pipe.

PLASTER

Best Brass, Keene's Cement Co., Medicine Lodge, Kan.
Information Book. Brochure, 24 pp., 5 x 9 ins. Lists grades of plaster manufactured; gives specifications and uses for plaster.


Interior Walls Everlasting. Brochure, 20 pp., 8% x 5% ins. Holcim Pipe Handbook. Booklet, 40 pp., 5 x 7 7/8 ins. Details of Keene's Cement and uses of buildings in which it is used.

PLUMBING EQUIPMENT

Catalog S. W., Booklet. 95 pp., 7 1/2 x 10% in. Illustrated. Explanatory and descriptive, with Sani-White and Sani-Black toilet seats.

Clow & Sons, James B., 548 S. Franklin St., Chicago, Ill.
Catalogue No. 12. 8% x 11 in. 12 pp. Illustrated. Shows complete line of plumbing fixtures for Schools, Railroads and Industrial Buildings.


Duriron Company, Dayton, Ohio.
Duriron Acid, Alkali and Rust-Proof Drain Pipe and Fittings. Catalogue No. 16. 8% x 11 in. Illustrated. Full details regarding a valuable line of piping.

Eljer Company, Ford City, Pa.
Complete Catalog. 384 pp., 8% x 6% in. Illustrated. Describes full, the complete Eljer line of standardized vitrified china plumbing fixtures, with diagrams, weights and measurements.

Imperial Brass Mfg. Co., 120 W. Harrison St., Chicago, Ill.
Water Filter, 8% x 11 in. 20 pp. Illustrated. Catalogue of Modern Showers and Brass Plumbing Fixtures, with drawings showing layouts, measurements, etc. Toned Up in Ten Minutes. Booklet. 75% x 10% ins. 16 pp. Illustrated. Modern Showers and Washups for Industrial Plants, showing the sanitary method of washing in running water.

Maddock's Sons Company, Thomas, Trenton, N. J.

Speakman Company, Wilmington, Del.
Speakman Showers and Fixtures. Catalog. 49% x 7% in. 230 pp. Illustrated. Catalogue of Modern Showers and Brass Plumbing Fixtures, with drawings showing layouts, measurements, etc. Toned Up in Ten Minutes. Booklet. 75% x 10% in. 16 pp. Illustrated. Modern Showers and Washups for Industrial Plants, showing the sanitary method of washing in running water.

RANKS

Ramp Buildings Corporation, 21 Rast 40th St. New York, N. Y.
Building Gargues for Probable Operations. Booklet. 85% x 11 in. 16 pp. Illustrated. Discusses the need for modern mid-city parking, and the possibilities of the Himmay Motorpump system of design, on the basis of its superior space economy and leasability, and operating convenience. Gives best analyses of garages of different sizes, and calculates probable earnings.


The Trane Co., LaCrosse, Wis.
Trane Sprinkler Individual Pumps. Booklet. 8% x 8 in. 16 pp. Complete data on an important type of pump.

REFRIGERATION

The Fulton Steam Co., Knoxville, Tenn.
Temperature Control of Refrigerating Plant. Booklet. 8% x 11 in. Illustrated. Details with cold storage, chilling of water, etc.

REFRIGERATORS

Lloyd's Refrigerator Company, Kingston, N. Y.
Lloyd's Refrigerator, for hotels, restaurants, and clubs. Brochure. 43 pp. 8 x 10 ins. Illustrated. Data on line of refrigerators.

REINFORCED CONCRETE—See also Construction, Concrete

Lauder Steel Company, Youngstown, Ohio.
Self-Setting Handbook. 85% x 11 in. 16 pp. Illustrated. Methods and specifications on reinforced concrete floors, roofs and floors with a combined form and reinforced material.

Truscon Steel Company, Youngstown, Ohio.
Shearing Strength in Reinforced Concrete Beams. Booklet. 85% x 11 in. 12 pp.

North Western Expanded Metal Company, Chicago, Ill.
Design Data Book. 6 x 9 in. 32 pp. Illustrated. Covers the use of Komo Expanded Metal for various types of reinforced concrete construction.

Longspan %-% inch Rib Lath. Folder 44 pp., 85% x 11 in. Illustrated. Deals with a new type of V-rib expanded metal.

ROOFING

Specifications, Chicago Standard Trinidad Lake Asphalt Built-up Roofing. Booklet. 8 x 10% in. 48 pp. Illustrated. Gives specifications for use of several valuable roofing and waterproofing materials.

The Barrett Company, 40 Rector St., New York City.
Architects and Engineers' Built-up Roofing Reference Series; Volume IV. Roof Drainage System. Brochure. 60 pp. 85% x 1154 ins. Gives complete data and specifications for many details of roofing.

Philip Carey Co., Lockland, Cincinnati, Ohio.
Architects Specifications for Carey Built-up Roofing. Booklet. 8 x 10% in. 42 pp. Illustrated. A study of school buildings of a number of different kinds and the roofing materials adapted for each type.

Heinz Roofing Tile Co., 1730 Champa St., Denver.
Plymouth-Shingle Tile with Sprocket Hips. Leaflet. 85% x 11 ins. Illustrated. Shows use of English tile, with special hips. Italian Promenade Floor Tile. Folder. 2 pp., 8% x 11% in. Illustrated. Floor tiling adapted from that of Davenport Palace. Mission Tile. Leaflet. 85% x 11 ins. Illustrated. Tile such as are used in Italy and southern California. Georgian Tile. Leaflet. 85% x 11 ins. Illustrated. Tiling as used in old English and French farmhouses.

"Ancient" Tapered Mission Tiles, hand-made with full corners and designed to be applied with irregular exposures.

Milwaukee Carving Co., Milwaukee, Wis.

U. S. Gypsum Co., Chicago.
Pyroly Roof Construction. Booklet. 8 x 11 in. 46 pp. Illustrated. Gives valuable data on the use of tile in roof construction.

Sheetrock Pyrofill Roof Construction. Folder. 8% x 11 in. Illustrated. Covers use of roof surfacing which is poured in place.

SASH CHAIN

Smith & Egge Mfg. Co., The, Bridgeport, Conn.
Chain Catalog. 6 x 8% in. 24 pp. Illustrated. Covers complete line of chains.

SEWAGE DISPOSAL

Kewanee Waste Utilies Co., 442 Franklin St., Kewanee, Il.

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- American Brass Co., The, Waterbury, Conn.
- Forte for Architects, Albert S. Shading. Illustrated, folder, 95 1/2 x 13 in., giving actual samples of metal screen cloth and data on 8y screens and screen doors.
- Athey Company, 6015 West 66th St., Chicago, Ill.
- The Athey Perennial Window Shade. An accordion pleated window shade, made from translucent Herrington woven screen cloth, which raises from the bottom and lowers from the top. It eliminates awnings, affords ventilation, can be dry-cleaned and will wear indefinitely.
- The Higgin Manufacturing Co., Newport, Ky.

SHELVING-STEEL
- Lupton Steel Shelving. Catalog D. Illustrated brochure, 40 pp., 8 1/2 x 11 in. Illustrated. Data on important line of wire glass lights.
- The Effectiveness of Sidewalk Lights. Folder, 4 pp., 8 1/2 x 11 in. Illustrated. Sidewalk or vault lights. Let in the light—The Light That's Free. Folder, 4 pp., 8 1/2 x 11 in. Illustrated. Data on securing good lighting.

SKYLIGHTS
- Albert Grauer & Co., 1408 Seventeenth St., Detroit, Mich.
- Grauer Wire Glass Skylights. Folder, 4 pp., 8 1/2 x 11 in. Illustrated. Data on important line of wire glass lights. Includes sections of glass, methods of installation, and will wear indefinitely.

SOUND DEADENER
- Cabot's Deadening Quilt. Brochure 7 1/4 x 12 in. Illustrated. Data on an important type of valve.

STAIRWAYS
- Woodbridge Ornamental Iron Co., 1312 Altgeld St., Chicago.
- Presteel Tested for Strength—stairsways, catalog, 32 pp., 8 1/2 x 11 ins. Illustrated. Important data on stairways.

STEEL PRODUCTS FOR BUILDING
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- The Arc Welding of Structural Steel. Brochure, 32 pp., 8 1/2 x 11 ins. Illustrated. Deals with an important structural process.

STONE, BUILDING
- Indiana Limestone Company, Bedford, Ind.

STORE FRONTS
- Brasco Manufacturing Co., 5025-35 South Wabash Avenue, Chicago, Ill.
- Catalog No. 24. Series 800. All-Copper Construction. Illustrated brochure, 20 pp. 8 1/2 x 11 ins. Deals with store fronts of a high type.
- Brasco Copper Store Front. Catalog No. 22, Series 202. Balanced Construction. Illustrated brochure, 16 pp., 8 1/2 x 11 ins. Complete data on an important type of building. Detailed Sheets. Set of seven sheets; printed on tracing paper, showing full sized details and suggestions for store front design, enclosed in envelope suitable for filing. Folds to 8 1/2 x 11 1/4 in.
- Davis Solid Architectural Bronze Sash. Set of five sheets, printed on tracing paper, giving full sized details and suggestions for designing special bronze store front construction, enclosed in envelope suitable for filing. Folds to 25 3/4 x 11 ins.

PUBLICATIONS—Continued from page 196

SWIMMING POOL EQUIPMENT & STERILIZATION
- The Kawneer Company, Niles, Mich.
- Store Front Suggestions. Booklet, 96 pp., 6 x 8 1/2 ins. Illustrated. Shows different types of Kawneer Solid Copper Store Fronts.
- Detail Sheets for Use in Tracing. Full-sized details on sheets 17 x 22 ins.

MODERN BRONZE STORE FRONT Co., Chicago Heights, Ill.

ZOURI DRAWN METALS COMPANY, Chicago Heights, Ill.
- Zouri Safety Key-Set Store Front Construction. Catalog. 8 1/4 x 10 1/2 in. Illustrated. Complete information with detailed sheets and installation instructions convenient for architects' files.

INTERNATIONAL STORE FRONT CONSTRUCTION. Catalog. 8 1/2 x 11 in. 60 pages, illustrated. Complete information with detailed sheets and installation instructions convenient for architects' files.


TERRA COTTA
- National Terra Cotta Society, 19 West 44th St., New York, N.Y.
- Color in Architecture. Revised Edition. Permanently bound volume 9 1/4 x 12 1/4 in., containing a treatise upon the basic principles of color in architectural design, illustrating early European and modern American examples. Excellent illustrations in color.
- Present Day Schools. 8 1/2 x 11 in. 32 pp. Illustrating 42 examples of school architecture with article upon school building design by James O. Betelle, A. I. A.
- Better Banks. 8 1/2 x 11 in. 32 pp. Illustrating many banking buildings in terra cotta with an article on its use in bank design by Alfred C. Bossom, Architect.

TILE, HOLLOW
- National Wall Construction Bulletin 174, 8 1/2 x 11 in. 32 pp. Illustrated. A treatise on the subject of hollow tile wall construction.
- Standard Fireproofing Bulletin 171, 8 1/2 x 11 in., 32 pp. Illustrated. A treatise on the subject of hollow tile as used for floors, girders, column and beam covering and similar construction.
- Natco Unibacker Tile Bulletin, 8 1/2 x 11 in. 4 pp. Illustrated.
- Natcofoor Bulletin, 8 1/2 x 11 in. 6 pp. Illustrated.
- Natco Face Tile for the Up-to-Date Farm Bulletin, 8 1/2 x 11 ins.

TILES

VALVES
- Crane Co., 366 S. Michigan Ave., Chicago, Ill.
- No. 21. General Catalog. Illustrated. Describes the complete line of the Crane Co.
- C. A. Dunham Co., 490 East Ohio St., Chicago.
- The Dunham Packless Radiator Valve Brochure, 12 pp., 8 1/2 x 11 ins. Illustrated. Data on an important type of valve.
- Illinois Engineering Co., Racine Ave., at 22nd St., Chicago, Ill.
- Catalog. 8 1/2 x 11 in. 88 pp. Illustrated.
- Jenkins Bros., 80 White St., New York.
- Jenkins Valves for Plumbing Service. Booklet. 4 1/4 x 7 3/4 in. 16 pp. Illustrated. Description of Jenkins Brass Globe, Angle Check and Stop valves, and Jenkins Brass store front and interior wall finishes, and Iron Body Valves used for larger plumbing installations.
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In buildings requiring a large amount of radiation, Thermodine Unit Heaters can be strategically located to deliver the heat down wherever it is needed. They suspend from the steam main out of the way, focusing heat wherever it is desired. They can be easily located to accommodate any heating conditions that may arise after their installation. Where a large number of Thermodine Unit Heaters are installed, part of them may be turned off as occasion demands. In mild weather, or in parts of a building where heat is required intermittently, some of the heaters may be shut off and only those permitted to run that are necessary. A remarkable saving of fuel and power is thus accomplished. Real flexibility in heating — in every sense.

Furthermore, portability of Thermodine Unit Heaters makes their installation a sound investment. In case it is desired to move some of the heaters to another building, or another portion of the same building, a Thermodine Unit Heater can be quickly taken down, moved and connected in a new location at slight expense. This portability is made possible by their light weight and method of suspension — outstanding Thermodine features.

Let us send you complete information and the name of our nearest representative. He will give further details and tell you of some of the installations we have in your vicinity.

MODINE MANUFACTURING CO. (Heating Division)
1718 RACINE STREET
RACINE, WISCONSIN
Branch offices in all large cities

Thermodine Unit Heater No. 701
Is the equivalent of two tons of direct radiation — between 600 and 700 sq. ft.

Thermodine Utility Heater — No. 101
The smallest Thermodine — 12" wide, 12" high, 9½" deep. Equivalent of 90 to 100 sq. ft. of direct radiation. There’s a Thermodine adaptable to every size space.
"What's the matter with him?" asks a caller. "He always seems so tired; he should see a doctor."

"This certainly is our unlucky year," remarks the boss. "More sickness, more absences, more careless mistakes than I have ever run into before."

There is nothing the matter . . . except that everybody is air-starved.

In every office, large or small, proper ventilation is of vital importance to good health and good work . . . Employees work better and feel better in properly ventilated places of business . . . Customers feel more like buying and sales people more like selling where the air is changed at proper intervals.

For over 47 years the American Blower Corporation has been manufacturing air conditioning apparatus of every type and description . . . electric ventilating, drying, air washing and heating equipment. American Blower products are the scientific answer to every ventilation problem.

Ventilating contractors everywhere, working in co-operation with American Blower engineers, will gladly give you complete information on installing American Blower electric ventilating equipment or heating and ventilating equipment combined in your place of business. Write today for complete information, and also for your copy of "Ventilation News," a beautifully illustrated rotogravure magazine full of interesting facts and pictures, showing the part electric ventilation plays in industry.

AMERICAN BLOWER CORP., DETROIT, MICH.
CANADIAN SIROCCO CO., LTD., WINDSOR, ONT.
BRANCH OFFICES IN ALL PRINCIPAL CITIES

Proper Ventilation Demands the Following Air Changes*

<table>
<thead>
<tr>
<th>Location</th>
<th>Air Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offices</td>
<td>6 to 10 minutes</td>
</tr>
<tr>
<td>碧etrys</td>
<td>2 to 3 minutes</td>
</tr>
<tr>
<td>Laboratories</td>
<td>2 to 3 minutes</td>
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<tr>
<td>Ship Holds</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Restaurants</td>
<td>2 to 3 minutes</td>
</tr>
<tr>
<td>Theaters</td>
<td>5 to 10 minutes</td>
</tr>
<tr>
<td>Cafeterias</td>
<td>5 to 10 minutes</td>
</tr>
<tr>
<td>Dining Rooms</td>
<td>5 to 10 minutes</td>
</tr>
<tr>
<td>Machine Shops</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Lodge Rooms</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Kitchens (Home)</td>
<td>2 to 3 minutes</td>
</tr>
<tr>
<td>Kitchens (Homo)</td>
<td>5 to 10 minutes</td>
</tr>
<tr>
<td>Foundries</td>
<td>5 to 10 minutes</td>
</tr>
<tr>
<td>Retail Stores</td>
<td>5 to 10 minutes</td>
</tr>
</tbody>
</table>

*This table is based on climatic conditions in Central United States. Other tables for specific localities are available.

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**Editor's Note:**

American Blower engineers will gladly give you complete information on installing American Blower electric ventilating equipment or heating and ventilating equipment combined in your place of business. Write today for complete information, and also for your copy of "Ventilation News," a beautifully illustrated rotogravure magazine full of interesting facts and pictures, showing the part electric ventilation plays in industry.
THE DAWN OF A NEW ERA

With the nation-wide acceptance of the Dunham Differential Vacuum Heating System is ushered in the dawn of a new era in heating.

Throughout the United States and Canada architects, consulting engineers, heating contractors and owners have been quick to realize the vital importance of this new Dunham contribution to heating service.

Between two and three hundred prominent buildings scattered from California to Nova Scotia, from British Columbia to Florida, have installed and are using, or are in the process of installing the Dunham Differential Vacuum Heating System, utilizing Sub-Atmospheric Steam.

Records are rapidly accumulating that prove how economically any type of building may be heated with the Dunham Differential System.

From these we can conservatively offer a fuel saving of 25% in a correctly designed and properly installed Dunham System. But more than economies of fuel and flexibility of operation are offered by this new system of heating.

Greater comfort to tenants, better health through maintenance of proper indoor temperatures contribute to make sub-atmospheric steam a most satisfactory form of heat.

A quarter-century ago steam heating was revolutionized by the invention of the Dunham Thermostatic Radiator Trap. Today the beginning of a new quarter-century of Dunham Service finds the art and science of heating standing in the dawn of a new era, the heating developments of which we purpose shall be even more remarkably far-reaching than those of the past twenty-five years.

Over seventy branch and local sales offices in the United States, Canada and the United Kingdom bring Dunham Heating Service as close to you as your telephone. Consult your telephone directory for the address of our office in your city. An engineer will counsel with you on any project.

U. S. Patent No. 1644114. Additional patents in the United States, Canada and Foreign Countries now pending.

C. A. DUNHAM CO.
DUNHAM BUILDING
450 East Ohio Street, Chicago
You can safely have confidence in HARDINGE FUEL OIL HEAT

10 Brief Reasons Why Hardinge Is Endorsed and Specified By Architects and Heating Engineers

1. Because there are twelve different sizes and combinations—all parts standard and inter-changeable—providing individual treatment to fit heating requirements in any building from bungalow to skyscraper.

2. Because it is listed as standard by Underwriters Laboratories and approved by Board of Standards and Appeals of New York.

3. Because scientific distribution of flame over grate area of boiler and numerous exclusive, patented features assure economy and dependability unobtainable elsewhere.

4. Because it is quiet—automatic—durable—easily understood—economical, completely burning cheaper grades of oil efficiently.

5. Because it is the only oil burner giving a TEN-YEAR FACTORY GUARANTEE—a real bond of confidence.

6. Because, built by a financially strong company with 37-years' experience in manufacturing precision-built machines, our ten-year guarantee means something, buyers investment protection is assured.

7. Because of the evidence of satisfactory performance, thousands of satisfied users having found it dependable season-after-season.

8. Because all bearings are submerged in lubricating oil, and require a minimum of attention.

9. Because it is sold only by dealers equipped to render prompt day and night service—a service demanded by Hardinge policy, seldom found necessary, but nevertheless a reassurance to the layman.

10. Because it is not built to meet a price, but to give economical dependable service and actually return dividends in the form of fuel savings and unmatched automatic heat satisfaction.

You will find full information and specifications in our section of Sweet's Architectural Catalogue, extra bound copies of which we will supply on request. Our nearest dealer will be glad to serve you; or write direct to us.

HARDINGE BROTHERS, Inc.
Manufacturers of Precision-Built Machines for 37 Years

Factory and General Offices
4149 Ravenswood Avenue, Chicago, III.

FACTORY BRANCHES
CHICAGO
Michigan Ave. at Ohio St.
BOSTON
939 Beacon St.

There is a Hardinge Dealer in Your City.
ARCHITECTS specify "Globe" ventilators for Universities and School buildings because "Globes" can be relied upon to furnish efficient ventilation.

The "Globe" removes all impure air, but air cannot enter the building through the ventilator, therefore, downward drafts are eliminated.

These ventilators on the Bayonne High School are sturdily constructed of heavy weight copper, making them practically everlasting, and they are absolutely stormproof and troubleproof.

There is no upkeep expense, and there are no moving parts to get out of order or to require lubrication.

We shall be glad to send you a catalog, blue prints showing full measurements of ventilators, or furnish any special data.

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"GLOBE"
Ventilation for School Buildings
The most complete electrical wiring which could possibly be had could cost so small a proportion of the total cost of a building of any kind that it is surprising it is not always insisted upon. If economy must be practiced, could it not better be somewhere else? This is suggested upon examining this booklet or brochure which is intended apparently for the information of owners of suburban and country homes, but which is so full of data that it will deserve a place in the specification files of every architect's office. The brochure takes up, one by one, every part of a house and its surroundings,—the porch, front door, hall, the different rooms, cellar, attic, garage, etc.,—not only explaining the electrical appliances and devices useful for each, but giving diagrams of the proper wiring.

**NORTH WESTERN EXPANDED METAL COMPANY,**
Chicago. “North Western Expanded Metal Products.”

However full and complete may be the description of a building material, it is never half as "convincing" as an actual sample. Probably because the selling departments of this large concern realize this there has been issued this book which is so made and bound that along with the paragraphs describing the firm's products there are given samples of many of the materials. There are, for example, paragraphs giving data regarding Kro-Burn Metal Lath; Plasta-Saver Metal Lath; Copper-Bearing Plasta-Saver; Galvanized Metal Lath; Century Copper-Bearing Metal Lath; Corrugated Metal Lath; Steelhart Stucco Base; Longspan, etc.; and along with the descriptions there are given samples and complete instructions or specifications for using the materials. The publication is of course extremely valuable to architects and engineers and to builders.

**THE FINISHING LIME ASSOCIATION OF OHIO,** Toledo.

Securing good plaster for interior use requires that the plaster have a proper "bond" as well as an appropriate finish, the importance of the bond being obvious, while that of the finish is important because besides having much to do with the cost of a building's upkeep it must often afford a base or ground for some form of interior decoration. Highly necessary in securing good plaster is the use of the proper lime, and this brochure dwells upon the value of finishing hydrated lime from which there is produced a white high magnesium or dolomitic finishing hydrated lime, having high plasticity and cool working properties which cause it to work smoothly under the trowel and to shrink less than any other lime. The Bureau of Standards recommends that magnesium limes be used for plaster work in preference to others. This brochure is replete with data on this lime and testimonials from many of those who have used it.

**L. MUNDET & SON, INC., Hillside, N. J.**
“Roof Insulation.” Data on its importance to architects and builders.

The value of buildings of certain types is regulated largely by the extent to which they are insulated against heat and cold; buildings of some kinds, in fact, could hardly be used at all were they not insulated. This folder deals with the merits of Mundet Jointite Cork Board. The insulating value of cork in preventing the passage of heat or cold through roof surfaces is of course widely known. Being immune to moisture, it is not subject to processes which destroy the value of certain materials which might otherwise be useful for insulating. Use of cork also prevents sweating of ceilings. All air contains moisture. Usually the warmer the air the greater the moisture content. When the warmest air in a room comes in contact with the cold ceiling conditions are ideal for deposit of moisture. As long as the ceiling is cold enough to cause the precipitation to continue, it will collect and drip. When a roof is insulated with baled cork board, the temperature of the ceiling will be that of the air with which it comes in contact.
An Approved School Fixture of Highest Sanitary Quality and Design—

More than twelve hundred Douglas Vitreous China Urinal Stalls were used during 1926 and 1927 in Chicago Schools alone. Sixty-three were installed in the Roosevelt High School, America's largest and most modern High School building. Made of genuine vitreous china, the same material as is used in the manufacture of water closet bowls and china lavatories.

The John Douglas Co.  
Cincinnati, Ohio

Manufacturers of School Plumbing Fixtures Since 1887
REVIEWS AND ANNOUNCEMENTS

FRIGIDAIRE CORPORATION, Dayton, O. "Frigidaire Electric Refrigeration Systems for Residential Apartments." There are quite a number of advantages which follow the use of refrigerators chilled by electrical current instead of by ice. The planning of apartment structures, particularly those having many small suites to a floor, generally precludes use of service entrances, which means of course that all deliveries must be made by way of the front doors, and the delivery of ice is likely to mean a train of moisture, while with use of electrical refrigeration and with the use of ice eliminated there will be few or no deliveries not easily made by means of the dumbwaiter which is easily installed. Another advantage is in the matter of economy, for it can be readily seen that with the refrigeration coming from one source the saving which follows "quantity production" is readily had. One more advantage is that there are no pans of water to empty (less they overflow and injure ceilings), and still another, which might outweigh all the others, is that electrical refrigeration is dry. This brochure is quite naturally highly valuable to architects.

BISHOP & BABCOCK SALES COMPANY, Cleveland. "Air Washing and Air Conditioning Systems." The planning required of present-day architects necessitates many compromises between what is desirable and what can be had. Consider, for example, a delightful apartment, in hotels, theaters, schools, banks and other similar structures there are large areas which must be used for important purposes, but which are wholly without exposure to the outer air, and under these circumstances complete dependence must be placed, if these areas are to be useful, on the means for securing ventilation and particularly purified supplies. Nor is it necessarily found to be in any way lacking, as this brochure abundantly proves. This large concern is among the best known firms supplying apparatus for ventilation and for washing and conditioning air, and this booklet in addition to giving all the data regarding such equipment which an architect or an engineer would be likely to desire, presents an impressive list of architects who have made successful use of the equipment, and in many instances it gives illustrations of the structures in which the installations have been made. To the general public and even to some architects of the structures in which the installations have been made, the means for securing ventilation and particularly purified air constitute a deep, unfathomable mystery. There is really nothing mysterious about it. The mechanism is quite simple, when once its governing principles are fully grasped.

VAPOR HEATING COMPANY, York, Pa. "The Broomell System of Vapor Heating." Data on valuable equipment. With the constantly increasing use of steam for heating there have come, quite logically, greater skill in its use and with it improvement in the mechanism which renders its use possible. This brochure, in answer to the question, "What is the Broomell System of Vapor Heating?" gives a detailed statement, which in part says: "The Broomell Vapor System is one of applied engineering principles, producing a positive circulation of steam through radiators, without pressure and without mechanical devices to circulate the steam through, or to remove the air from the system. As the Broomell Vapor System has been properly designed and certain laws of nature observed, no pushing or pulling of vapor is necessary. If there is sufficient fire in the boiler to generate vapor it will flow through the piping and radiators smoothly, silently, and continuously, until every radiator is full to the bottom and hot all over. With the Broomell Vapor System, the supply of vapor to the radiators is controlled by a four-ported modulating valve, this valve being readily adjusted to regulate the temperature of the room. This results not only in a delightfully heated house, but in great economy and ease of management. With the Broomell Vapor System, the Broomell receiver, which is attached to the boiler, automatically regulates the draft, checking or stimulating the fire as may be necessary for the production of vapor in relation to the amount being consumed by the radiators, this consumption being controlled by the modulating valve, which is adjusted to regulate the temperature of the room." Full data on heating are given.

C. A. DUNHAM CO., Chicago. "The Dunham Differential Vacuum Heating System"; Bulletins Nos. 114 and 115. Many systems of heating are amazingly wasteful of fuel, whether the fuel used be coal, gas or oil, and in perhaps the great majority of instances much could be saved were careful surveys of conditions made and the heating equipment remodeled to function without the usual fuel and heat waste caused by overheating and excessive window ventilation. These two brochures deal with the Dunham Differential Vacuum Heating System, 114 as applied to the heating of residences and small buildings, and 115 as applied to heating hotels, apartment houses, and other large structures. The system furnishes steam to the radiators at the high degree of vacuum, with correspondingly low radiator temperature, or at the pressure above atmosphere which the weather conditions call for. These two booklets afford abundant data for a really intelligent use of heat, describe the mechanism adapted for use with each of the fuels in ordinary use, and illustrate by means of charts, diagrams, etc., the Dunham specialties which the system makes use of.

PORTLAND CEMENT ASSOCIATION. "Design and Control of Concrete Mixtures." Important data on the subject. Concrete is made by mixing cement, water, and certain inert materials, the mixture being put into place or "worked" in a plastic condition, but hardening presently, due to the process of hydration of cement, the chemical reactions between cement and water. Unfortunately the quality or value of concrete cannot be judged until it has become hard. This therefore requires that great care be taken in the mixing or "fabricating" of the material. Study and research have made evident the dependence for strength and other necessary qualities of the concrete upon the quantity of the mixing water. The importance of proper control of the mixing water has long been known, but only later research has shown the importance of the relation between strength and the water-cement ratio. This brochure is one of the many which the Portland Cement Association issues in the interests of intelligent use of concrete. It deals not only with the important detail of mixing but also with the working of the material under field conditions. Many points are made plain by use of tables and diagrams, and part of the booklet is given up to giving the Standard Specifications and Tests for Concrete and Concrete Aggregates of the American Society for Testing Materials. The value and importance of the data here presented are great.

Wetherill P. Trout and Dale Truscott announce their removal to 442 Land Title Building, Philadelphia.

O. W. & H. B. Dryer are occupying their recently completed offices in the Fitch Building, 315 Alexander Street, Rochester, N.Y.

Henry Carlton Newton and Robert Dennis Murray announce the opening of new offices in the Architects' Building, Los Angeles.

Page 3 of THE FORUM for January carried an illustration of the Old National City Bank, Lima, Ohio. The architects of the building are Walker & Weeks, of Cleveland, not of Chicago.

VAN RENSSLEAER P. SAXE, C.E.
Consulting Engineer

STRUCTURAL STEEL
CONCRETE CONSTRUCTION

Knickerbocker Building
Baltimore
What the U. S. Forest Service, in Technical Note No. 181, says about linseed oil as a wood floor preservative:

Linseed Oil Won’t Do for preserving wood floors—
Says U. S. Forest Service

Shellac Wears Off!
Varnish Wears Off!

Only LIGNOPHOL Lasts!

You can make wood floors serve without repairs. You can restore the natural gums and oils of the wood. You can keep the floors from splintering, rottting, drying out. This applies to both new and old floors.

But there is only one way. It requires Lignophol. Lignophol alone can give you smooth, hard, dustless floors that last for years. Tests conducted by the U. S. Forest Products Service proved that wood panels treated with 5 coats hot linseed oil and 2 coats wax registered a moisture-proofing efficiency of only 38%. Wood panels treated with just 1 dip coat of Lignophol registered a moisture-proofing efficiency of 60%.

In schools, churches, factories and other important buildings all over the country, Lignophol is being used as a life-saver for wood. It is easily and quickly applied at a low labor cost, and one treatment gives service for many years. THERE IS BUT ONE LABOR AND MATERIAL COST!

Permanently preserve wood floors. Eliminate future floor troubles. Prevent splintering, warping, dry and wet-rot! Lignophol will do it.

Lignophol is made in four standard colors: Natural, Light Brown, Medium Brown, and Dark Brown. Lignophol Wax Finish is Lignophol with floor wax incorporated. For floors in residences, apartments and dance floors. Medium or high polish. The Sonneborn Policy is that the architect must always be satisfied. Sonneborn always makes good.

L. SONNEBORN SONS, Inc.

Some other Sonneborn Products

LAPIDOLITH—a chemical liquid hardener for hardening and dustproofing concrete floors.

HYDROCIDE COLORLESS— for waterproofing exposed exterior walls.

CEMCOAT—a paint that stays white after others turn yellow. Can be washed over endlessly. Adheres to brick or concrete as easily as to wood.

Mail this coupon today!

A few of the many users of LIGNOPHOL

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Lewistown, Pa.

S. S. Kresge Company,
Detroit

Wm. F. Schrafft & Sons Corp.,
Boston

Lincoln School of Teachers College,
New York

Armour & Company,
Saint Paul

L. SONNEBORN SONS, Inc. 114 FIFTH AVENUE NEW YORK

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