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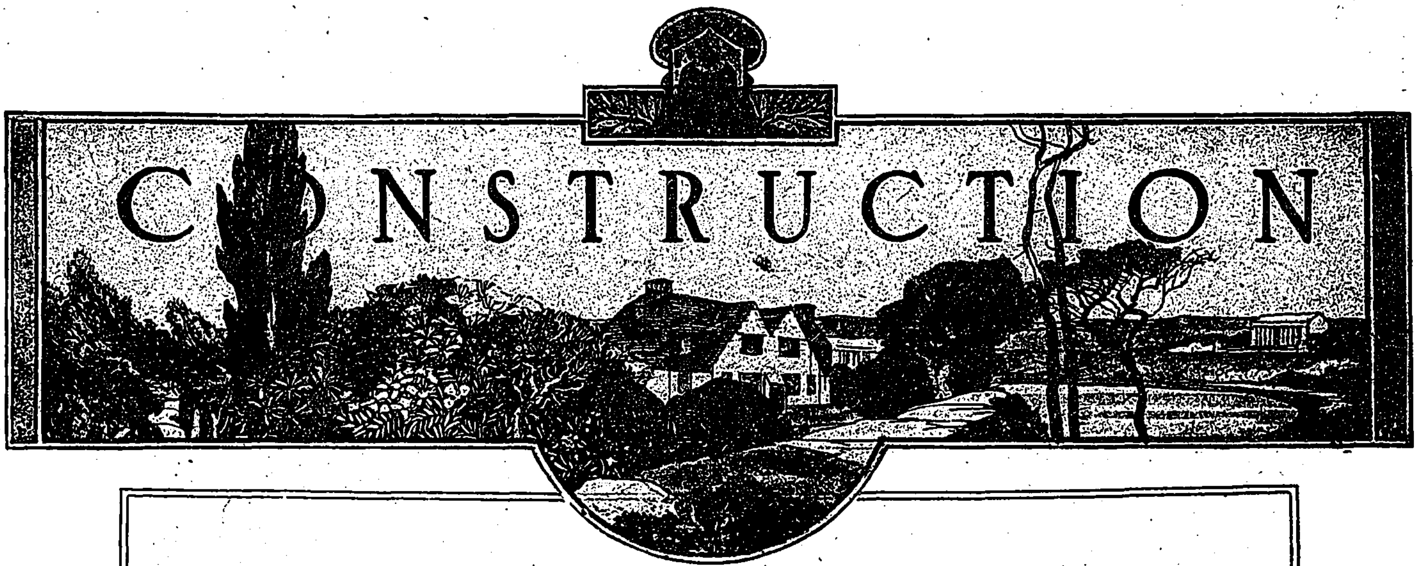

November, 1918 Volume XI, No. 11

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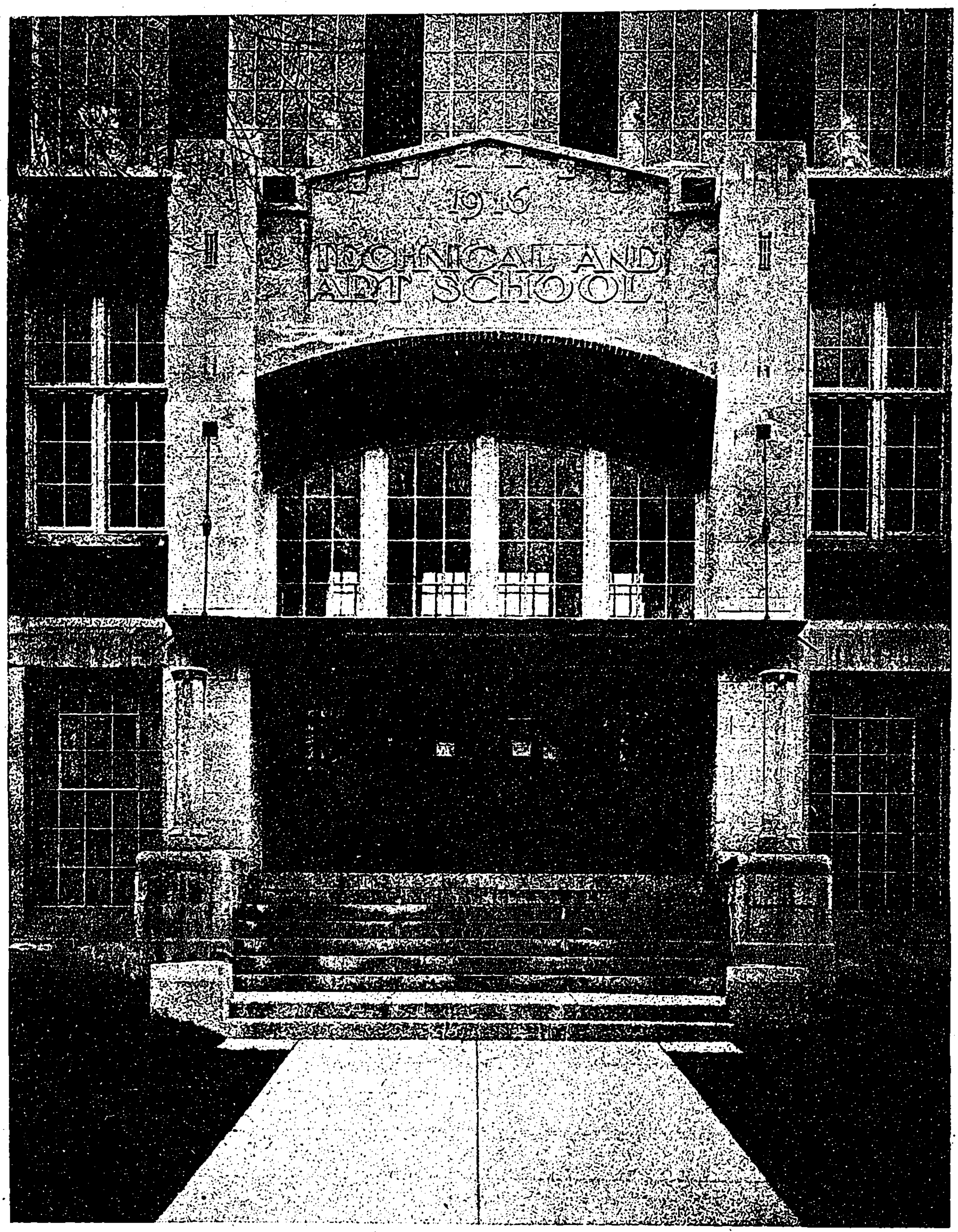
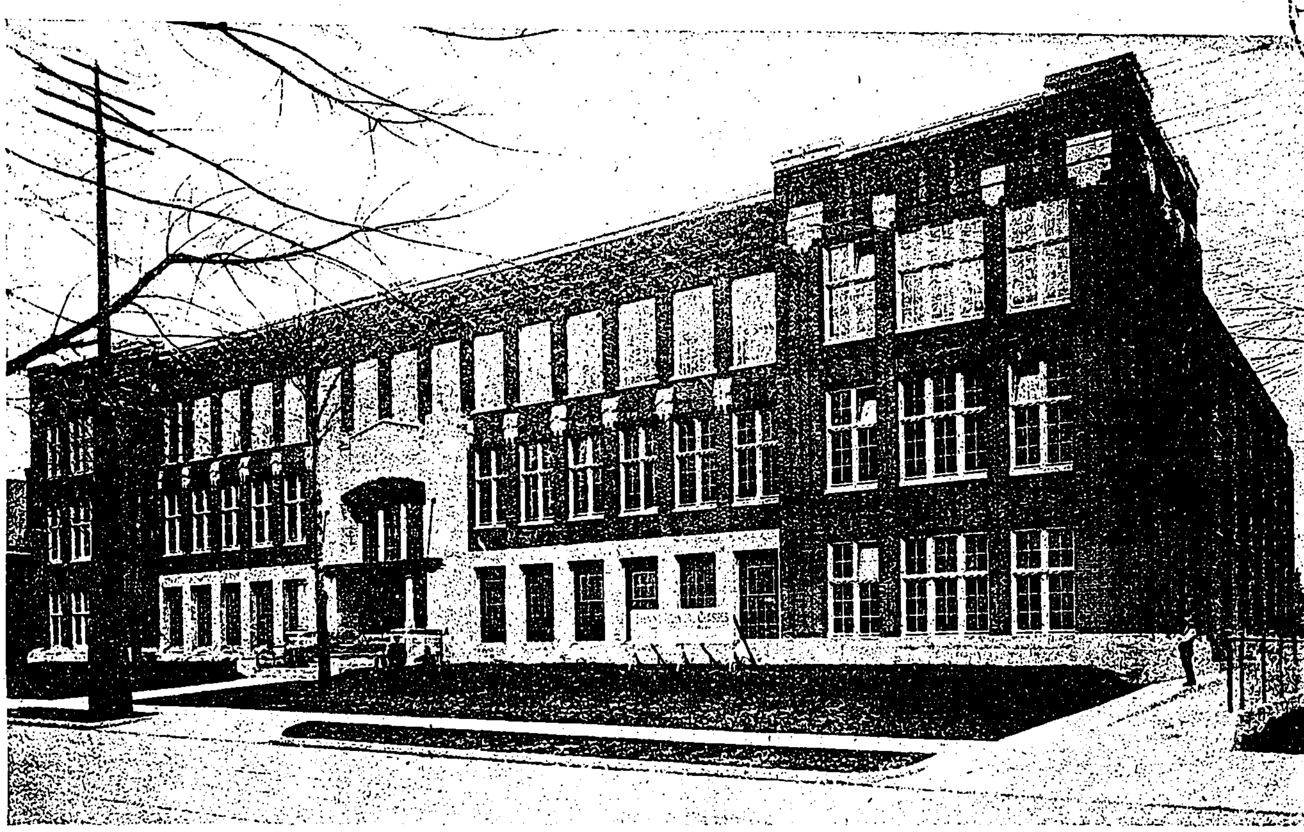


ENTRANCE TO NEW TECHNICAL AND ART SCHOOL, LONDON, ONT.



FRONT VIEW OF NEW TECHNICAL AND ART SCHOOL, LONDON, ONT.

New Technical and Art School, London, Ont.

By Victor J. Blackwell, Watt & Blackwell, Architects.

THE Technical and Art School recently erected by the Industrial Advisory Committee of the London Board of Education at London is of the solid block type; a large auditorium being planned in the centre of the building with spacious corridors at the sides; the classrooms and work shops being arranged along the outside walls, which allows for most excellent non-obstructed lighting.

The building throughout is absolutely fireproof being built of reinforced concrete, with the front and two side elevations faced with tapestry brick and white stone trimmings, steel sash being used in the larger portion of the openings.

The corridors throughout have red quarry tile floors and a brown glazed brick dado.

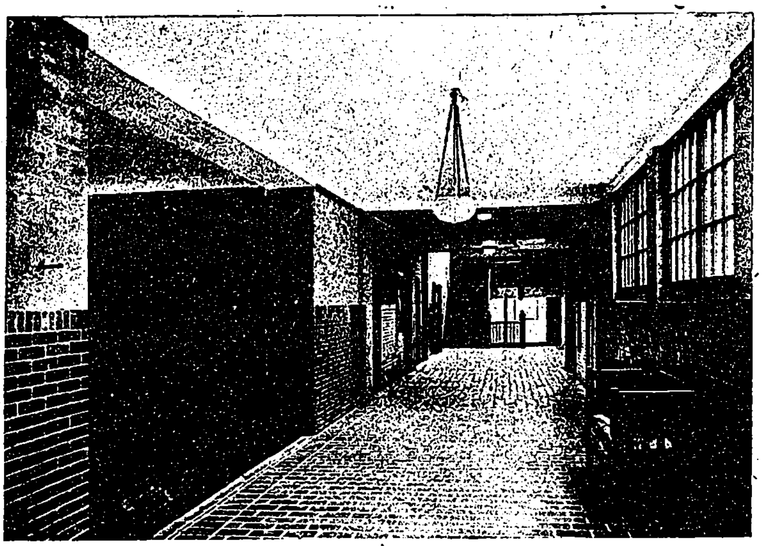
The lighting of class rooms and work shops is by a large group of windows on one side only to the left of pupils in accordance with established practice in school building.

The ground floor with public entrances on each side of the building, contains machine shops, building construction, printing classrooms, etc., and although gymnasium and swimming pool were omitted owing to conditions of the war-time economy and were deemed a non-essential for the time being, provision is left for the future carrying out of the scheme. Lavatory accomodation is amply provided for by two units on each floor, well lighted and with the most up-to-date fittings; special lavatories being provided for teaching staff at other points in the building in connection with teachers' coat rooms, etc.

The first floor which is reached by the main entrance stair hall, enters direct to auditorium, and at the right is the general business offices, board room, etc., the board room being trimmed in walnut panelling and massive tapestry brick fireplace of approved design. On this floor are the wood working department, millinery, embroidery, dressmaking, classrooms, teachers' preparation rooms, etc.

The second floor contains the draughting rooms for mechanical, architectural and free hand drawing, wood-carving, and allied arts, also the physics and chemistry classrooms. A feature of this floor is a complete model apartment in connection with the domestic science department.

The corridors also contain spaces in walls for metal lockers, one for each pupil in the school, thus doing away with the necessity of cloakrooms in the different departments. Each locker is ventilated by a special arrangement, there being an air space in the opening in the wall behind the rows of lockers.



MAIN CORRIDOR, TECHNICAL SCHOOL, LONDON.

The basement contains the boiler room and accomodation for the heating and ventilating apparatus.

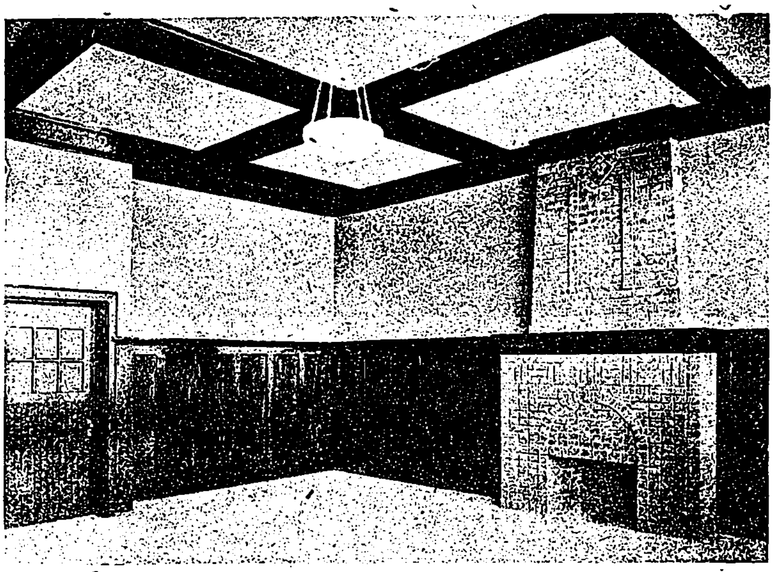
The equipment, though not complete as yet, is ample for the time being and includes special desks, cupboards, filing cabinets, etc., along with the varied pieces of machinery used for teaching the different trades, for which the school was erected; the purpose being to give a general course in all the different departments shown on the plan, thus equipping a pupil to carry on his work to better advantage after securing employment in his chosen vocation.

The lighting, heating and ventilating are of the most modern design.

High School Science Department

Walter H. Kilham, in the Brickbuilder.

THE problems presented to the architect in the designing of a modern high school, while identical in matters of general detail with those of an elementary school, are much more complicated and varied on account of the many different courses of study, the elaborate apparatus which is installed, and the "collegiate" feature connected with the social life and physical welfare of the pupils. A commercial or vocational high school of the present period combines most of the features which until recently were found only in the larger universities, together with many others which are purely a development of high school education. A high school of a thousand or twelve hundred pupils may require in addition to the regular standard class rooms, 24 by 30 feet, accomodating say thirty-five pupils, a certain number of recitation rooms seating about twenty pupils each; probably one or two study halls; large rooms with single desks and chairs accomodating from seventy-five to one hundred and fifty or more pupils; a library; a science department with laboratories and lecture rooms euipped for instruction in chemistry, physics, and possibly biology and botany; a commercial department for instruction in bookkeeping, stenography, typewriting, and banking; rooms for freehand and mechanical drawing; a music room; a department for domestic science, i.e., cooking, housekeeping and sewing; and a manual training department for wood and iron working. In addition to these usual pedagogical requirements some cities introduce facilities for the study of print-



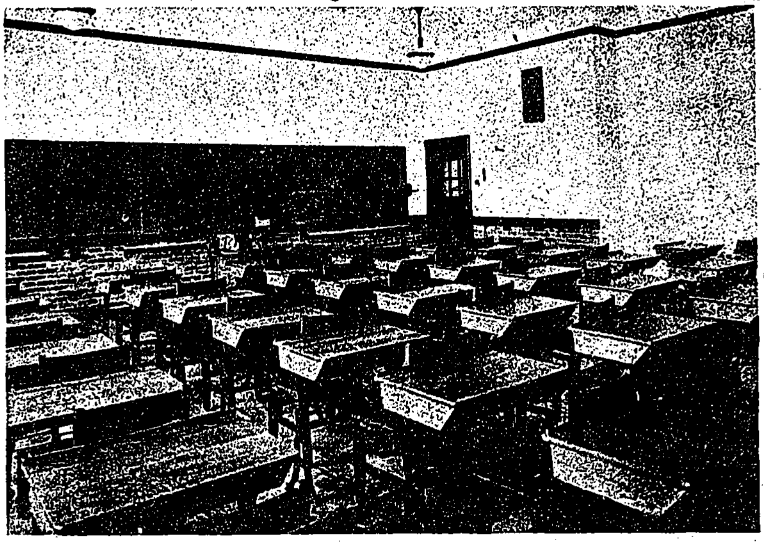
BOARD ROOM, TECHNICAL SCHOOL, LONDON.

CORRIDOR, SHOWING LOCKERS IN WALL, TECHNICAL SCHOOL, LONDON.

ing, bookbinding, natural history (with menageries of animals and birds), and various other topics.

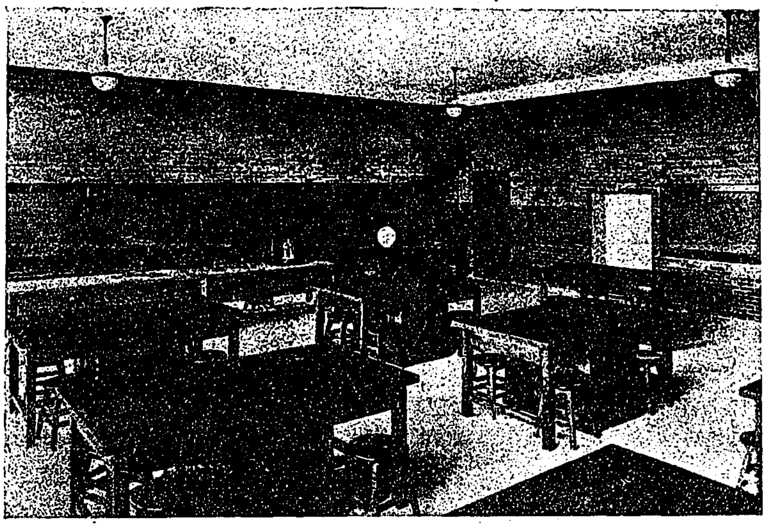
The social and physical culture side of the school's work requires an assembly hall, gymnasium, and locker accommodations, perhaps a swimming pool, a lunch room, rooms for the school paper and athletic society, and in large cities sometimes an arrangement on the roof for outdoor dancing.

The administrative department requires accomodations for the principal and his assistants, clerks, retiring rooms for men and women teachers, a teachers' lunch room, and rooms for the physical directors for boys and girls.



TYPICAL CLASS ROOM, TECHNICAL SCHOOL, LONDON.

Provision also has to be made for the pupils' clothing storage of books, and apparatus, unpacking of cases, toilets, bicycles, heating and ventilating apparatus, vacuum cleaner, and various other things which may vary in different places, not forgetting permanent provision for the inevitable wireless outfit which will surely encumber the roof with unsightly aerials made by a local carpenter unless a neat construction is provided in the contract.

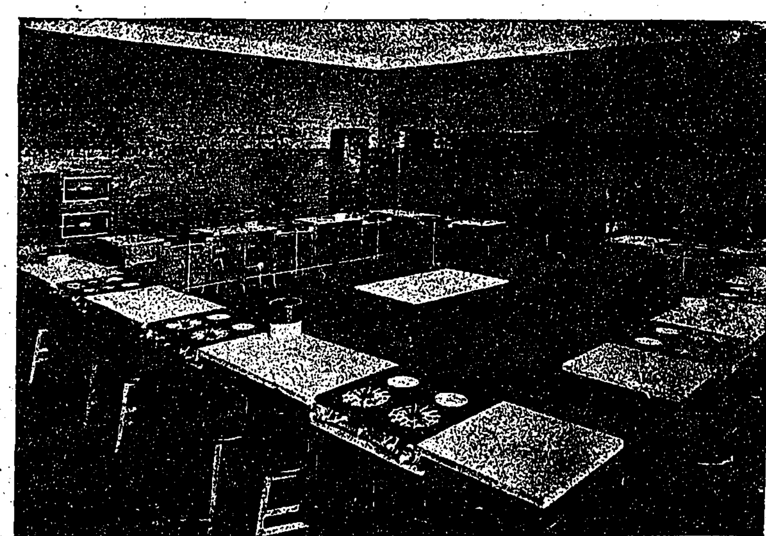


CHEMISTRY CLASS ROOM, TECHNICAL SCHOOL, LONDON.

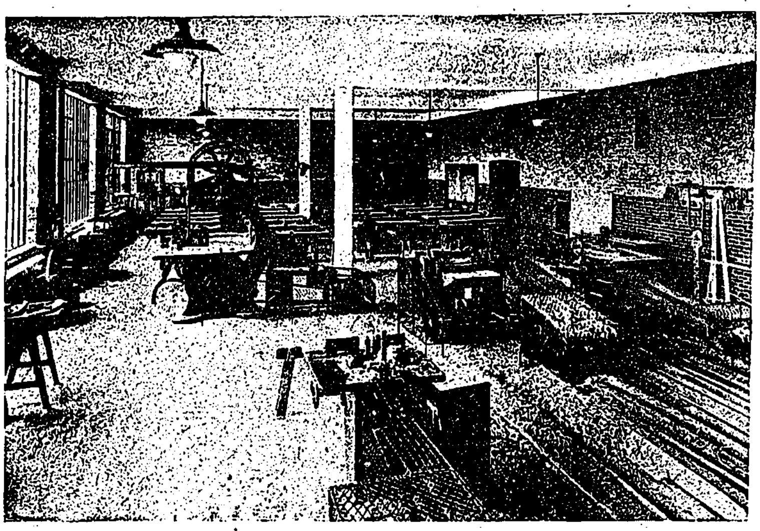
High schools are generally equipped for instruction in chemistry and physics, and sometimes for biology, physiography, and various other sciences. The most elaborate equipment is that required for chemistry and physics, and a separate laboratory is generally provided for each of these two studies, ordinarily fitted up for sections of twenty-four students at a time to practice experiments. As the lectures on these subjects require the setting up of special apparatus which requires a good deal of time, it is convenient to assemble several sections at one time in a lecture room which seats multiples of sections, as forty-eight, seventy-two, ninety-six, or one hundred and twenty. This lecture room is most conveniently placed between the chemistry and physics laboratories, with storerooms adjoining on either hand for chemical and physical apparatus. When the school is a small one and one teacher handles the entire science department, one storeroom may be enough; but it is always better to provide separate rooms to avoid possible damage to delicate physical apparatus by fumes from chemicals. Windows may be arranged in these storerooms for passing out materials, but doors will usually suffice.

LOCATION OF SCIENCE DEPARTMENT

On account of the desirability of quickly getting rid of the fumes from chemical experiments the science department is generally located on the top.



DOMESTIC SCIENCE ROOM, TECHNICAL SCHOOL, LONDON.



WOODWORKING SHOP, TECHNICAL SCHOOL, LONDON.

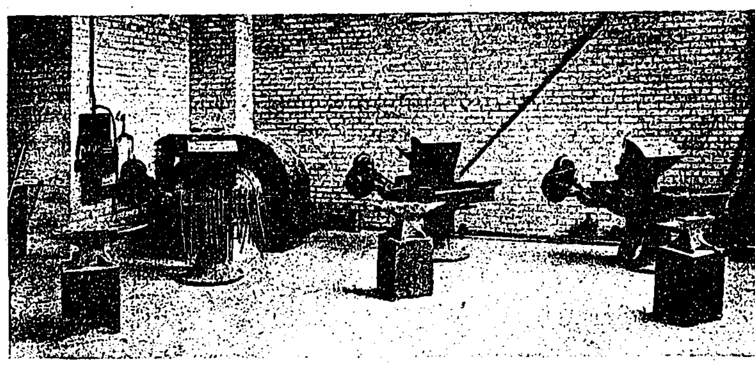
floor. If placed on the first floor or basement, the plumbing would be greatly simplified and the wastes from the chemistry sinks which have a tendency to corrode iron pipes could be carried away in tile. Some educators also prefer to keep the older classes on the ground floor, where they may receive more personal attention from the principal, and as science is an upper class study this at once locates the laboratories on the ground floor. But the most general practice by far is to keep the younger children near the ground and the laboratories at the top, where they can be easily ventilated and well lighted by skylights, if necessary. Another advantage is the additional ceiling height which may be obtained for the science lecture room. On account of the amphitheatrical arrangement of seats a high ceiling is often required which is difficult to provide on the ground story, but can be easily managed at the top of the building. This arrangement also involves placing most of the class and recitation rooms downstairs and hence precludes a great amount of stair climbing by pupils who do not need to use the laboratories. Two stories ought to be the limit of height for surburban high schools, and the realization of such a practice seems to be in sight. At all events, the place for the laboratories is generally conceded to be the top story.

MACHINE SHOP, TECHNICAL SCHOOL, LONDON.

THE CHEMISTRY LABORATORY

The walls of the chemistry laboratory may preferably be of brick covered with a paint containing no lead, as lead will soon become discolored by the chemical action of the gases. Plastered walls are often used to give a more finished aspect to the room, or on account of constructional difficulties in making all the walls of brick.

The ventilation of the rooms is arranged as in other rooms, except that special ventilation for noxious gases is provided in hoods which



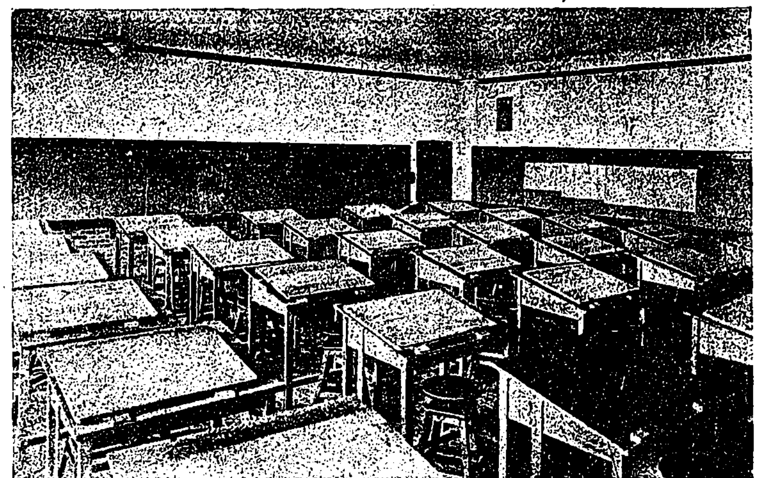
FORGE SECTION OF MACHINE SHOP, TECHNICAL SCHOOL, LONDON.

will be later described. In some cities provision is made for removal of gases from all experiments "at the source" over the working desks, by funnel-like pipes of copper leading down to a underneath, but this is not usually thought to be necessary.

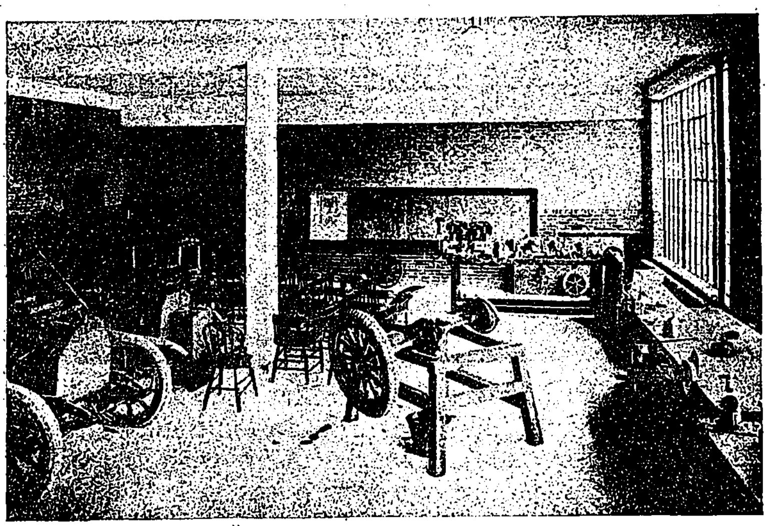
Various opinions exist as to the floor of the chemistry laboratory. A cement floor is hard, cold, liable to "dust," and subject to injury from acids. Floors perhaps not so cold and are in some ways superior. Terazzo is subject to the same objections as cement. Asphalt is suitable in many ways, and is waterproof, but is unpleasant in appearance and somewhat soft and liable to injury by chairs and tables sinking into it. Tile, set in cement, is expensive, but in many ways makes an ideal floor for a laboratory. Wood is very commonly used for cheapness, and narrow strips filled in by asphalt make a very satisfactory compromise. It is rarely necessary to drain the floor. Some carefully kept schools have immaculate doors of waxed maple in their laboratories.

EQUIPMENT

The working desks are generally made 4 feet wide, with spaces 4 feet wide between, to allow students to work facing each other. This causes half of the students to have their backs toward the instructor at all times, resulting, as some claim, in a loss of the teacher's efficiency of at least 50 per cent. Some laboratories have been fitted up with one-way desks at which all the pupils face toward the front of the room. These may be 28 inches wide, with aisles 3 feet wide and some educators make the claim that one instructor can handle twice as many students when the desks are so arranged. When the double-front system is used the desks are made in sections which are placed back to back and are movable when the top is removed. This enables the room to be thoroughly cleaned during the summer vacation without dis- the plumbing pipes. The desks contain drawers and lockers arranged for 4 times as many pupils at one time, i.e., a laboratory which accomodates twenty-four students at one time would have drawer and locker accomodations for ninety-six, or four sections during the day. In large high schools, or schools operating also in the evening with a night master, a still further development of this space is necessary, which may be accomplished as in the Boston High School of Commerce by alternating with the working benches "blanks" or tables 3 feet wide, containing drawers and lockers, but no plumbing. These tables are very useful in providing additional apparatus space for the pupils while working. The working tables are 36 or 38 inches in width and a linear working space of 4 feet is allowed per pupil. Under each pupil's position an open space is arranged, both to give toe room and to provide a place for a stone receptacle for waste. The table is generally built of oak with a top of splined white pine 2 inches thick, treated with and acid-proof finish made as follows:



DRAUGHTING ROOM, TECHNICAL SCHOOL, LONDON.

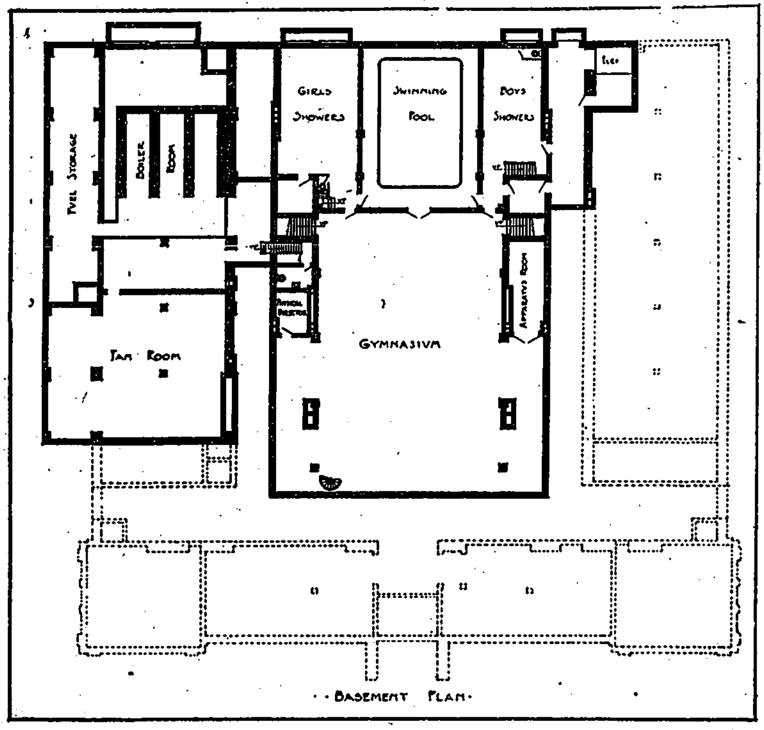


MOTOR MECHANICS DEPARTMENT, TECHNICAL SCHOOL, LONDON.

First Coat. 125 grains copper sulphate, powder, 125 grains potassium chlorate, 1 liter of water. Heat in steam bath or double kettle in glass or porcelain vessel till dissolved. Apply one coat hot with clean brush.

Second Coat. 150 grains of analine hydrochlorate, 1 liter of water. Dissolve same as above. Apply three coats with a clean brush, each coat to become thoroughly dry before applying next. Color will become green when first applied, but in several days will turn a dead black. Allow material to thoroughly dry and wipe bench tops with

ONE SECTION OF ART DEPARTMENT, TECHNICAL SCHOOL, LONDON.



TECHNICAL AND ART SCHOOL, LONDON, ONT.

linseed oil. The above quantities will cover about 5 square yards.

Slate or soapstone tops are occasionally provided and have the advantage of presenting a neater appearance, but the bill for the breakage of glass apparatus is higher and they are less easily removed. The appearance of a laboratory rests mainly with the instructor. In some laboratories the woodwork is stained and corroded by acids after a year's wear, while others retain their first freshness through a considerable period of time. Soapstone sinks are arranged in the form of a continuous trough or individual sinks. The long trough is adequate for teaching elementary chemistry and is less expensive than the separate sinks. It should be at least 8 inches wide, 6 inches deep at the upper end and 8 inches deep at the lower.

Reagen shelves are generally provided, running longitudinally in the center, 10 or 12 inches above the desk, supported standards. This shelf should have an acid-proof surface, which is sometimes accomplished by giving it a surface of plate glass, clamped firmly to the wood, which may be painted white under the glass. Others prefer to keep the reagents in cases at the ends of the working desks; but the general tendency is to eliminate all unnecessary complication of the laboratory equipment and in many modern schools the shelves are being omitted entirely.

In addition to the plumbing the desks are equipped with gas, alternating and direct electric current, steam and comcompressed air, located as shown in the accompanying drawing.

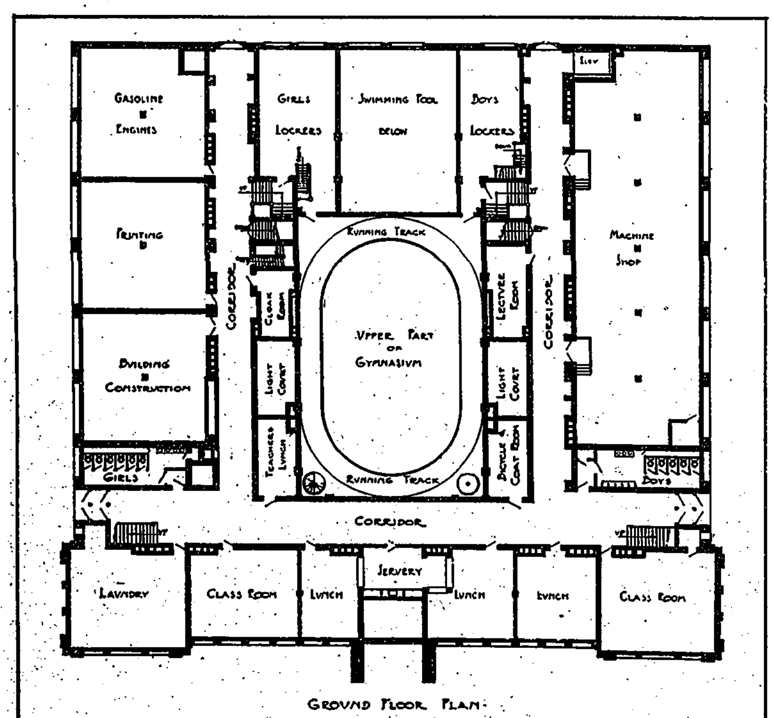
Some teachers like to have a space in the laboratory equipped with a demonstration desk and about twenty-four tablet chairs where the section can assemble for instruction before going to the tables to perform the experiments. A "battery" of triple blackboards may be located behind the demonstration desk.

For use in experimenting with substances which produce noxious gases, a half dozen or more hoods are provided at the side of the room. These are best lined with white tile, with slate or red tile floors and sliding glass fronts. The space above the opening may be utilized for a blackboard. Electric light and gas outlets are provided in each hood, or if desired, the electric light may be hung outside each window. "Down draft" ventilating outlets are sometimes built in the pupils' tables with movable hoods to fit into them, but their use is scarcely necessary and tends to complicate the equipment.

Wall benches are often provided for special or additional students, provided like the other tables, with gas, electricity, etc., and copper sinks, which are made removable so as to gain additional working space.

A good sized soapstone sink is also desirable with draining pegs above for drying beakers and test tubes.

The teacher should be provided with a private office fitted up with a laboratory, table, space for a desk, etc., where he can prepare his lecture apparatus and

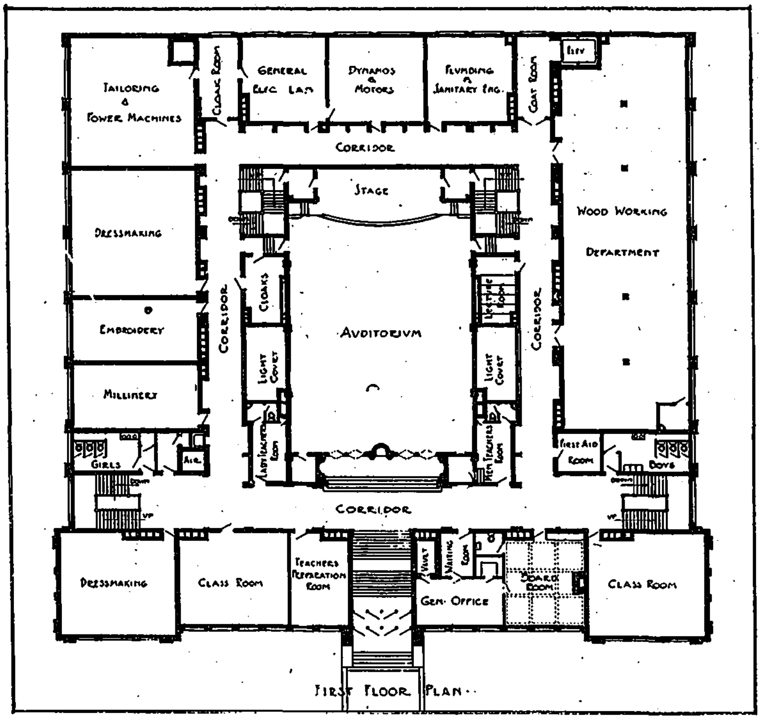


TECHNICAL AND ART SCHOOL, LONDON, ONT.

work on experiments without danger of disturbance. The motor generator set is sometimes located here.

THE SCIENCE LECTURE ROOM.

Adjoining the chemistry laboratory, and separating it from the physics laboratory, is located the lecture room, which should accommodate from forty-eight to one hundred and twenty pupils in seats raised in an amphitheatre in such a way as to give them the best possible view of the lecturer and the demonstration desk. Behind the desk one or two hoods should be located and a battery blackboard, and, if the room is located in the upper storey, a skylight may profitably be placed directly above the lecturer. In fact, outside window light is not necessary for this room. The best arrangement is undoubtedly to have the room lighted from one side, so that the pupils face parallel with the light; but if the rise of the bank of seats is high enough to prevent the light from shining directly into the teacher's eyes, the windows may be located behind the pupils.



TECHNICAL AND ART SCHOOL, LONDON, ONT.

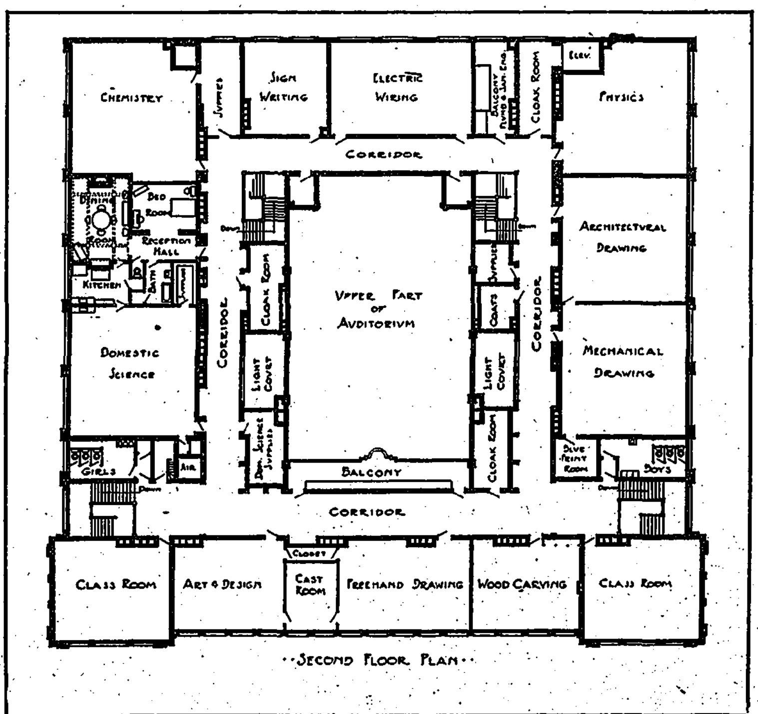
As a stereopticon will often be used in connection with science lectures, a space should be arranged for one at the rear of the room with receptacle for plugging in for electric current and a concealed signal system operated from the demonstration desk. To ensure absolute darkness for the steropticon, the windows, skylights, and glass panes in the doors, if there be any, should be equipped with light-proof black shades, running in grooves, which prevent the entrance of any light. Some time is lost and confusion caused by sending pupils to draw these shades, which may be prevented by operating the cords by a small electric motor controlled from the demonstration desk.

This desk is about 15 feet long, 3 feet wide, and 2 feet 8 inches high, with splined pine top and a sink of two depths, placed at the right hand end facing the pupils. A dished soapstone slab covers about 5 feet of this end of the desk. Electric receptacles and gas cocks are provided, together with steam, compressed air, a down shaft outlet with cover, a pair of brass standards 4 feet high with adjustable clamps for a horizontal bar, and switches for controlling the lights in the room, the stereopticon, and the curtain motor. Cupboards and drawers and the switchboard cabinet are arranged underneath. All connections of any sort for apparatus used in experiments should be placed in the demonstration desk to avoid the necessity of stretching wires, etc., across the space between it and the wall. On account of the large number of pupils to be accomodated, this room should have two doors to the coridor.

A dark room, with sink for use in photography, should be provided, and a photometry room, with a table allowing a free length of at least 14 feet.

Ample storage space with shelving and glass

(*Concluded on page* 361.)



TECHNICAL AND ART SCHOOL, LONDON, ONT.

Royal Architectural Institute of Canada

A meeting of the Council of the Royal Architectural Institute of Canada was held on October 5, 1918, in the rooms of the Ontario Association of Architects, No. 96 King street west, Toronto, Ont.

Those present were: Messrs. J. P. Ouellet, A. Frank Wickson, C. H. Acton Bond, A. E. Nicholson, David R. Brown, Alcide Chausse and J. P. Hynes. Mr. J. P. Ouellet, president, in the chair.

The minutes of the meeting of the council held at Ottawa on October 1 and 2, 1917, were read, and were approved as corrected. The minutes of the matters decided upon by correspondence were taken as read, as all the members of the council had received copies of same.

The hon. secretary reported that the Architectural Institute of British Columbia had conformed to the wish of the council as expressed in a resolution adopted in October, 1917, sending satisfactory evidence that the Society of Architects of British Columbia had been disbanded, by sending $34, being the amount of their contribution for seventeen members composing this association; and by sending the list of their members, the names of their officers and of their delegates to the council of the R.A.I.C.

It was proposed by J. P. Hynes, seconded by Alcide Chausse, that the application of the Architectural Institute of British Columbia be accepted, and that federation with this body be effected. This motion was adopted unanimously.

The hon. secretary reported that the Ontario Association of Architects had appointed A. E. Nicholson as their delegate to this council, to fill the vacancy caused by the death of the late J. W. H. Watts; that the delegates to this council appointed by the Architectural Institute of British Columbia are Messrs. S. M. Eveleigh and Kennerly Bryan, both of Vancouver, B.C.

It was proposed by J. P. Hynes, seconded by Alcide Chausse, that Messrs. A. E. Nicholson, S. M. Eveleigh and Kennerly Bryan be elected as members of the council of the Royal Architectural Institute of Canada. This motion was adopted unanimously.

It was proposed by J. P. Hynes, and seconded by C. H. Acton Bond, that John I. Sutcliffe, of Toronto, be appointed as auditor for the current year. This resolution was adopted unanimously.

It was proposed by A. Frank Wickson, seconded by David R. Brown, and adopted unanimously, that the hon. treasurer be authorized to make the necessary arrangements to bond the hon. treasurer for $2,000, by the Employers' Liability Co., of London, England, and to pay the required premium.

It was proposed by C. H. Acton Bond, seconded by J. P. Hynes, and adopted unanimously, that the actual travelling expenses of the members of the council attending a meeting of the council, other than the officers, up to and not exceeding $25, be paid by the hon. treasurer upon presentation of a detailed statement of such travelling expenses. This resolution applies to the present meeting of the council.

The hon. secretary reported that through the joint effort of the Architectural Institute of British Columbia, the Royal Architectural Institute of Canada, and the Canadian Society of Civil Engineers, the proposed bill to incorporate the Engineering and Technical Institute of British Columbia, by the Legislature of the Province of British Columbia, was not adopted.

The matter of the extension of the R.A.I.C. in the Maritime Provinces came up for discussion, and was left pending until the coming annual assembly.

A letter received from Charles Harris Whitaker, editor of the "Journal of the American Institute of Architects," was read. It is in connection with the competition for a solution of the housing problem, and also suggesting the possibilities of a closer affiliation between the Royal Architectural Institute of Canada and the American Institute of Architects.

It was proposed by A. Frank Wickson, seconded by David R. Brown, and resolved: that the $200 received from Lord Strathcona in 1913 be deposited in a "scholarship fund," and that said amount be used to purchase Victory Bonds.

It was proposed by Alcide Chausse, seconded by A. E. Nicholson, and resolved: That Messrs. J. P. Ouellet, A. Frank Wickson, J. P. Hynes and David R. Brown be appointed a committee to report on the matter of the conservation of technical education.

It was proposed by David R. Brown, seconded by A. Frank Wickson, and resolved: That the council of the Royal Architectural Institute of Canada learn with regret the Government's action in having started the erection of a government office building on O'Connor street, in the city of Ottawa, in direct opposition to the advice given them by the Federal Plan Commission. In the opinion of the council this is a serious mistake, and though now too late to be remedied, they wish to enter a protest against it having been started, and they also wish earnestly to protest against the erection of any future buildings that may violate the advice given by the commission. The hon. secretary was requested to forward a copy of this resolution to the Prime Minister.

It was suggested by the hon. secretary that the coming General Annual Assembly of the R.A.I.C. be held at the same place and time as the annual convention of the Province of Quebec Association of Architects, which will be held in Montreal in January, 1919, and that in future years the annual assembly of the institute be held in connection with the annual convention of one of the provincial associations.

It was resolved that Messrs. J. P. Ouellet, David R. Brown and Alcide Chausse be appointed a special committee to meet the council of the P.Q.A.A. and organize such joint convention. It was suggested that an exhibition on architectural subjects, and discussions on matters relating to the profession be arranged. The names of Messrs. A. B. Pond, of Chicago; C. Harris Whitaker, of Washington; Claude P. Braydon, of Rochester; Ackerman, Adams, were mentioned among others who might be invited to be present at a special meeting and speak on prearranged questions.

It was suggested that in the future all meetings of the council be held in Ottawa, which, according to clause 2 of the charter of the institute, is its head office.

There being no other matters before the chair the meeting was adjourned.

R.A.I.C. TO HOLD JOINT MEETING WITH P.Q.A.A.

It is now definitely announced that the General Assembly of the Royal Architectural Institute of Canada will be held at Montreal, on Friday and Saturday, the 17th and 18th January 1919, at the same time as the Annual Convention of the Province of Quebec Association of Architects. The program of the Assembly will be sent to all members of the Institute in the month of December.

Big Gathering of Builders Anticipated

The Ottawa conference of the proposed Canadian Building Industries, to be held November 26, 27 and 28, gives every promise of arriving successfully at the object in view, namely, a much-needed and efficiently organized national association, comprising builders, contractors and supply and material dealers.

This is indicated by the active manner in which the movement since its inception has been taken up, and by the encouraging reports received by the temporary executive from eastern, central and a large number of western sections, giving assurance of support and co-operation to bring the organization to a full state of realization.

The Montreal Builders' Exchange, which originally fostered the idea of this organization, and has labored diligently to make it effective, will send a large size delegation to the conference.

Toronto will likewise be well represented. At a meeting held at the Builders' Exchange in the latter city on November 6th, representatives of some thirty firms gathered for the purpose of making final arrangements to attend. This meeting was presided over by Mr. Maxwell, of the sanitary and heating engineers' section. Mr. A. H. Dancy, of H. N. Dancy & Son, explained what had been accomplished at a previous preliminary meeting at Ottawa, and Mr. W. E. Dillion and Mr. H. Elgie both spoke of the purpose of the conference, and urged as many as possible to attend. Mr. McIntyre, of the firm of McGregor & McIntyre, also strongly endorsed the object of the association, and drew a comparison between the building trades and other industries to show what could be accomplished where full effort and support were given to get the desired results.

Altogether it is expected that the conference will find delegates from all the principal cities, cluding extreme eastern and western points, participating in its sessions. It will be in every sense a strictly business gathering, subordinating entirely any social features to the important transactions to come before the meetings.

It is certain with the advent of the armistice and the period of reconstruction immediately ahead, the conference comes at a particularly opportune time. War time curtailments and inactivities will now merge into a period of peaceful pursuit and development which eventually promises much and in which the building interests will naturally largely figure. Consequently other phases than those perhaps originally considered will be dealt with at the conference.

By getting together in a thoroughly national organization a much better understanding is bound to exist. It is only by this means that the many evils which at present beset the contracting business can be effectively overcome, and with a representative membership and a capable executive directing its affairs, the association will not only be to present a solid front in all matters which might be necessary to establish the legitimate rights of those whom it represents, but in various other respects will be an agency of mutual service and benefit to the contracting and building fraternity in general.

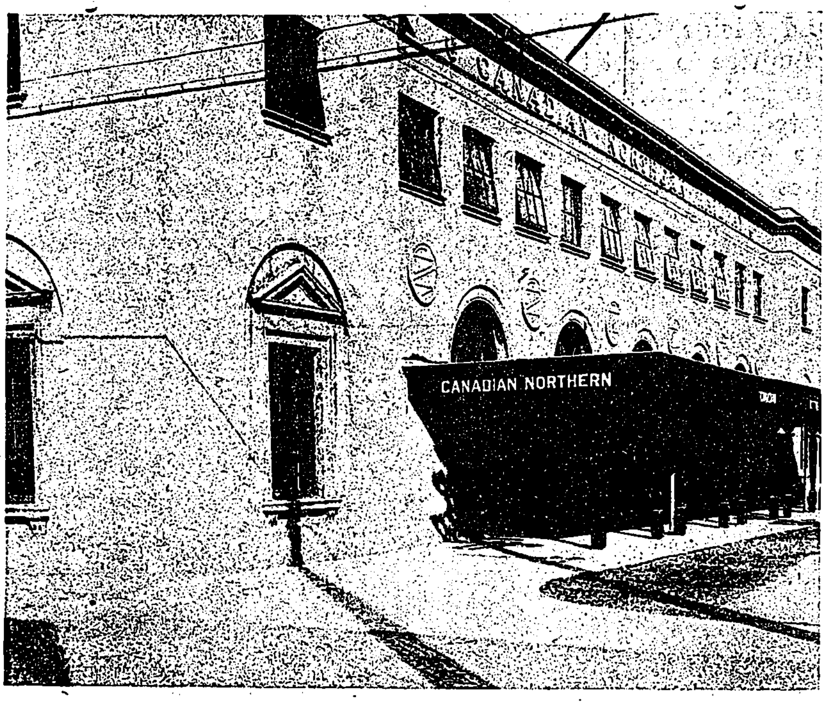
It is therefore of utmost importance that all branches of the contracting and building trades should be strongly in evidence at the approaching meeting and that the association should be made thoroughly representative and effective from the very start.

Canadian Northern's Tunnel, Montreal

By Henry K. Wicksteed, Chief Locating Engineer for the Canadian Northern Railway.

THE recent opening for traffic of the Montreal tunnel of the Canadian Northern Railway, marks an era in the history of the road itself, and in the history of transportation in Canada.

It was accomplished without fuss or ceremonial on October 21st last, and on account of the stupendous happenings in Europe, very little notice has been taken of it in the newspapers or periodicals. Yet, it is the greatest work but one of its kind in Canada, and one of the great tunnels of the world, dwarfed only by the three great Alpine tunnels, the Mount Cenis, the St. Gothard, and the Simplon. The greater one in Canada is that of the C. P. R. through the Selkirks, but this tunnel is a detail only in the general improvement scheme of the Canadian Pacific, while the Montreal tunnel was an essential feature of the Canadian Northern, the missing link in its transcontinental line.



ENTRANCE TO C.N.R. STATION, MONTREAL.

VIEW OF TERMINAL FROM REAR ALONG TRACKS.

The Canadian Northern System extends east of Montreal to Quebec and Chicoutimi, but the extensions are more in the nature of feeders and branches than main line, and their traffic is towards Montreal rather than away from it.

Montreal, for much the same reasons as Duluth, is a long, narrow city. It is wedged between the St. Lawrence and the great mass of volcanic rock known as Mount Royal, from which it takes its name. It answers to the description of the Eastern man who characterized Duluth as being twenty-five miles long, one mile wide, and nearly a mile high, even more completely than Duluth itself. One offshoot of the city has climbed over the northern slope and reached nearly to the Back River, but this is a comparatively modern growth, and in no way stopped or hindered the extension along the water front, which is now practically continuous from Lachine to near Bout de L'Ile. These are the "Dan and Beersheba," the "John O'Groats and Land's End" of Montreal. The original Montreal which is still, and is likely to remain, the busiest part of it, and of its port, is directly opposite the highest point of this mountain mass, which rises some 700 or 800 feet above the river.

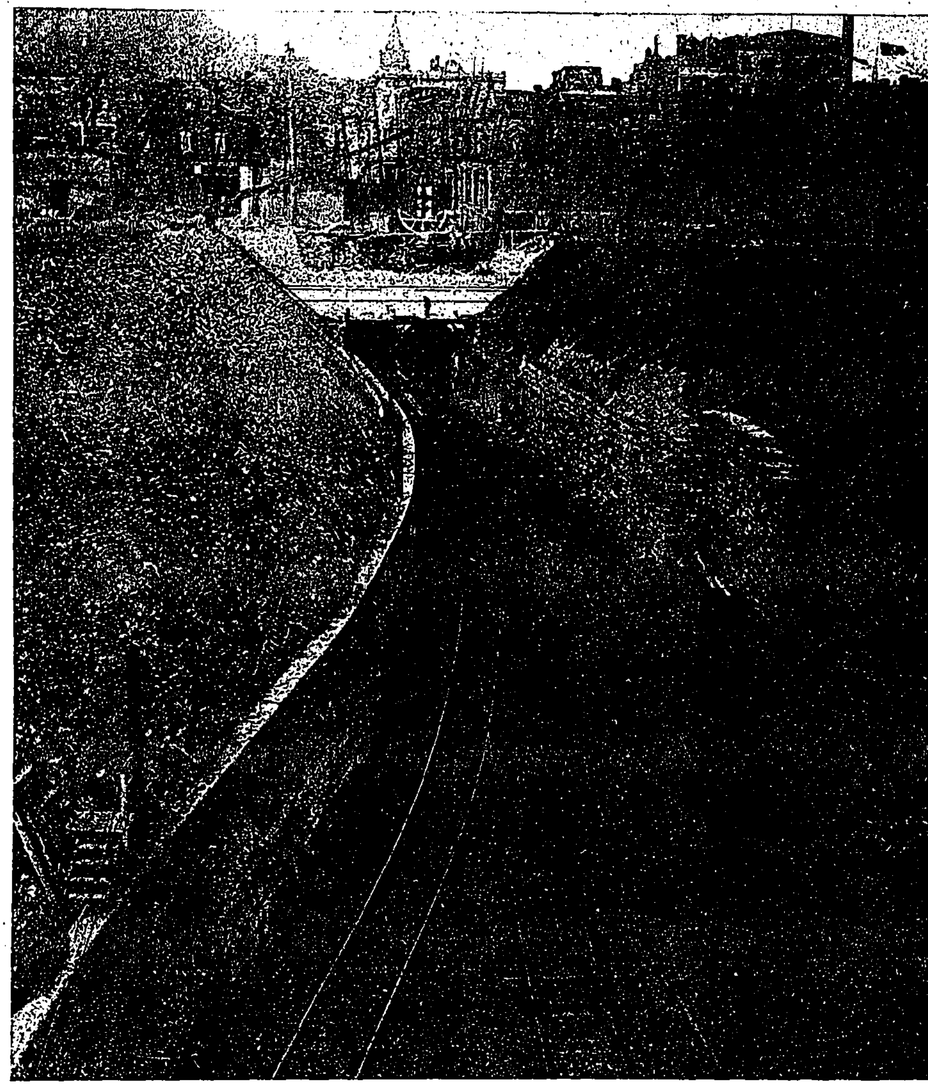
To reach the city's heart from the west it was necessary either to go round it, or to bore a hole through it. The Grand Trunk, built in earlier days, and heading southwest rather than west, got in and out again with tolerable facility, although only at the expense of a two-mile branch for its passenger and local freight service; and the C.P.R., also senior to the Canadian Northern by twenty-five years, came round both ends and established one terminal near the south, and the other near the *then* north end of the city.

To duplicate either of these entries was almost out of the question. Twenty-five years makes a big difference in the growth of a large city, and in the land values. Also, it had made a difference in the attitude of the public and its demands. It had been found that the level crossings of the streets interfered with internal traffic and threatened life and limb; and even where level crossings were avoided, there still remained a growing objection on the ground of noise and trails of filthy black smoke for which railway trains are responsible.

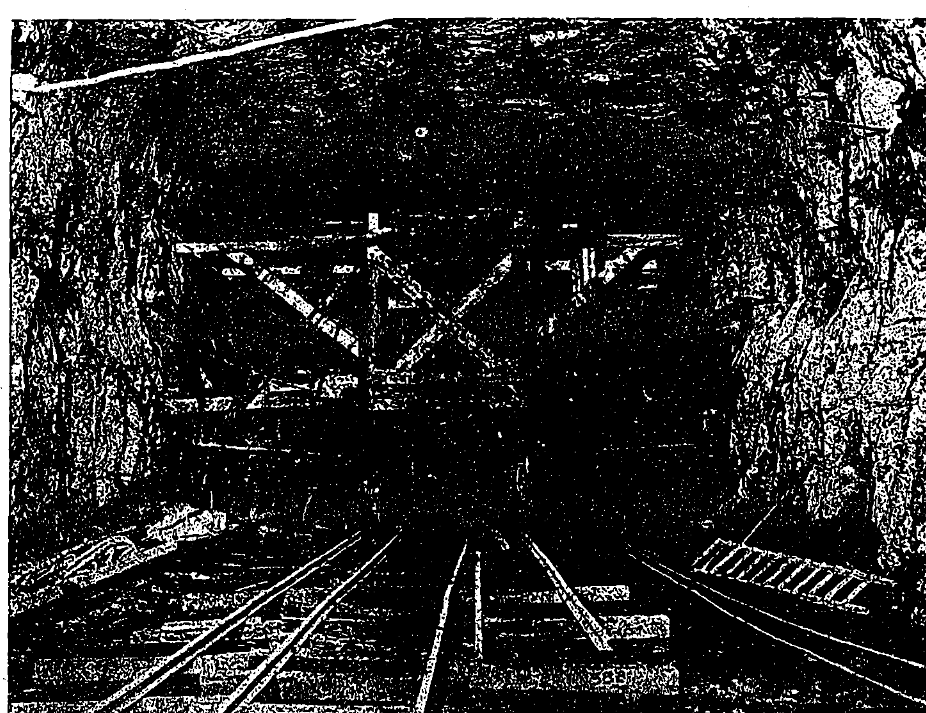
In consequence of these conditions it was decided to enter the city by an under-the-mountain route. This led to the construction of the present tunnel, which gives passage through from the unoccupied slope of the mountain, merging into the plain, or flat country known as Back River.

The station building or terminal itself within the city of Montreal, is located in the two blocks between Cathcart, St. Montique, Lagauchetiere, and Mansfield streets, and is but a few blocks' distance from both the C.P.R. and Grand Trunk stations. There are five tracks devoted entirely to passenger, mail and express service. These branch from the two tracks leading from the tunnel, and terminate with stub ends at the station building.

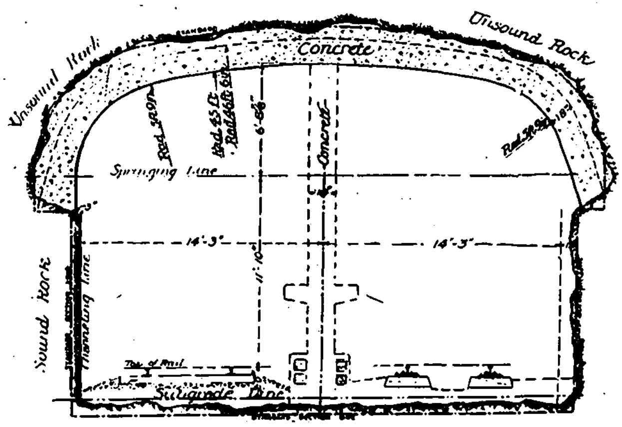
The tunnel itself is double-tracked throughout, and is 3.25 miles long. The western portal is its highest point, and is roughly 150 feet above the harbor. It then descends



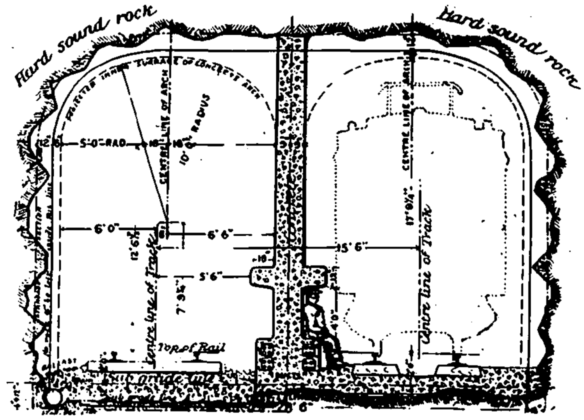
ENTRANCE TO C.N.R. TUNNEL, MONTREAL, AS SEEN FROM DORCHESTER STREET BRIDGE.



PROGRESS VIEW, SHOWING TUNNEL DURING PERIOD OF CONSTRUCTION.



SINGLE ARCH TUNNEL SECTION.—UNSOUND ROCK IN ROOF.



TYPICAL TUNNEL SECTION IN HARD ROCK.

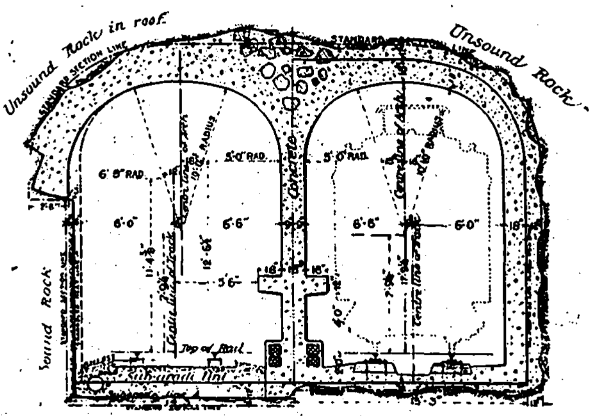
CANADIAN NORTHERN RAILWAY TUNNEL, MONTREAL.

on a grade of 30 feet to the mile, just sufficient to provide good drainage, to the portal at Cathcart street. From the portal the grade is practically level through the terminal to the water front. At Cathcart and Dorchester the grade is some 45 feet below the street level. These streets are on the upper, or terrace, level. Below Dorchester the ground drops rapidly. Lagauchetiere can just be carried comfortably overhead. St. Antoine, St. James, Notre Dame and a number of minor streets are on the lower level, and all carried easily and with ample clearance underneath. An absolute avoidance of grade crossings is thus secured, with only one very slight change in the grade of an unimportant street.

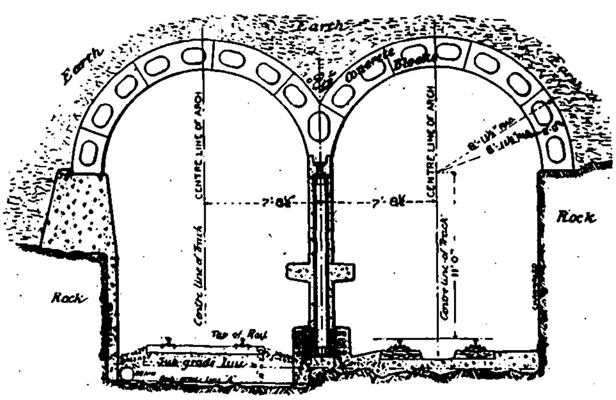
The alignment is a straight line to within a half mile of the east portal, where, in order to avoid property damages, a two-degree curve was inserted to bring it immediately under the centre of McGill College avenue, and at right angles to the arterial north and south thoroughfares.

For a few hundred feet from the west portal, the excavation is in earth as to the roof, although the grade strikes rock almost immediately. This was excavated and arched in and then refilled. For another half mile or more the material is limestone, resting undisturbed on the older strata. Then comes a short length of crystalline rocks, and finally the solid core of volcanic rock, generally referred to by geologists as Essexite. At the east end the transition is reversed and similar, except that it is direct from the Essexite to the limestone.

The most difficult portion was from Sherbrooke street to the portal, about 2,000 feet, where the roof ran out of the limestone into a superincumbent surface deposit known as the "Leda" clay. This clay is a marine deposit and extremely impalpable and plastic, and carried much moisture. A shield was used throughout on this section, and a double arch built of concrete blocks cast in Voussoir form, and resting on either side on the limestone walls and in the centre on a partition wall of reinforced concrete between the double tracks. In spite of great precautions to prevent leakage there was a settlement of the street overhead to the extent sometimes of three or four inches. This was manifestly due to the abstraction of the moisture, although even this did not appear inside. Many of the adjacent houses had been built on this semi-fluid material, and had shown more or less settlement and distortion in advance, so that further subsidence did not cause much further damage. Some old brick sewers had to be rebuilt. They needed rebuilding anyway. But on the whole, the amount of damage done or claimed was very moderate.



TYPICAL TUNNEL SECTION.—BAD ROCK IN ROOF.



SECTION OF TUNNEL BENEATH EARTH ROOF.

CANADIAN NORTHERN RAILWAY TUNNEL, MONTREAL.

A very satisfactory feature on the work generally was the almost absolute absence of water. A spring of moderate flow was struck where it was most likely to be met, at the contact between the limestone and the crystalline rocks. This is carried through the entire length of the tunnel. This dryness was a very fortunate feature, because the heading was driven very largely from the west end, and consequently down grade. Any considerable influx of water would therefore have been a great drawback and hindrance.

The heading (a bottom one) was driven from both ends, and from a 250-foot shaft one mile from the west end. The easterly driving was also pushed harder than that in the opposite direction, because the disposal of material was easier at the west than at the city end. Some ingenious machinery was devised by the managing engineer, with the result that the world's record for speed in hard rock tunnelling was for a time broken with a record of an average of 26 feet per day for a whole month of thirty-one days. Unfortunately, before the succeeding operations were completed, financial troubles supervened, and the benefit of the high speed was not realized.

The drills, generally three in number, were mounted on a horizontal shaft wedged into place with jackscrews, and were driven by compressed air, the volume of which was so large that but little inconvenience was suffered from the fouling of the air by explosives. The removal of this bar with its drills every time a blast was fired, and its readjustment in a very confined space for the next drilling operation, was a work of time and difficulty. A machine electrically driven was devised with a long projecting arm in front, which lifted the bar with its attached drills, and ran it back out of the way of the blast. This being fired, it returned to the front and held it in the new position while being wedged, and at the same time an endless belt on the same machine and carriage carried the "muck," or broken rock, to the rear, where it was loaded on to the ordinary contractors' dump cars and taken out of the west portal.

The drills, as already stated, were run by compressed air, the mucking trains by electricity. Some storage battery traction engines were tried, but were not very satisfactory, and soon superseded by a regular trolley system. In the space of an 8 ft. by 12 ft. heading, this would seem to entail considerable risk, but as a matter of fact, few accidents occurred, and no fatal ones. Such pumps as were necessary were also operated electrically.

It may be imagined that all this power entailed a considerable power plant, which was supplied electrically by the Montreal Light, Heat and Power Company, even the air compressors being operated by dynamos.

The permanent operation of the tunnel will also be carried on by electricity, and three large locomotives are already on the ground and ready for work. A departure from ordinary standards was made by the installation of a 2,400-volt system, which is four times as heavy as the ordinary street railway standard. This, of course, is to save wire and transmission losses.

So much of the tunnel being bored through solid rock, and most of this through a very hard volcanic material, it was thought that very little lining would have to be done. As a matter of fact, had it been an ordinary tunnel on the open road operated through by steam locomotives, very little would have been done, but the rock, after the tunnel was drilled out and the round of the roof finished, proved to be somewhat seamy and friable, and some small falls took place. Inasmuch as the trolley wire had to be suspended from the rock roof, and any interruption of traffic was inadmissable, it was thought better to put in a thin lining of concrete. This extends almost throughout its length. This is about the only contingency in connection with the work which was not foreseen and anticipated, and it delayed the completion somewhat, although it was in itself very rapidly done over a moveable mould run on the construction tracks. The clearance and thickness of the arch ring being small, a great deal of the necessary concrete was blown in by compressed air.

The Montreal tunnel, therefore, while remarkable on account of its magnitude and speed of initial construction, shows no special difficulties which had to be overcome, and the novelties were all of the nature of higher development of working methods on the same general lines as had been already initiated.

The chief locating engineer was H. K. Wicksteed. The managing engineer was Mr. S. P. Brown, who had been engaged on similar work for the Pennsylvania and Brooklyn Rapid Transit tunnels. Mr. W. A. Lancaster designed and supervised the electrical plant, and Mr. Fisher attended to the alignment and levels.

The alignment had to be carried some two miles from the west end, and something over one mile with a curve from the east. The final closure was "out" less than one inch, and the levels only one-quarter of that amount.

Practising at Halifax, N. S.

Wm. Fraser and Harold S. Kaplan, recently of Toronto, Ont., have opened an office in the St. Paul Building, Halifax, N.S., for practice as associate architects. They are at present preparing plans for two schools for the Halifax School Commissioners. The buildings will be brick, reinforced concrete and hollow tile construction.

Developments in the Theory of Ventilation

By Charles L. Hubbard.

THE term recent, as used above, has a somewhat broader meaning than is usually given to it, as the developments referred to had their beginning some ten or twelve years ago. However, it is only within the past three years or so that a general discussion of the matter has appeared to any extent in the technical journals, and at the present time investigations are still being carried on to reduce these theories to a practical working basis. While considerable matter along this line has been published, it has not appeared to any extent in the various heating, medical and school journals, and has usually taken the form of a radical presentation by the adherents of either the *natural* or *artificial* system according to their personal belief.

It is proposed in the present article to review the matter in a simple manner, giving what seems to be the general opinion of a majority of those who have made a special study of the subject, and who should be able to give reliable information to those interested. As these new developments, when finally worked out, are likely to call for more or less change in building construction, as regards the ventilating arrangements, it would seem that the matter should have an especial interest for the architect.

Air has two principal functions: a chemical and a physical; it aerates the blood and absorbs the body heat. In order to perform the first of these it must contain a sufficient amount of oxygen and a minimum of harmful gases. Absorption of bodily heat depends upon the temperature, humidity and motion of the air. If the air of a room is not renewed its oxygen is gradually consumed and it becomes laden with heat and moisture from the bodies of the occupants.

Until within a comparatively short time all efforts toward better ventilation have been directed to chemical improvement instead of physical.

The theory upon which all systems of ventilation were formerly designed was that the percentage of oxygen must be maintained as nearly as possible to correspond with that of outside country air and that the proportion of carbon dioxide, or carbon acid gas, must be kept below a certain maximum. The method employed for obtaining this condition was that of dilution or the supplying of large volumes of fresh air at the room temperature or higher, depending upon the system of heating employed. Normal outside air contains approximately 21 per cent. of oxygen and from 3 to 5 parts of carbon dioxide in 10,000 parts of air. It has been assumed, arbitrarily, that the carbon dioxide should not be allowed to rise above 10 parts in 10,000, and for the best results 6 to 7 parts have been considered the limit.

The harmful results of an insufficient air supply were supposed to come principally from the poisonous effects of the carbon dioxide coupled with the corresponding diminution of oxygen. Later it was thought the effect of poor ventilation was due, not only to the presence of carbon dioxide, but to certain harmful gases and organisms which were given off in the process of respiration. As these substances were supposed to exist in a fixed proportion to the carbon dioxide, the latter was still considered to indicate the quality of the air, although in itself it was thought to be less harmful, especially in small quantities.

The common allowance of 30 cubic feet of air per occupant per hour is based on an increase of carbon dioxide from 4 parts in 10,000 of air to slightly less than 7 parts. A maximum of 6 parts in 10,000 calls for a supply of 50 cubic feet per minute under the same conditions. As already stated, the sole object of ventilation was one of dilution, so as to keep the carbon dioxide content and its accompanying products of respiration below a certain percentage. While this has been the accepted theory of the heating engineer and the general public until a comparatively recent date, there has been some doubt among those engaged in laboratory research as to the importance of the chemical purity of the air to the exclusion of its physical characteristics, and it was only with the advent of the air washer that we began to learn of the advantages of air "conditioning."

The perfection of the air washer was the outgrowth of the demand for a filter which would be more effective and more nearly automatic in its action than the older form of dry filter, which were extremely bulky when made of the proper proportions and required frequent removal for cleaning in order to limit the resistance to air flow. While the primary use of the air washer was for the removal of dust and soot from city air, its field was soon extended to air moistening, cooling, and the removal of some of the products of respiration.

Although most of the ventilating systems at the present time are designed along the same general lines as in the past (with the exception of air washing in large city buildings), the *theory* of ventilation, as accepted by many of the leading authorities at home and abroad, has radically changed, the idea being that the physical characteristics of the air we breathe are of much greater importance than chemical purity.

While there are still some who give considerable importance to the chemical theory, a majority of those who have made an exhaustive study of the matter seem to have discarded the older theory and recommend that future development in the design of ventilating equipment be along the line of improvement in temperature and humidity control and in air movement.

Briefly stated, the chemical composition of the air, as regards contamination through respiration under ordinary conditions, is negligible, as compared with the removal of bodily heat and moisture. It will be interesting at this point, before considering the physical effects of air, to examine briefly into the reasons for this change in theory in regard to the chemical characteristics, as related to bodily health and comfort.

In order to show the relative importance of changes in the percentage of oxygen and carbon dioxide in the air for breathing, it is necessary to have a clear understanding of the process of respiration and the changes which take place in the air within the passages of the respiratory tract. At the beginning, it should be clearly understood that the lungs are never filled with *pure* air, even under the most favorable conditions, because breathing is only a frequently repeated slight dilution of the air remaining in the throat and larger bronchial tubes after expiration.

So far as its chemical composition is concerned, this is air which has passed out of the lungs, and after being mixed with a certain proportion of outside air, during the next breath, is again drawn into the lungs as a mixture which does not even remotely approach chemically pure air. This results in making respiration a continuous instead of an intermittent process, and so provides for a constant supply of oxygen which is necessary to the life of the tissues.

Thus we see that any changes in the proportion of oxygen and carbon dioxide, which are likely to occur in the air of a poorly ventilated room, will have no appreciable effect upon the air within the lungs.

As previously stated, pure outside air contains about 21 per cent. of oxygen, and this hardly ever falls below 20 per cent. in the poorest ventilated room. As the air in the lungs contains but 16 per cent. under normal conditions, it is evident that any changes which may take place in the oxygen content of the surrounding air will have but slight effect internally. Furthermore, the supply of oxygen in the lungs is not dependent upon the outside conditions, but is regulated by the amount of carbon dioxide dissolved in the blood, and this, in turn, acts upon certain nerve centres which control the depth and rate of breathing. If the carbon dioxide falls too low, stimulation of the nerve centres ceases, and the process of respiration does not take place until the proper proportion has again been accumulated. The normal proportion of carbon dioxide in the air of the lungs is about 5 per cent., and is kept at this point automatically by the action of respiration. Under these conditions the only effect of breathing in an excess of this gas with the surrounding air is an unnoticeable increase in the action of the lungs through faster and deeper breathing.

Thus we see that the amount of carbon dioxide remaining in the blood depends entirely upon internal conditions rather than external, and is entirely automatic in its action—the rate of ventilation of the lungs being the means by which a proper balance is maintained between the oxygen and carbon dioxide.

It is also evident that our chief safeguard against a want of oxygen by the body tissues is a definite accumulation of carbon dioxide, and this is maintained by rebreathing the "dead-space" air, so called, contained in the throat and larger bronchial tubes.

Besides the necessary reinspiration of the dead-space air, it is also known that one usually takes in again a part of the breath entirely expelled from the body during the preceding expiration. When standing alone in a room a person will rebreathe from 1 to 2 per cent. of the air he has just exhaled. When lying in bed he will rebreathe from 2 to 6 per cent. or more, depending upon his position, and even in the open, if there is a shield to break the wind, a small proportion is taken back with nearly every breath.

While the above seems to prove the fallacy of the older method of reasoning, it is interesting to note the results of certain experiments which have been carried out from time to time. Although a large amount of investigation has been done in this direction, space allows the mention of only a few results.

As far back as 1842 Leblanc found that an animal could survive exposure to atmosphere containing 30 per cent. of carbon dioxide, provided the proportion of oxygen was 70 per cent., and recover quickly from the depression produced by this mixture.

Pettenkofer, in 1849, demonstrated that the symptoms produced in crowded places were due neither to an excess of carbon dioxide nor a deficiency of oxygen. He also found that air containing 1 per cent. (100 parts in 10,000) of carbon dioxide could be breathed for hours without discomfort, and laid down the doctrine, accepted by sanitarians, that the percentage of carbon dioxide was only a guide to the other harmful properties contained in the atmosphere.

Later tests in an English brewery, where carbonic acid gas was compressed and bottled, showed the air of the workroom to contain from 0.14 to 0.93 per cent. of this gas (14 to 93 parts in 10,000). Work was carried on continuously in 12-hour shifts, the men having their meals in the room. Some, it is stated, had followed this employment for eighteen years without detriment to health.

Other experiments have shown that the air may contain from 3 to 4 per cent. (300 to 400 parts in 10,000) of carbon dioxide before increased respiration will be noticed by an individual at rest, but percentages over 1 per cent. (100 parts in 10,000) diminish the power to do muscular work.

The widespread belief in the presence of organic poisons in the expired air is mainly based on the statements of Brown-Sequard and D'Arsonval, and it has been assumed by sanitarians that the carbon dioxide must be kept below 10 parts in 10,000 of air to prevent harmful results from this condition, the percentage of carbon dioxide being taken as an index of their amount.

The evil smell of crowded rooms has long been accepted as proof of the existence of such poisons. As a matter of fact, such odors come from secretions of the skin; from food eaten, such as onions and garlic; decayed teeth; the bad breath of dyspepsia; soiled clothes, etc., etc. While such a mixture of odors is offensive and disgusting, it has been proved to be harmless, so far as its direct effect upon health is concerned.

The theory of Brown-Sequard and D'Arsonval was based on three series of tests, as follows: In the first case, water with which they had repeatedly washed out the air tubes of a dog, was injected into the blood-vessels of a rabbit. In the second, they injected the water condensed from the exhaled breath of a man; and in the third, the water condensed from the breath of a dog. The principal symptoms recorded were dilation of the pupil, acceleration of the heart, and paralysis of the lower limbs. The larger doses caused, as a rule, labored breathing, retching and contracted pupils.

Extensive investigations carried out along this same line more recently have proved this theory at fault and seem to show that the results were due to the injection of comparatively large quantities of water, or to its containing infectious bacteria, rather than to any harmful organic matter.

For example, an experiment was arranged where the breath of one dog was exhaled directly into the lungs of another continuously for nearly seven hours without harmful results.

In other cases the exhaled breath of human beings was condensed, then dried, sterilized, mixed with distilled water, and injected beneath the skin of rabbits and mice. Here, as before, no sign of disturbance was shown. In comparison with this, both rabbits and a puppy were killed by injecting sufficient quantities of pure distilled water.

A considerable portion of the above data has been obtained from the Smithsonian Miscellaneous Collections, Volume 60, No. 23, which gives a large number of other tests along similar lines.

Having shown, in a general way, the course of reasoning followed in discrediting the older theory of ventilation, let us now see what has been advanced to take its place.

More than thirty years ago Hermans suggested that the results of poor ventilation might be due, in some way, to heat rather than the chemical condition of the air, and recent investigations have been carried out along this line.

Experiments show that an ordinary adult will produce, and must be relieved of, sufficient heat in the course of an hour to raise the temperature of 1,000 cubic feet of air 15 or 20 degrees. In addition to this, a considerable amount of moisture is given off, partly by perspiration and partly as vapor in the air exhaled from the lungs.

Unless this heat and moisture are promptly removed the body becomes surrounded by an envelope of stagnant air, having the same effect as an oppressive day in the summer, with a high temperature and excessive humidity.

The remedy for this condition is evidently suitable temperature and humidity regulation and air movement, which combination forms the basis of design for the latest systems of ventilation.

The physiological effect upon the human body of overheating is a derangement of the vaso motor system, that is, the nerves which regulate the circulation through the blood-vessels, other than the action of the heart. For example, a cool wind striking the skin, stimulates, through the sensory nerves, the vaso motor constrictors, which causes the small vessels near the surface to contract and drives the blood deeper in the tissues and so preserves the bodily heat. A warm wind, or other source of external heat, causes the superficial vessels to dilate and draws the blood to the surface, thus cooling it more rapidly and maintaining the normal bodily temperature. Health, and life itself, depend upon a uniform temperature of the blood, the usual sunstroke or heat prostration being the result of a very slight rise in temperature. When the heat regulating functions of the body are interfered with by an envelope of still air, at a high degree of temperature and humidity, the usual discomforts of a sultry day or a badly ventilated room are experienced.

Briefly stated, living beings constantly produce and give off to their surroundings an excess of bodily heat. This heat must be disposed of, and is constantly carried away from the body, partly in the air exhaled from the lungs, but chiefly through the skin by radiation and conduction assisted by the evaporation of perspiration. It is evident that the prompt removal of this heat will depend upon a surrounding atmosphere neither too hot nor too moist, and furthermore, that the process will be hastened if the air is in motion.

Either too high a temperature or too much moisture in the air will retard the cooling of the body, and when these two conditions occur at the same time, as is usually the case in a poorly ventilated room, the result is doubly harmful.

According to this conception, the problem of ventilation is one of physics, and not of chemistry. It seems strange that although more than thirty years have elapsed since this doctrine was first advanced, so little has been known of it outside of laboratories, and that the theory of an excess of carbon dioxide and a mysterious organic poison has prevailed so persistently until the present time.

An interesting coincidence which may be mentioned at this point is, that the usual allowance of 30 cubic feet of air per occupant per minute, based on the amount of dilution to maintain a certain standard of chemical purity, is also the amount of air which is required to remove the heat and moisture given off by one person when introducing it into the room at a temperature 10 degrees less than the room temperature, which is about as low as is possible without causing drafts or chilling the occupants.

This fact is not only of general interest, but serves to show that our modern ventilating systems, while designed upon a wrong assumption, may be made to fulfill the requirements of our later ideas, pending future developments in the way of greater efficiency and effectiveness.

Thus far the new theory of ventilation has been stated as a fact without giving any of the reasons leading up to its adoption.

Investigations in this direction have been under way for a number of years and are quite fully reported in the publication of the Smithsonian Institution previously referred to. Only a few of the simpler experiments will be mentioned in the present article.

In a series of tests at the Institute of Hygiene in Breslau, and reported in 1905, normal individuals were placed in a cabinet of about 80 cubic feet capacity and confined for periods up to five hours until the carbon dioxide rose to 100 to 150 parts in 10,000. No symptoms of illness or discomfort were felt, and the chemical impurity of the air had no effect upon the mental activity of the occupant so long as the temperature and humidity of the air were kept moderately low. Raising the temperature to 75 degrees and the humidity to 89 per cent., with the carbon dioxide at 120 parts in 10,000, caused much discomfort. Breathing outside air through a tube gave no relief under these conditions, while breathing air from the cabinet by those outside caused no discomfort.

Circulating the air within the cabinet, by means of a fan, without changes in temperature, humidity, or chemical composition, removed the disagreeable symptoms experienced by the occupants. When the chamber was cooled to 62 degrees there were no feelings of discomfort, although the carbon dioxide rose to 160 parts in 10,000.

Experiments reported in Bulletin 175, U.S. Department of Agriculture, page 235, show that a man can live many days in a closed calorimeter chamber in comfort, without damage to his health, and having not the slightest knowledge of any defect in ventilation when the carbon dioxide rises to 100 to 200 parts in 10,000, so long as the air in the chamber is kept cool and dry.

Recent investigations have also been carried out along a similar line in the Physiological Laboratory of the London Hospital Medical College with practically the same results.

In this case the chamber was of wood, made airtight with suitable insulation, and equipped with an electric heater, a coil through which cold water could be circulated, humidifying apparatus, and two electric fans for circulating the air within the chamber. Without going into details, the results showed that decreased oxygen and an increase in carbon dioxide up to 200 to 500 parts in 10,000 had little effect upon the pulse, while the temperature and humidity had a profound effect. The feelings of discomfort which were produced depended upon the excessive heat and humidity, and were relieved by cooling and stirring the air by means of the water coil and fans. The carbon dioxide could be suddenly raised to 200 parts in 10,000 without the occupants becoming aware of it. Those outside the chamber could breathe air from within, through a tube, without experiencing any of the discomfort felt by those inside when the temperature and humidity were high, while the breathing of outside air by those within the chamber brought no relief.

A series of tests carried out some time ago by the Chicago Commission of Ventilation seemed to show that there was a temperature and humidity range within which the occupants of a room were comfortable, and this range has given rise to what is called the "comfort zone." This means that there is a maximum temperature with a minimum relative humidity, and a minimum temperature with a corresponding maximum relative humidity, between the limits of which the occupants of a room are comfortable. In other words, there seems to be no *best* temperature or *best* relative humidity; but the maximum temperature at which one is comfortable will be associated with a minimum relative humidity and the minimum temperature for comfort will have associated with it a maximum relative humidity.

Under the conditions of the tests made it was found that a temperature of 64 to 70 degrees with a corresponding relative humidity of 55 to 30 per cent., seemed to be the limit; that is, the comfort zone was between 64 degrees with 55 per cent. humidity, and 70 degrees with 30 per cent. humidity.

We have heard much recently of the necessity of more humidity in the air we breathe, the atmosphere of our dwelling and public buildings being likened to that of an arid desert.

While a certain amount of moisture adds to our comfort, too much is injurious to health, as shown by the experiments just described. Taken alone, a certain degree of humidity does not signify very much, within certain limits, but must be considered in connection with the existing temperature; the combination being what produces comfort or discomfort. It is probably safe to say, where no special provision is made for humidity control, that during the winter our dwellings are too dry and our audience halls and theatres too moist. This is due to the proportion of cubic space per occupant, being large in the former and small in the latter case.

While much has been said of the harmfulness of too dry an atmosphere and its effect upon the mucous membrane of the respiratory passages, there seems to be some reason to doubt that lack of moisture, within practical limits, has any particular effect in this direction.

The membranes of the throat and nose are kept moist by the secretions from certain glands provided for this purpose, and not by the moisture in the air which we inhale. Of course, the drier the air the greater will be the tax upon these glands, but the surfaces themselves will remain moist so long as the function of the glands is not overtaxed. It seems more likely that the sensation of smarting in the throat and nose, which is often experienced in a dry atmosphere, is due to dust rather than a low degree of humidity.

While dry air does not necessarily contain more dust than moist air, a low humidity tends to extract moisture from the floors, furniture, and other objects and thus liberates a certain amount of dust which is readily picked up by the moving air. It is probable that one of the most important beneficial effects of outdoor sleeping is breathing a comparatively dust free air. The relative humidity is higher at night and the amount of dust in the air consequently low.

The most extensive investigations in both theoretical and practical ventilation are being carried out in this country by the Chicago Commission on Ventilation and the New York State Commission on Ventilation.

The former was organized in February, 1910, and has done a large amount of practical work along the line of ventilation as related to schools, churches, theatres, industrial buildings of various kinds, and street cars. The work is carried on partly in laboratories, especially equipped for this purpose, and partly in buildings in actual operation, where tests are conducted under practical working conditions.

The New York Commission was organized in June, 1913, and began its actual work in December of the same year.

The phases of the problem which have been given special study may be classified as follows:

Chemistry of the Air—Oxygen, carbon dioxide, organic matter, odors, ozone.

Air Conditioning—Temperature, humidity, dust.

Mechanics of Ventilation—Air volume, air movement, heating of air, cooling, recirculation, natural and artificial ventilation.

Efficiency of installation and operation. Ventilating apparatus.

The laboratory is equipped with a ventilation chamber having a capacity of 1,150 cubic feet, which is provided with apparatus by which the air of the chamber may be confined and rebreathed, or renewed at any desired rate, may be maintained at any desired temperature and humidity, may be kept quiet or in motion, may be removed, washed and recirculated, and may be given any desired chemical composition.

In this chamber from one to six persons may be confined for any length of time. On certain days they may engage in definite mental tasks, while on other days they perform a definite amount of physical work under a given combination of air conditions. By the quantitative study of a considerable number of bodily functions, such as temperature, sensitiveness of the skin, blood-pressure and pulse rate, respiratory exchange, the production of heat, duration of digestion, various changes in the urine, etc., an endeavor is being made to learn in what respects, if any, the physical and mental efficiency are altered by changes in air conditions.

In addition to laboratory investigations, outside work is being carried on under the direction of members of the laboratory staff.

Addition to Lake Louise C. P. R. Hotel

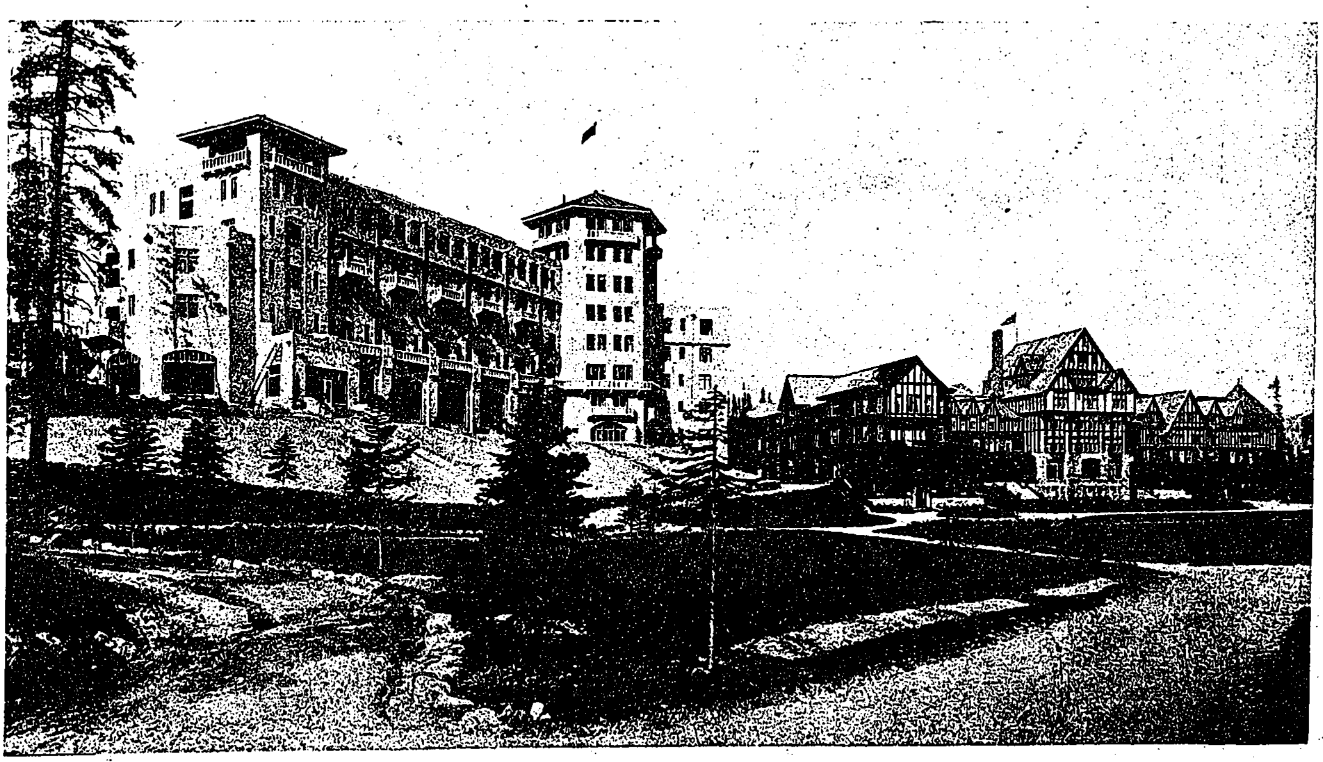
By William Wren Hay (Jr. Eng. Soc. of Canada).

THE Canadian Pacific Railway Co. has completed extensive additions to their hotels at Banff and at Lake Louise, in the Rocky Mountains, one of the structures at Lake Louise involving unusual features of design. The group at Lake Louise provides accommodations for upwards of 400 guests, and by reason of its isolation, has an electric light plant, water supply system, power laundry, central heating plant and septic tanks. It is connected to the main line of the railroad by about 4½ miles of narrow-gauge track, on which are operated gasoline motor cars.

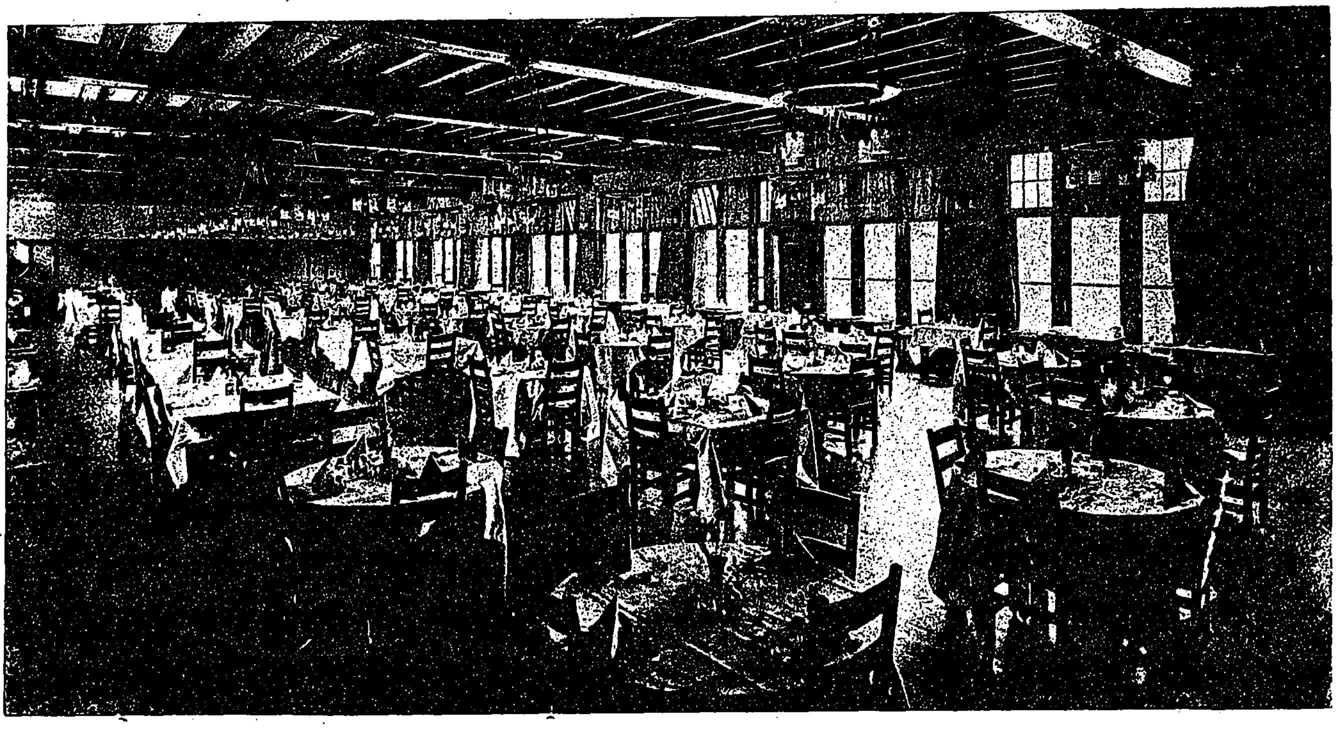
The first Chalet was erected in the early nineties, and was a simple log cabin, used only for private parties, guests of the railway. From time to time additional facilities have been provided, but it was not until 1910 that a definite group was planned, and in the summer of 1911 construction was commenced on the new buildings, and additions and alterations to existing buildings, to provide ultimate accommodations for 500 guests, so that, together with the servants and other employees, the entire plant must take care of at least 750 persons. As the hotel is some distance from any other community, it was necessary to provide for water supply, lighting and other necessities of modern life.

The present group of buildings consists of the original Chalet, which is built of timber, with rooms for 250 persons, and includes the hotel office and lobby, to which is attached the kitchen store room and servants' quarters; a large reinforced concrete wing, on the ground floor of which is a large ballroom, billiard room, ladies' parlor, and public rest rooms, contains 122 bedrooms; three frame annexes, with bedrooms, unit heating plant, septic tank, dining-room and kitchen, with servants' quarters; a laundry and boiler house, with additional servants' quarters in the second storey, and connected with the main groups by a concrete subway; and a group of buildings in the rear housing the livery teams and the ponies.

Each of the three units are the same in plan, having a length of 160 feet, main width of 40 feet, with service wing in the rear, 28 feet by 44 feet. They are all three storeys high, containing 31 bedrooms, and 19 private baths, all rooms along the corridors being intercommunicating through the bathrooms. The exteriors follow certain of the Swiss Chalets, two being alike, with rough cast ground floor and clapboards on the upper storeys; wide, overhanging eaves, and low, shingled roofs; the third has boarded ground floor and rough cast plaster above, with steeper roof slopes, and small turrets at intersections. The interiors are finished much alike, using British Columbia fir panelling and wainscotting, with rough plastered walls and ceilings. In the big lounging room, the trim is all "carded," and the unusual grains to be had in British Columbia fir have been worked into con-



LAKE LOUISE, HOTEL, SHOWING NEW AND OLD WINGS, LAKE LOUISE, ALBERTA.



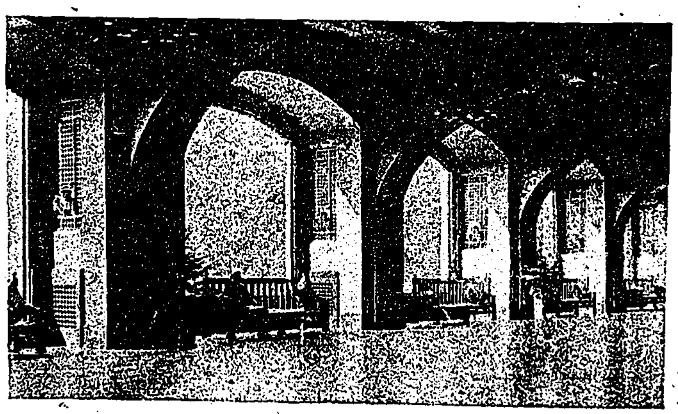
MAIN DINING ROOM IN LAKE LOUISE HOTEL.

ventional patterns for frieze and coffered ceilings. The framing is of ordinary construction, except in the lounging room, where there is a clear span of 24 feet, bridged by two trussed timber beams on four timber columns, and carrying the floor joists and framing for the storeys above. A single corridor runs the length of the building, with a main staircase in the middle, separating the dining-room and lounging-room; and other stairs at either end for use in case of fire.

These units cost about $65,000 apiece, with steam and hot water heating systems, electric lighting, and finish. They have about 230,000 cubic feet of contents, and the cost of 28 cents per cubic foot is about equally divided between labor and materials. The design of these units is such that they can be operated as one, two, or three units at one time, either in connection with the main Chalet, or independently, as for large parties.

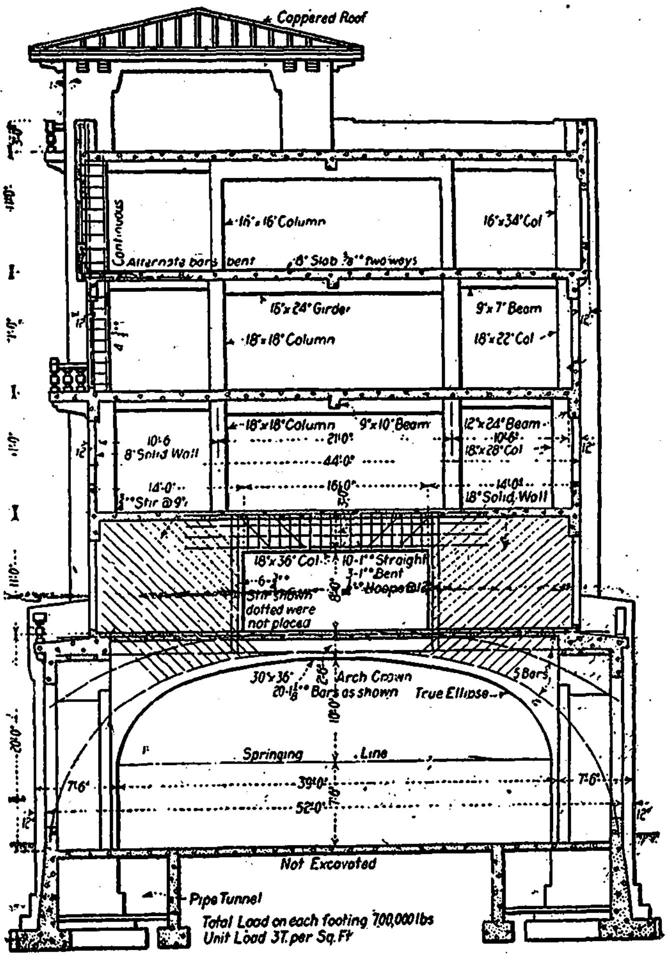
ARCHITECTURAL FEATURES.

The fireproof wing has been erected in accordance with the policy of the hotel management of replacing and adding buildings of fireproof construction throughout. The structure is of reinforced concrete construction, with solid 8-inch exterior walls and terra cotta block partitions. It is approximately 265 feet long on its longitudinal axis, 44 feet wide in the upper storeys, and six storeys high, with an eight-storey tower on the front. The ground floor is devoted entirely to the public. The feature of the building is the ball room, which is about 120 feet long, 43 feet wide, and 20 feet high, occupying the full width of the building without any columns, thus introducing quite a problem in the structural design of the building. The architectural design called for the use of arches across the room, supporting the four bedroom floors above, but the nature of the foundations, part fill and part cut, precluded any such thrust; therefore, a solid 8-inch wall was carried up one storey above the barrel arches across the room, and was designed as a girder having a span of 42 feet, the distance centre to centre of the columns. It was necessary to cut through the wall for the corridor, and in order to have the opening symmetrical, it was made 16 feet wide and 8 feet high. The crown of the architectural arch below was then designed in full tension, the reinforcing bars being carried back into the haunches as for an arch design; while the floor beam over the opening was designed in combined bending and compression. The spacing of beams and arches throughout is 21 feet, dividing the floor areas into square panels, reinforced in two directions. Under ordinary



INTERESTING VIEW OF OPEN VERANDAH.

conditions, there would have been a single row of interior columns down the centre of the building, which would have given beams of the same dimensions throughout, but in order to take the concentrated load off the centre of the top chord of the girder, there are two rows of columns in the centre of the building, spaced 10 feet 6 inches from the centre line. This arrangement required a girder across the corridor to carry the longitudinal beams, and gave very small beams running from the columns to the wall. This idea slightly increased the cost of the concrete formwork. The introduction of the hexagonal tower in the recess formed by the angle in the front wall also complicated the arrangement of the beams. This tower had an inside diameter of 42 feet, and is eight storeys high, with a single column in the centre, floor beams radiating to the six columns of the hexagon. The smoking room occupied the ground floor of this tower, and the floor slab over it is flat; all the other slabs in the tower are triangular in shape, with steel placed in three directions. The tower is 115 feet above the footings, terminating in a peaked roof covered with copper. Beneath the roof there is a water tank of 5,000 gallons capacity, hexagonal in shape and supported upon skeleton beams over the top floor.



CROSS SECTION OF REINFORCED C.P.R. HOTEL AT LAKE LOUISE. SECTION TAKEN CENTRE OF BALL ROOM.

There are four rooms and two baths on each floor of the tower. There is a total of 122 bedrooms, with 102 private baths and eight public toilets.

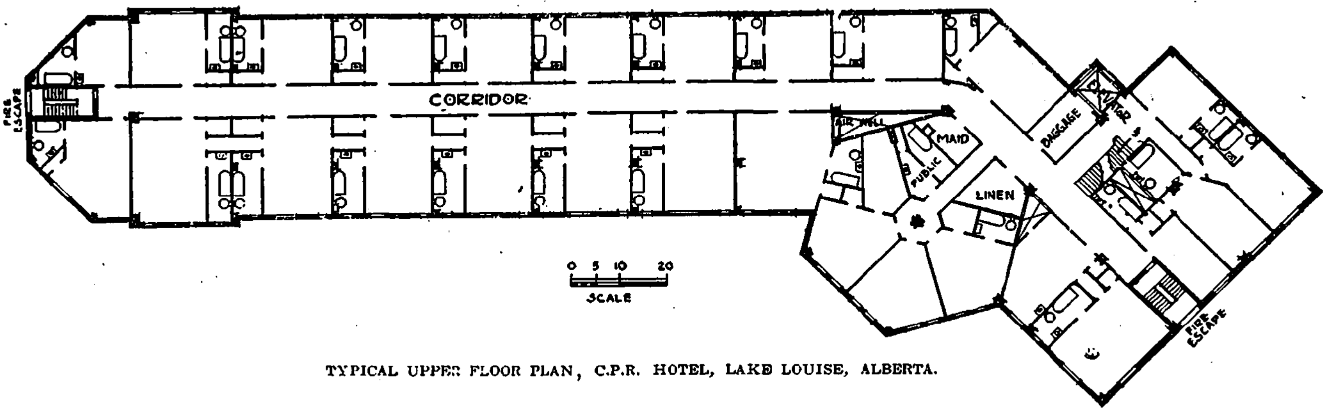
The roof of the main portions of the structure is flat, with a parapet 3 feet high, and the slabs supporting it were designed for a live load of 125 pounds per square foot, or the equivalent of two feet of melted snow and ice. The outside walls of this building are of concrete, 8 inches thick, poured monolithic with the structural concrete, and reinforced inside and out against temperature stresses. They were bush-hammered by hand, to remove projections, and were then painted with a special cement paint, giving a uniform color. The interior partitions are plastered on terra cotta blocks, using a carpet float, and finished with tinted colors. The interior trim is entirely of British Columbia fir. The treatment of the ground floor took full advantage of the concrete construction, all the floors except the dancing floor being of red Welsh quarry tiles, with cement borders. A feature of the large rooms on this floor are the huge fireplaces, built of a true rose quartz quarried at the head of the lake. The cost of the building was $400,000, or about 28 cents per cubic foot.

GENERAL DESIGN FEATURES.

The original buildings had been allowed to encroach upon practically all of the available ground at the outlet of the lake, so that the new wing had to be built into the side of rising ground in order to communicate with the main Chalet, and at the same time face upon the lake. The principal axis of the main group was prolonged for a distance of about 75 feet, where the nature of the ground caused a change of 45 degrees to parallel the hill. The slope of the ground was so steep that to excavate a bench for the foundations, and at the same time cut back to provide light for the rear windows, would have been extravagant. The building was therefore built upon a cut-and-fill bench.

The requirement for a large unobstructed ground floor, without excessive head room, could be met only by the use of an arched ceiling, and the imposed weights of the four floors above rendered the design a difficult problem. It would not have been safe to have designed these arches as such, for the nature of the foundations and the absence of abutments to transfer the horizontal thrust would have invited trouble; nor was it possible to use a deep girder across the building, at least as is ordinarily done, as the headroom was limited by the architectural design and by the rqquirements of the hotel management.

In the design adopted 18-in. walls, pierced to provide the corridor, were built over each arch for the full depth of the bedroom story,

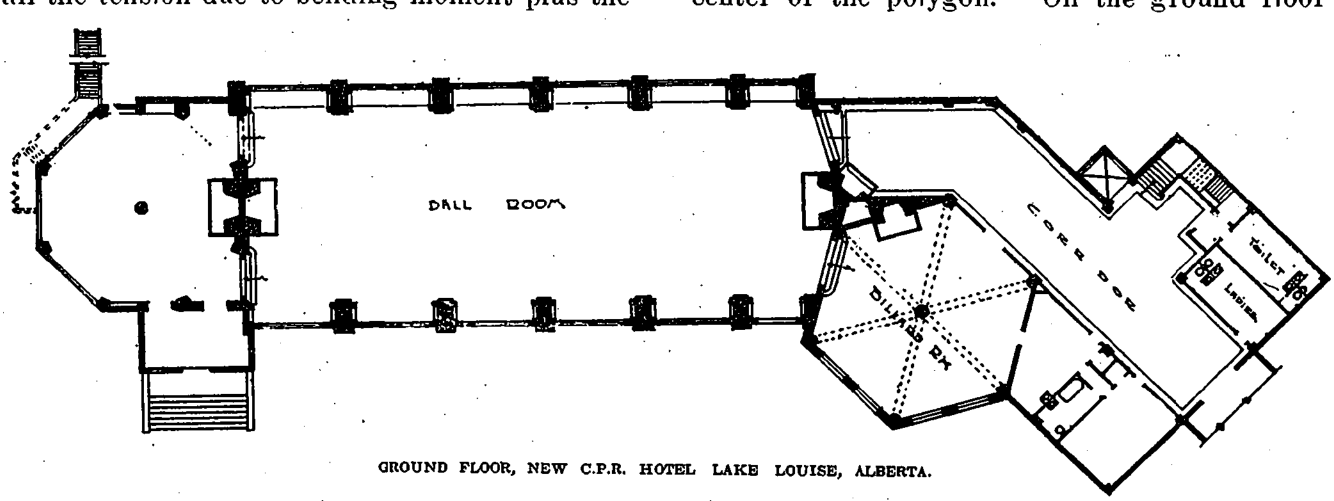


TYPICAL UPPER FLOOR PLAN, C.P.R. HOTEL, LAKE LOUISE, ALBERTA.

and the crown of the arch was designed in tension, while the beam over the corridor was designed in compression, the wall answering for the web of the girder. Except where complicated by the framing of the angles (introduced by a hexagonal tower and by the octagonal terminal at one end), and by a bend in the main axis, the beams and girders were spaced 21 ft. on centers throughout the building with steel in two directions. Over the arches the columns were spaced 10 ft. 6 in. from the main axis, and 21 ft. along the length of the building, bringing the loads from the upper stories onto the wall girder below at such a distance from the center of the span as cleared the opening through the web of the girder and simplified the design of the compression member. Generally, the beams were run around the building, and a single beam was run down the center of the three top slabs, but this center beam was omitted where the load would have come upon the center of the span, and the slab was carried from girder to girder, making the load uniform, rather than concentrated.

When all the loads from the floor above had been determined, together with those from the two floors carried directly across the girder, the girder was designed for bending, as a simple beam of depth equal to the distance from floor to floor plus half the thickness of the arch crown, or 147 in. The crown, which is 36 in. wide and 30 in. thick, was then designed to carry all the tension due to bending moment plus the bending due to the uniform floor load, the reinforcing bars being so placed as to resist any such action that might be developed in the ring. The remainder of the steel was run horizontally to the outside of the building to provide for bond and to assist in taking shear. The upper chord, which is 36 in. deep and 18 in. wide, was designed as a horizontal column subject to direct compression, and also for bending due to the floor loads. Steel was placed as for a hooped column, and additional steel was added for the bending stress, the bars being bent up into the slab to take care of diagonal shear. The diagonal shear in the entire girder was estimated, taking into account the direct loads of the columns and the weight of the girder; and sufficient steel was ordered to take care of the total theoretical shear across a plane at an angle of 45° downward and to the outside from the opening through the web. As actually constructed, none of this steel was placed beyond the bottom of the opening, largely for reasons of a practical nature. The arches were poured some time before the wall was poured, and only such diagonal steel as actually entered the arch ring was placed.

As mentioned before, there is an eight-story tower on the front of the structure, placed in the re-entrant angle formed by the bend in the axis. The tower is hexagonal in shape, with a circumscribed diameter of 56 feet., center to center of columns, and a single column in the center of the polygon. On the ground floor



GROUND FLOOR, NEW C.P.R. HOTEL LAKE LOUISE, ALBERTA.

there is a single room, 11 ft. high, with a flat-slab ceiling, while on the bedroom floors the tower is cut up into small rooms, and beams radiate from the center, forming, with the perimeter beams, triangular slabs which were reinforced in three directions. The roof of this tower has a rise of 14 ft., the beams radiating from the central column to form the hips. In the peak, formed under this roof, is a concrete regulating tank, carried on similar beams placed in a horizontal plane, with a false ceiling. It is interesting to note that the rise of this roof was determined by the architectural requirement that the slope of the roof must be visible from the edge of the lake, 200 ft. lower and less than 500 ft. away. The building terminates in an octagonal tower, 43 ft. in diameter, forming a single room on the ground floor 18 ft. high, with a single column in the center.

Except for the use of the solid exterior walls, the only other unusual feature was an overhang of 12 in. in the top floor—purely an architectural feature. The extremes of temperature are very high in the Rocky Mountains, and the use of the thin walls of solid concrete might be questioned. However, ample protection against temperature stresses has been secured by reinforcing all exposed surfaces with ½ in. square twisted bars, spaced 2 ft. apart horizontally and vertically, and staggered inside and outside the walls. No difficulty has been experienced with cracking, although the total range in temperature has been known to reach 140 F.

LOADS, ALLOWABLE STRESSES AND ASSUMPTIONS

In designing the structure the following values were used: Ratio of moduli, 15; concrete in bending, extreme fiber stress, 700 lb. per square inch; concrete in compression, 500 lb. per sq. inch.

The five loads assumed were 60 lb. per square foot for the bedroom floors and 125 lb. per square foot for the roof. There is a 3-ft. parapet surrounding the roof, and the assumption was made that there might be as much as 2 ft. of water behind this parapet, as the snowfall in this region is normally 10 to 14 ft. per year; the equivalent of 24 feet of snow therefore does not seem excessive.

In general, the columns are of the hooped type, with 1½ to 2 per cent, of longitudinal steel; those in the ground floor have spiral reinforcement in addition. All beams were figured for diagonal shear, and vertical stirrups were added to the bent bars, as the design and other conditions warranted. The transverse beams across the middle of the building were considered as partially continuous, and the longitudinal beams down the center of the structure, with the exception of the end spans, were figured as continuous.

The progress of the work was rendered extremely difficult by the isolation of the structure, and by the condition that the heaviest work had to be carried on during winter weather. The hotel was in use from the commencement of mild weather in the spring until the late fall, and construction was not allowed to proceed during this time. In addition, materials had to be freighted up from the railroad by teams, as the connecting narrow-gauge railway was not in operation at the time. It was particularly difficult to secure a sufficient supply of gravel to enable continuous progress, as the only available deposits were subject to freezing during the winter.

High School Science Department

(*Continued from page 345.*)

cases is needed for valuable chemistry and physics apparatus, and this should be located adjacent to the lecture room and laboratories. A few schools go so far as to provide a straight railway track the entire length of the science department, so that a table may be arranged for a lecture and then wheeled directly in; but this requirement is one which but seldom confronts the architect.

THE PHYSICS LABORATORY.

The physics laboratory requires room for six strong tables, each 4 by 6 feet, giving space at each for four pupils to work, and fitted with gas, electric current, compressed air, etc., as in the chemistry laboratory. Wall tables are located around the room on sides where there are windows. They are equipped with gas, electric current, and cold water supplies and drains. In order to save space movable copper sinks are made and arranged to fit into the holes leading to the drains. When not required they may be removed, allowing use of the bench for other purposes. Instead of double tables the "one-way" system is sometimes installed also in physics laboratories, allowing all pupils to face the front of the room, with corresponding gain in efficiency.

Another system sometimes adopted is to equip the physics laboratory with tables of ordinary height (30 inches), arranged in U-shape, at which pupils may sit in common chairs. These tables have gas and electric outlets, but no high cross bars. Rooms so arranged have a very attractive appearance.

The biological laboratory is often equipped with low, glass topped tables seating two pupils each, some built-in glass cases and drawers, an aquarium, and a large marble sink in two depths. The room may well have a southern aspect, and be equipped with a small conservatory for the observation of growing plants. A demonstration desk fitted up similarly to one for chemistry is sometimes, but not often, provided.

May Eliminate Mechanical Ventilation In New York Schools

At periodic intervals the exponents of open-window ventilation obtain the front of the stage to proclaim that the present-day method of ventilating buildings by mechanical means is not sufficiently superior to the open-window method to warrant the outlay for the elaborate systems usually installed.

The latest "bombshell" of this sort has been thrown by the New York City Department of Health. In a letter addressed to the New York City Department of Education attention is called to some recent tests of school buildings, some of which were mechanically ventilated and some ventilated only by opening the windows, which apparently show that the prevalence of respiratory diseases is lower when the open-window method is used. The letter concludes with the statement that these tests indicate that it is not necessary for the Department of Education to plan for mechanical ventilating systems in its proposed new school buildings.

While no school construction is contemplated for the present in New York City, plans have been, or are being drawn for a number of schools, so that the matter is one that requires an early decision.

In view of the possible consequences of such a step, which would involve the flashing of the word throughout the country and abroad that New York City had abandoned mechanical ventilation for its schools, the action of the New York Health Board is recognized as sufficiently serious to engage the attention of the Heating Engineers' Society, acting, for the time being, through the New York Chapter of the society.

On the call of President P. H. Seward, of the New York Chapter, a meeting of the chapter's officers and others was held September 13 at the society's headquarters, which resulted in the appointment of a committee "to investigate and report upon proper methods of ventilation of classrooms of schools."

THE TESTS IN QUESTION.

Due to the importance which has been assigned by the Department of Health to the tests referred to, it will be interesting to recall their principal features. They were made in 1916 by the Bureau of Child Hygiene, Department of Health of New York, in co-operation with the New York State Commission on Ventilation. The commission had full control of the selection of classrooms with reference to the type of ventilation to be included, the preparation of forms for recording observations relating to ventilation, the supervision of methods used in obtaining all data concerning ventilation and the final checking up and analysis of the data on ventilation. The Bureau of Child Hygiene had supervision of all other details of the plan.

The inquiry consisted of two complete studies. The first period lasted from February 19, 1916, to April 8, 1916. The second study began November 4, 1916, and extended to January 27, 1917. In 1916 eight schools were studied, and in 1916-1917 twelve schools were selected. For the study of 1916, 2,541 children were under observation, and for the 1916-1917 study 2,992 children were observed. Eighty-six per cent. were from eight to eleven years old. The children were grouped in 58 classrooms in 1916 and in 76 classrooms in the study of 1916-1917. They were of the same age in both studies, from the same localities and of the same nationalities, but an entirely different group were studied each time.

THREE TYPES OF VENTILATION USED.

It was decided that three types of ventilation should form the basis of the study:

1. Type A. These were the so-called cold, open-window classrooms, ventilated by natural means. It was the desire to have the temperature kept at 50 degrees F. This, however, was found to be impossible, owing to variations in the weather, and it therefore ranged from 50 to 60 degrees, and occasionally higher.

2. Type B. These were moderate-temperature classrooms, kept between 60 and 70 degrees F., averaging about 68 degrees F. Ventilation was wholly by open windows. Some rooms had gravity exhaust ducts, while others did not. Window deflectors were used in only one room in the 1916 study, while in the 1916-1917 study window deflectors were installed and used in all rooms.

3. Type C. These rooms were of the same moderate temperature as in Type B, that is, averaging 68 degrees F. Ventilation of the classrooms was by the plenum fan system installed in the buildings, the windows in these classrooms being kept closed.

Records were made by a corps of nurses at each school session of absences from all causes, absences from sickness other than respiratory, absences due to respiratory sickness, respiratory sickness occurring among pupils in attendance at school, temperature of classrooms at each school session, humidity of classrooms at each school session, and sensations of observers at each school session as to temperature, moisture, odor and air motion in the classroom. The record of air conditions was made at eleven o'clock each morning and each afternoon at the end of the period of study immediately before aerating the room for the recreation period. All data were recorded under the items of odor, temperature, moisture, air motion, and air vents. The temperature was taken with the dry and wet bulb, with the sling psychrometer in the centre of the room, about 3 to 4 feet from the floor, and the humidity was computed therefrom by standard methods.

There were 197,977 pupil session units in the 1916 study, and 317,881 pupil session units in the study of 1916-1917. The data obtained showed that there were 506 more pupil session absences due to respiratory sickness in Type C (the mechanically-ventilated classrooms at 68 degrees) than in Type B (the open-window classrooms at 68 degrees), and 983 more pupil session absences due to respiratory sickness in Type C than in Type A (the open-window classrooms at 50 degrees). Also, there were 7,257 more pupil sessions of respiratory illness occurring in pupils in attendance at school in Type C (the mechanically-ventilated classrooms at 68 degrees) than in Type A (the open-window classrooms at 50 degrees) and 9,170 more in Type C than in Type B (the open-window classrooms at 68 degrees).

It was also shown by the data that in absences from school of children who are ill with respiratory diseases, Type C (the mechanically-ventilated classrooms at 68 degrees) has the highest percentage in both studies. Types A and B (the open-window classrooms show variation, but in both instances are distinctly lower than in Type C.

The respiratory illness among pupils in attendance at school was found to be higher among the children of the Type A (open-window classrooms at 50 degrees) than in Type B (open-window classrooms at 68 degrees), while both remain lower than in Type C (mechanically-ventilated classrooms at 68 degrees). As an explanation of the excess of respiratory sickness in Type A over Type B, attention is called to the factor of temperature of 50 degrees in Type A and 68 degrees in Type B. In this study the children under observation wore only their ordinary clothing, no extra wraps being provided. Both of these types were open-window classrooms, the essential difference being in the temperature.

Based on these and other data obtained in the investigation the Bureau of Child Hygiene reached the following conclusions:

1. In the closed-window, mechanically-ventilated type of classroom kept at a temperature of about 68 degrees F. the rate of absences from respiratory diseases were 32 per cent. higher than in the open-window, naturally-ventilated type of classroom kept at the same temperature (about 68 degrees F., and about 40 per cent. higher than in the open-window, naturally-ventilated type of classroom kept at a temperature of about 50 degrees F.

2. In the closed-window, mechanically-ventilated type of classroom kept at a temperature of about 68 degrees F. the rate of respiratory diseases occurring among pupils in attendance was 98 per cent. higher than in the open-window naturally-ventilated type of classroom kept at the same temperature (about 68 degrees F.) and about 70 per cent. higher than in the open-window naturally-ventilated type of classroom, kept at a temperature of about 50 degrees.

3. It was found in this investigation that the relative humidity of classrooms, whether ventilated by natural or mechanical means, was not a causative factor in the occurrence of respiratory illness among school children.

4. It was found in this investigation that the occurrence of respiratory diseases among school children was not influenced by sex.

The tests here described were made the subject of a paper by S. Josephine Baker, M.D., director of the Bureau of Child Hygiene, and presented before the Sociological Section of the American Public Health Association at Washington, in October, 1917. The paper has now been reprinted by the New York City Department of Health as No. 68 of its "reprint series."

COMMENTS ON TESTS.

In discussing some of the features of these tests, Perry West calls attention to the fact that classrooms with mechanical ventilation and consequently more or less air motion are compared with those of the same temperature having open-window ventilation, and presumably less air motion. "We would naturally expect," he states, "poorer results from the mechanically-ventilated rooms under these circumstances, even with the same percentage of relative humidity. It is not stated, however, whether or not the same amount of relative humidity was carried, and if no moisture was added in either case, the mechanically-ventilated room would naturally be much drier, due to the more rapid air change and less opportunity to absorb moisture from the pupils.

"In the second place, open windows at 50 degrees F. are compared with a mechanically-ventilated room at 68 degrees, which is, without question, a futile comparison, as either type of room would naturally be more healthful at 50 degrees than at 68 degrees. In neither case is the temperature of the incoming air taken into consideration. This initial temperature has a marked influence on the relative humidity of the air in certain parts of the room, compared with the average humidity of the entire room.

Dominion Astrophysical Observatory at Victoria, B. C.

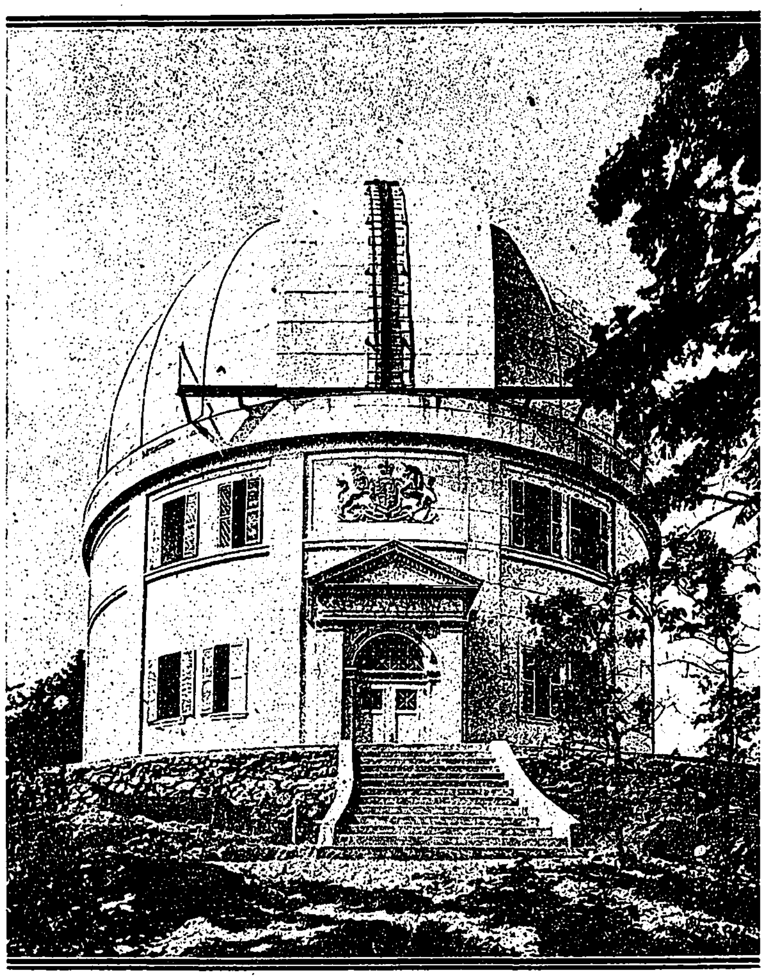
By J. S. Plaskett, Director, Victoria, B.C.

THE cause of astronomy in Canada has been markedly advanced by the completion of the 72-inch reflecting telescope at the Dominion Astrophysical Observatory at Victoria, B.C. By the construction of this splendid instrument, the second largest in the world, the Government has shown great progressiveness and enterprise in advancing science. This institution, with the well-known work of the Dominion Astronomical Observatory at Ottawa, will place Canada in the forefront among the nations in astronomical research, as no other national observatory has a telescope of half the aperture of the mammoth instrument at Victoria.

The project was first brought to the attention of the Government in 1911, and then again in 1912 by memorials from scientific societies, but it was not until the spring of 1913 that the Hon. Dr. W. J. Roche, Minister of the Interior, who has sympathetically supported the enterprise from the first, authorized enquiries and the calling for tenders for 60-inch and 72-inch reflecting telescopes. Contracts for the construction of a 72-inch reflecting telescope were let to the John A. Brashear Co. for the optical parts, and to the Warner & Swasey Co. for the mechanical parts, in the fall of 1913. These firms are probably the most favorably known in the world in their particular lines, and have produced a superb instrument, which is now engaged in regular astronomical work, and fully meeting all expectations.

This great telescope differs entirely from the layman's idea of such an instrument, which he conceives as a nicely mounted brass telescoping tube, with a lens at the outer end and an eyepiece at the inner. Such telescopes and the larger ones of the same type mounted at most observatories are refracting telescopes, in which the light coming from the star or other object at the outer end forms an image of the object at the inner end, a real image similar to that formed on the ground glass of a camera, and this image is magnified by the eyepiece, or ocular, as it is technically called. In the reflecting telescope the outer or upper end of the tube is open, and a concave mirror is placed at the lower end, which reflects the light back to the upper end, forming an image of the star there, where it can be magnified by the eyepiece as in the reflector.

For many years most observatories were supplied with refracting telescopes, which are slightly more convenient to operate, and are more suitable for the visual observations, which in the nineteenth century formed the major part of astronomical work.

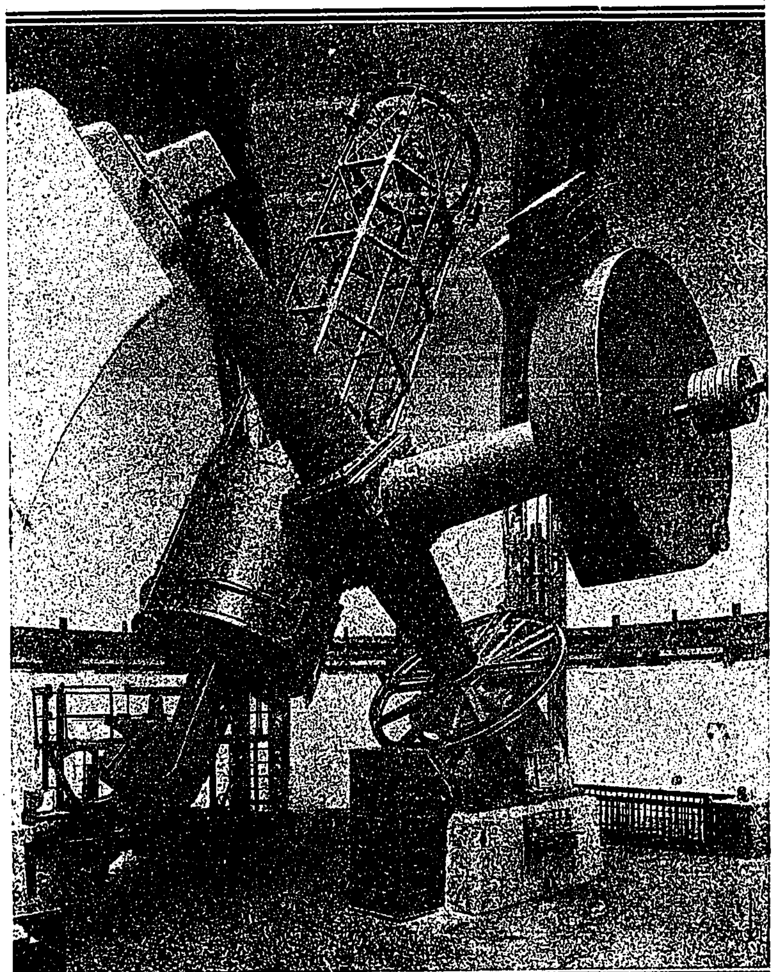


THE BRITISH COLUMBIA OBSERVATORY IS CIRCULAR, 66 FEET IN DIAMETER AND SURMOUNTED BY A REVOLVING DOME. IT IS ENTIRELY OF STEEL CONSTRUCTION.

The application of photography to astronomy, for which visual telescopes are not suited, and in which the reflector offers marked advantages, led to the greater use of reflectors, and this change was hastened by the practical impossibility of obtaining the large pieces of glass required for large lenses. The 40-inch Yerkes refractor, completed about 1895, the largest refractor in the world, was the last very large refracting telescope to be built. The change to the reflecting type was accelerated by the fact that a reflector with its dome can be built for about a quarter the cost of a refractor of the same aperture.

Hence, when the Dominion Government decided to obtain a large telescope, only the reflecting type was considered, and the aperture of 72 inches was considered about the useful practical limit. There were reflectors of 36 inches at several observatories, and a very successful one of 60 inches at Mt. Wilson, California. There was also at the latter place a reflector of 100 inches aperture under construction, but the material of the mirror was defective, and no better could be obtained. This instrument has since been completed, but the Dominion telescope was regularly employed in actual observing before the 100-inch.

In the 72-inch reflector, the principal optical part is the large mirror, which is 73 inches in diameter, 12 inches thick at the edge, 11-1/10 at the centre, with a central hole 10 inches in diameter. It is constructed of a kind of plate glass, and, as the upper surface only is finished accurately and has a bright coat of silver deposited chemically on it, so that the light does not enter or go through the glass, as in a refractor, it is evident, so long as this surface is perfect, that a few bubbles or other defects in the interior, which would be fatal in a lens, do not matter. This particular mirror, however, has very few such defects, and is a beautiful example of the glass makers' art. It was cast at Charleroi, in Belgium, in the spring of 1914, and shipped from Antwerp only three or four days before war was declared. It was ground and polished by the John A. Brashear Co., the most noted opticians in America, if not in the world. The extreme accuracy required in the reflecting surface can be realized when it is said that it must nowhere deviate over the whole 72-inch concave surface more than one two-hundred-thousandth of an inch from the true theoretical form. It is this accuracy, which is twenty times beyond mechanical methods of measurement, and is tested by an optical method, which explains the high cost and the long time required to obtain high grade lenses and mirrors.



THE 72-INCH REFLECTING TELESCOPE, THE TUBE OF WHICH WEIGHS 15 TONS, WHILE THE SKELETON UPPER SECTION IS 23 FEET LONG AND WEIGHS 2 TONS.

This mirror, which weighs 4,340 pounds, is mounted in the lower section of the tube of the telescope, seen to the left of the photograph. This section, which is a steel casting 7 ft. 6 in. in diameter and 1 ft. 6 in. deep, is arranged to support the mirror flexibly without strain, and yet invariably in position, and weighs nearly four tons, so that mirror and cell weigh six tons. The flange of this cell is bolted to a corresponding flange on the central section of the tube, also a steel casting of the same diameter and 6-ft. high, weighing seven tons. The upper section of the tube of skeleton form is built up of structural steel, is of exceedingly rigid and light construction, is 23 ft. long, and weighs two tons.

The light from the star or other object at which the telescope is pointed enters the tube and falls on the silvered concave surface of the big mirror. It is reflected upwards in a converging beam and forms an image of the object at the centre of the circular member, held centrally at the upper end of the tube by thin perforated webs, which being placed edgewise obstruct very little light. This image can be observed here by an auxiliary telescope reflecting it to the side of the tube, or, as is its chief purpose, can be photographed on a plate placed in a suitable holder at this point. Such observations are made at what is called the principal focus.

AN ALTERNATIVE METHOD.

An alternative method of using the telescope is to attach to the circular member a flat mirror about 20 inches in diameter, mounted diagonally about 4 feet down the tube. This reflects the beam to the side of the tube, where it can be conveniently observed with an eyepiece and directly photographed as before. The instrument arranged thus is called a Newtonian telescope.

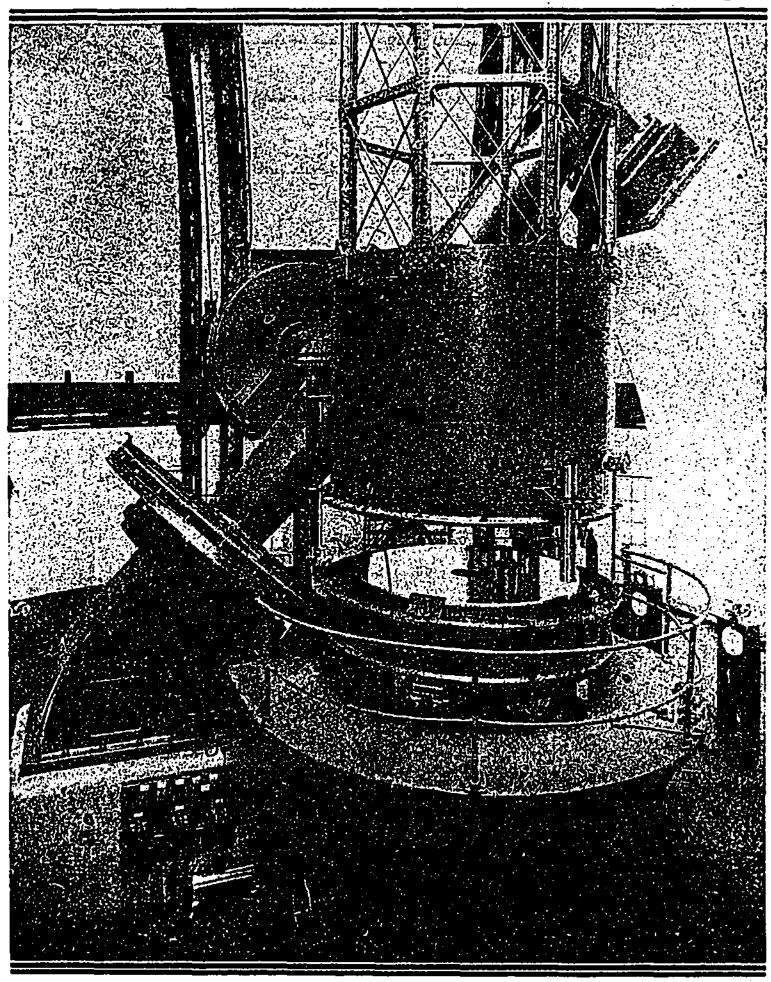
A third method, and the form in which the telescope will mostly be used, is the Cassegrain, in which a convex mirror, 20 inches in diameter, attached to the same circular member, and held about 7 feet down in the tube, reflects the light from the main mirror back again through its central hole and forms the image of the object pointed at about a foot below the mirror cell. Here it can be viewed by an eyepiece or photographed, but will in general be analyzed by the spectroscope, which is seen attached below the mirror cell at the bottom of the tube. The spectrum of the star is formed and photographed by the spectroscope, and from this spectrum can be determined, not only the elements present in the atmosphere of the star and its temperature and pressure, but also the velocity with which it is moving towards or from us, and, as a development of the last year or so, its distance. The spectroscope is probably the most wonderful instrument of research ever devised, as, by the character of the light from any body, no matter how distant, such marvellous knowledge can be obtained, and the telescope will mostly be used with this attachment.

The tube of the telescope weighs 15 tons, and this great weight is necessary in order that it may be sufficiently rigid to maintain the optical parts in their correct relative positions. At the same time, they, and the tube in which they are held, must be so mounted as to enable them to be readily pointed to any desired object in the sky and then to accurately follow its motion across the sky.

This is effected by attaching the tube to a cross shaft, passing horizontally to the right in the photograph, called the declination axis, which is 14 feet long, 16 inches in diameter and weighs over five tons. This axis ends in the weights shown, which balance the telescope on the polar axis, the large, inclined built-up shaft, running diagonally across the photograph and resting in bearings on the two piers. Motors and gearing for moving the declination axis and tube are contained in the large circular housing to the right.

The polar axis, so called because it is adjusted parallel to the earth's axis, is built up of three steel castings bolted together, and is 23 feet long, weighing nearly 10 tons. It carries tube, declination axis, housings and mechanism in ball-bearings on the north and south piers, the total weight of the moving parts being 45 tons, and is also moved by motors for setting the telescope to any desired object. In addition to such comparatively rapid movement, it is driven by a very accurate governor mechanism, called the driving clock, at the rate of one revolution every twenty-four hours on the polar axis. This revolution at the same rate and in an opposite direction and on a parallel axis to the earth, counteracts the effects of the earth's revolution, and enables the telescope to accurately follow the apparent motion of the stars across the sky.

All this mechanism has to move the enormous mass of the telescope with the greatest smoothness and accuracy, and requires the greatest perfection of workmanship. It is a masterpiece of the mechanician's art, and forms a marked advance, not only in size, but in design, quality of workmanship, accuracy and convenience of operation, with, at the same time, relative simplicity of construction, over any previously built. The builders of the mechanical parts of the telescope and of the dome were the Warner & Swasey Co., who have made the mountings for the Yerkes 40-inch, the Lick 36-inch, and



THIS MIRROR WEIGHS 4,340 POUNDS. ITS DIAMETER IS 73 INCHES AND IT IS 12 INCHES THICK AT THE EDGE. THE HOLE NOTICED IN THE CENTRE IS 10 INCHES IN DIAMETER.

(*Concluded on page* 368.)

CONSTRUCTION

A · JOURNAL · FOR · THE ARCHITECTURAL ENGINEERING · AND · CONTRACTING INTERESTS · OF · CANADA

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Better Prospects for Building

War-time restrictions will now release materials to their former uses. Consequently steel and other products required for building will become more available with the result that a resumption of work on a large number of suspended projects can be looked for, in addition to the erection of an increasing amount of newly planned work.

The feeling of optimism based on the recent turn of affairs not only warrant this assumption, but there are certain definite signs which point to an early return to former conditions. A hurried survey of the field already reveals a state of preliminary activity in many of the architectural offices. In a number of cases there is a demand for the services of competent draughtsmen, which indicates that the planning of new structures has arrived at a stage which practically assures early developments.

Among deferred projects in Toronto alone are a modern departmental store and large mail order house, each running into the millions, which will now undoubtedly go ahead. In fact almost every city or town of prominence in the Dominion has its quota of postponed and after-the-war work which under the influence of peace will materialize to a very large extent. Hardly a community exists but what has outgrown its school accommodations and will require new buildings. The housing problem will also likely be given more direct consideration. Moderate price dwellings are badly needed, while owners contemplating better residential work which has been deferred out of deference to the war sentiment, will now proceed to build. There are also a large number of churches for which funds are available and which in a number of cases have their basements completed, to be started and brought to completion.

Labor will also be easier to obtain, as a percentage of men released from munition work and returning from overseas will again take up the building trades and help the situation along. Prices, however, will probably remain as they are for some time, probably permanently, but this will not be such a deterring factor as heretofore. It is now more or less generally accepted that wages will stay pretty close to where they are, in which event the manufacturer and supply dealer will have to hold to present prices. The dollar has apparently taken on a new standard of value, and reconciled to this new condition owners who are going to build will no longer hold back proposed work.

At the very least there is much to look forward to. Of course getting back to a pre-wartime basis is going to be a gradual process, but the prospects are such as to justify the prediction that building work at any rate will increase steadily in volume, and that with the opening of the Spring season a vastly improved condition will exist.

U.S. Building Restriction Removed

All restrictions on non-war construction throughout the United States have now been officially removed. According to the U.S. Official Bulletin, formal notice to this effect has been telegraphed to the chairmen of all the State Councils of Defence by D. R. McLennan, chief of the non-war construction section of the War Industries Board.

The action taken permits all building operations of whatever character, held up in the interest of the war programme, to proceed. No further permits will be required from the War Industries Board or the State Councils, through whom control over the situation in each State was maintained.

Dominion Astrophysical Observatory

(*Continued from page 366.*)

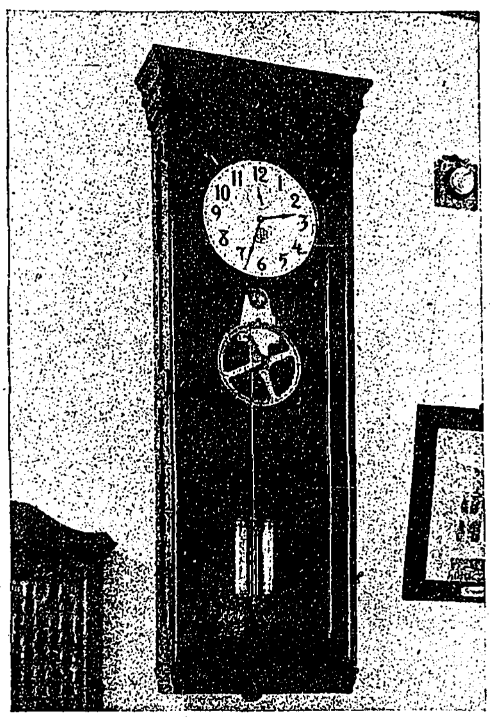
many other of the largest telescopes of the United States.

The building in which the telescope is housed is circular, sixty-six feet in diameter, surmounted by a revolving dome. It is built entirely of steel, and has a double steel covering, with provision for circulation of air between the walls from the ground up to louvres at the top of the dome. This is to prevent the building from getting overheated during the day and to enable it to quickly take the temperature of the air, both essential conditions for the satisfactory working of such a large instrument. The dome, as well as the telescope, though not the largest, is the most complete in all mechanical details of any before built. It is of hemispherical shape, provided with a double shutter to be opened during observing, sixteen feet wide and extending beyond the top. A movable platform raised and lowered by an electric motor, across the shutter opening enables the observer to conveniently reach the top of the tube when the principal focus or Newtonian focus methods are being used. Movable canvas curtains electrically operated move up from the bottom and down from the top so as to limit the length of the opening to prevent the wind shaking the telescope tube. The whole dome is revolved by a motor operated by a switch on the same boards from which the telescope is set. Indeed everything that could be thought of to facilitate the work of the telescope has been placed in dome and mounting, and use has demonstrated the completeness and perfection of the whole equipment.

The equipping of this observatory in such a splendid manner places Canada in the forefront among the nations in astronomical research, as no other country has in its national observatory a telescope of half the size of this splendid instrument. The work accomplished with this installation in its splendid location will undoubtedly materially help towards the solution of the problems of the constitution of the universe, and will make Canada and Victoria well known in the scientific world.

LONDON TECHNICAL SCHOOL CLOCK SYSTEM.

The clock system installed in the new Technical School, at London, Ont., is the most modern installation of electric clocks and automatic bell ringing systems in Canada. The



Type of Master Clock used in connection with Time Regulating System in London (Ont.) Technical and Art School.

entire system is a Canadian product, manufactured by the International Business Machines Co. of Toronto.

It consists of a self-winding master clock, forty secondary clocks, bell ringing programme, switch-board and distribution panel; storage battery, etc. The system is entirely operated by the master clock automatically; it winds itself every minute, which gives a uniform power all the time, every minute it transmits a weak impulse to the switch-board which in turn distributes a stronger electrical impulse to the secondary clocks located in the different class rooms. The master clock is of the dead beat Graham escapement type, with a compensation pendulum composed of a nickeled steel pendulum rod and two cut glass jars full of mercury, which will keep time within two seconds per month irrespective of a sudden change of temperature. This degree of precision transmits a degree of accuracy to all the units connected to the system.

CIRCULAR HOUSING PLAN

"Construction" desires to give credit to the "Canadian Engineer" for the main features of the text appearing in Mr. G. J. Lamb's article published in the September issue under the above title. The subject, which is a most interesting one, and has caused considerable discussion, deals with a housing scheme claiming special economic and engineering advantages, whereby a number of houses are grouped in a circular plan which can be adapted to rectangular city blocks.

CONTRACTORS and SUB-CONTRACTORS

TECHNICAL AND ART SCHOOL, LONDON, ONT.

General Contractors, John Putherbough.
Blackboards, Walter Scott.
Boilers, E. Leonard & Son.
Brick Contractors, John Putherbough.
Brick Exterior, Don Valley Brick Co.
Brick Interior, Inter-Provincial Brick Co.
Brick, Glazed, Stark Brick Co.
Carpenter, Samuel Willis.
Clocks, International Business Machines Company, Ltd.
Doors, William Geary & Son.
Electrical Contractors, Benson & Wilcox.
Electrical Conduits, Orpen Conduit Co.
Electrical Panel Boards, Crouse-Hinds Co.
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Plumbing Fixtures, Twyford & Co.
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Roofing Contractor, Walter Scott. "Barrett Specification."
Seating and Stools, Owen Sound Chair Co.
Stone Contractor, A. E. Mobbs & Co. "Ohio Sandstone."
Telephone Equipment, Northern Electric.
Ventilating System, Canadian Blower and Forge Co.
Woodworking Machinery, Cowan Mfg. Co.
Desks, George M. Hendry Co.. Canadian Office and School Furniture Co.
Electric Fixture, McDonald & Willson.
Steel Sash, Trusted Concrete Steel Co.
Tile and Terazzo, Italian Marble and Mosaic Co.