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ROYAL BANK BUILDING
TORONTO

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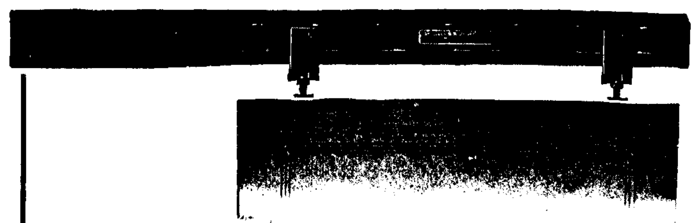

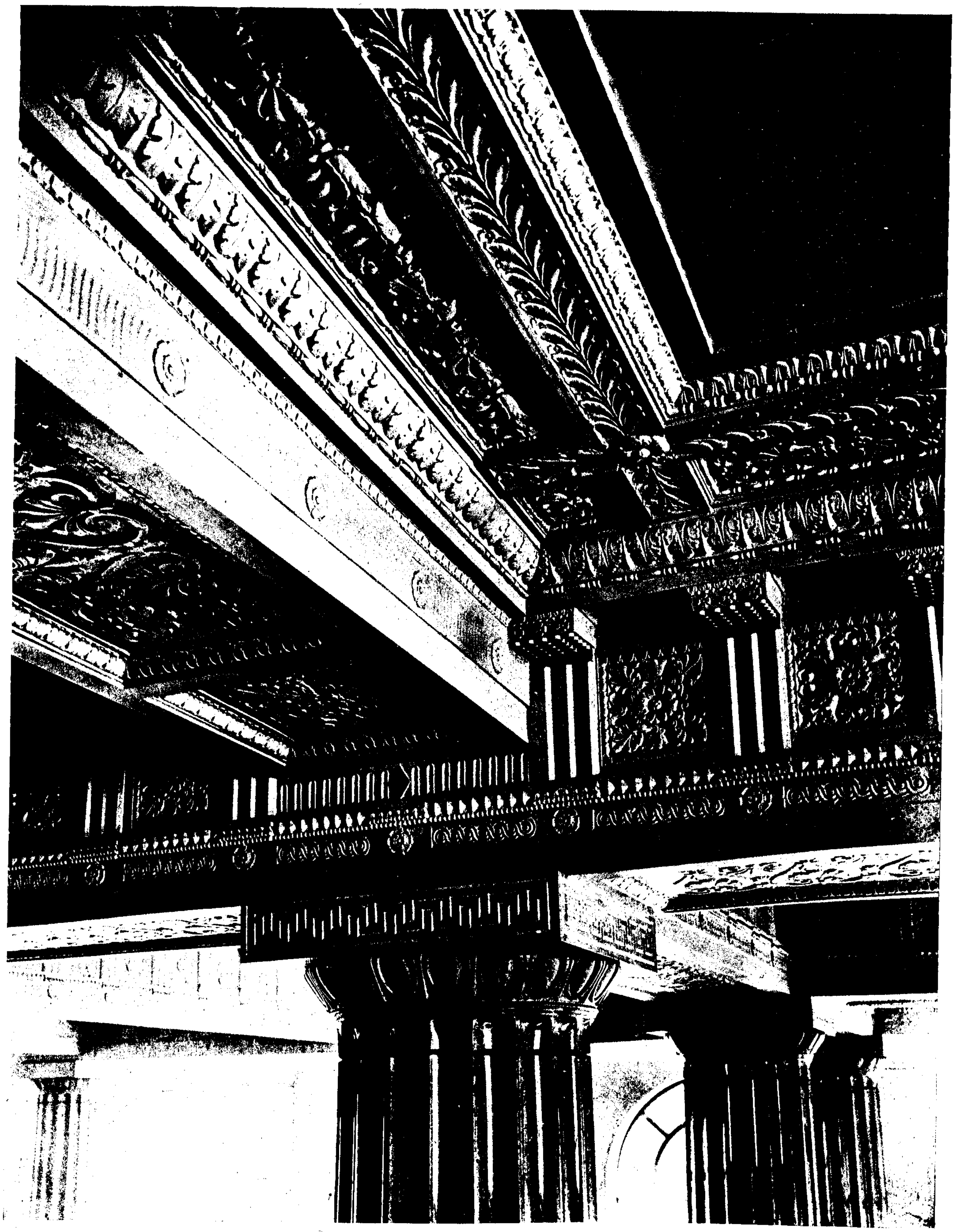

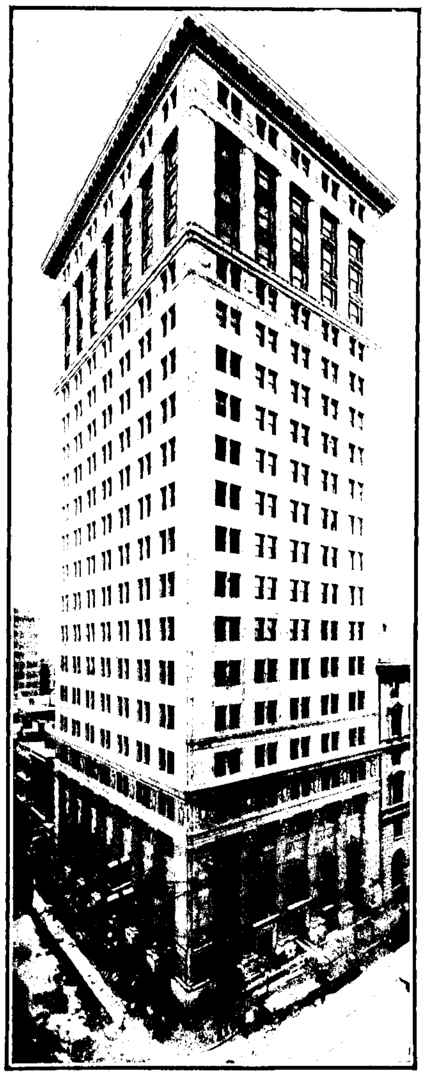

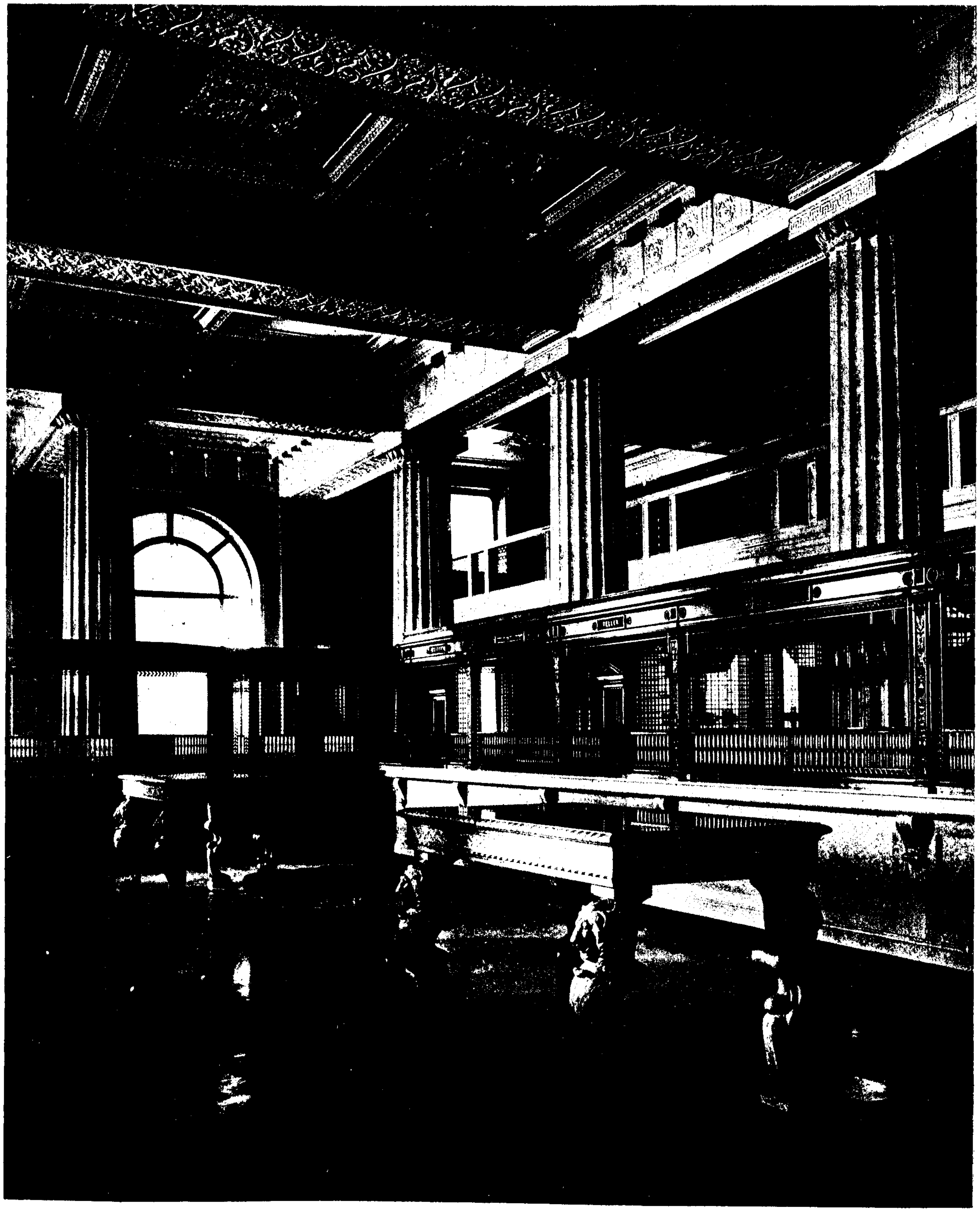

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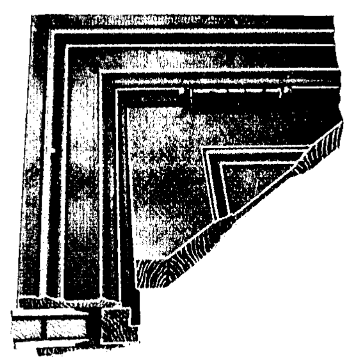

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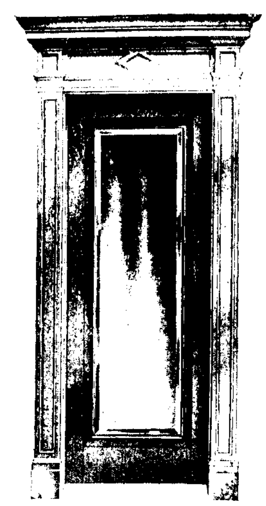

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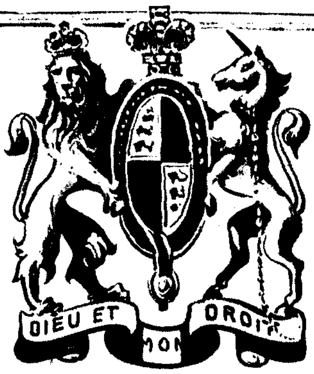

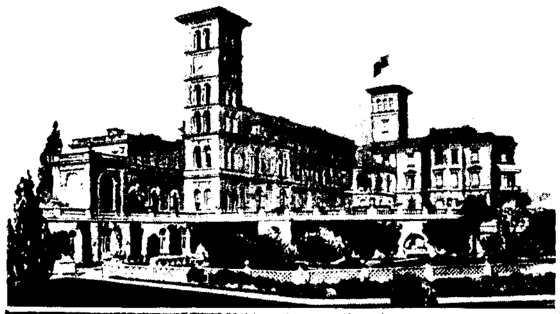

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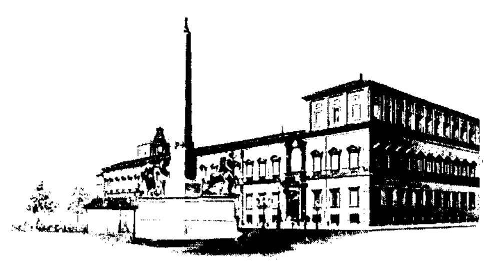

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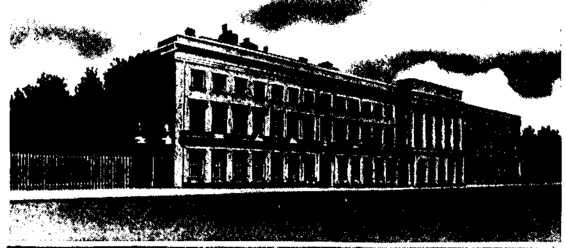
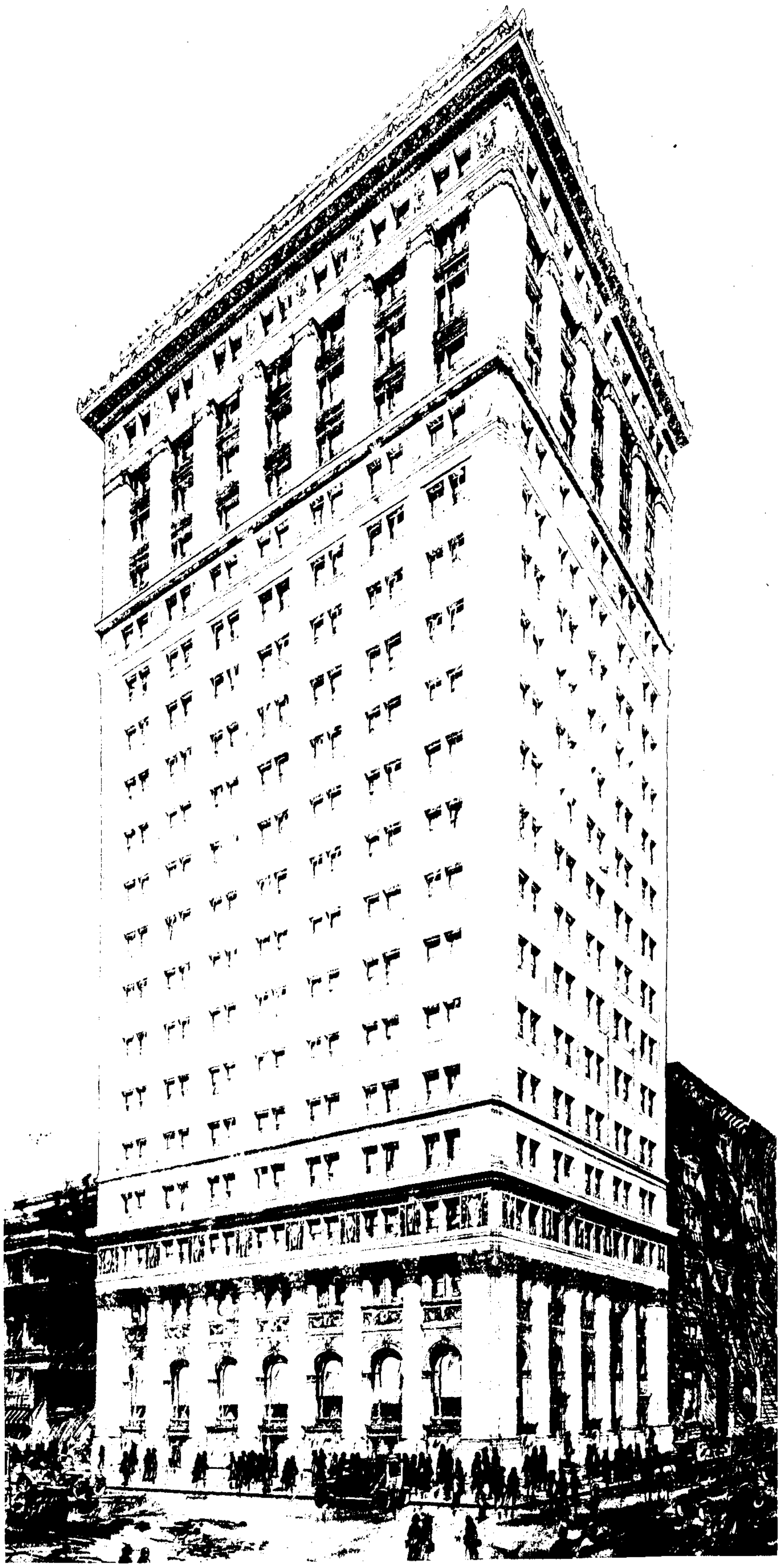
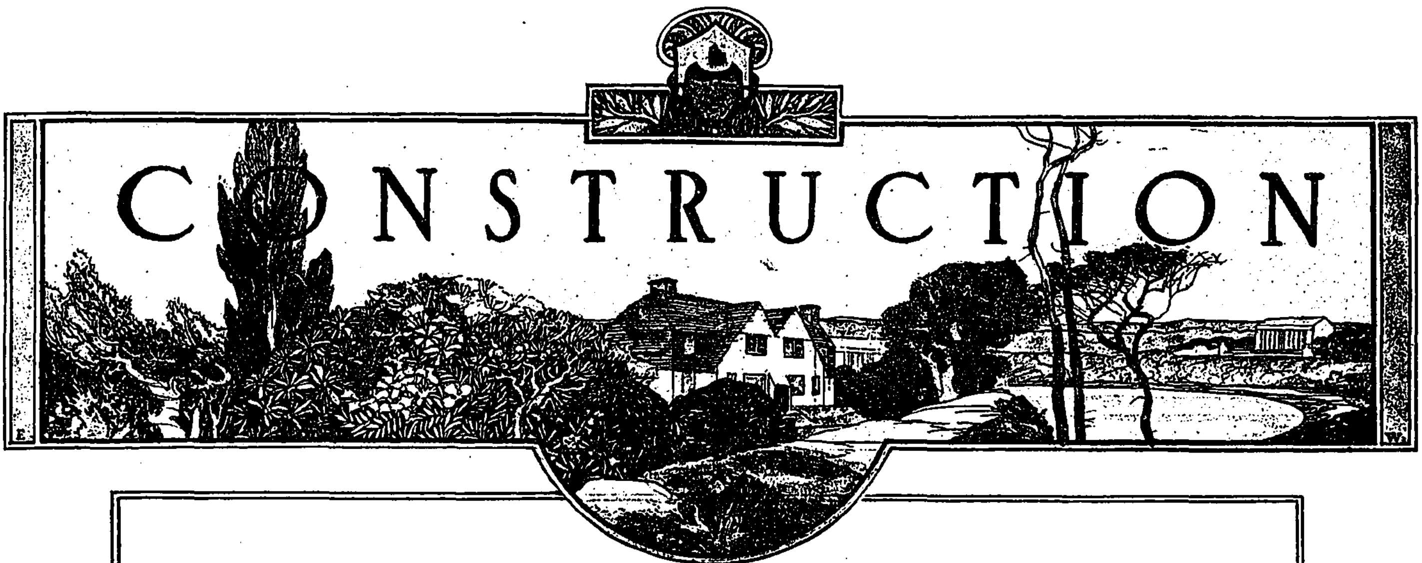


PALACE OF THE KING OF THE BELGIANS
BRUSSELS



PERSPECTIVE OF THE ROYAL BANK BUILDING, TORONTO.

ROSS & MACDONALD, ARCHITECTS.



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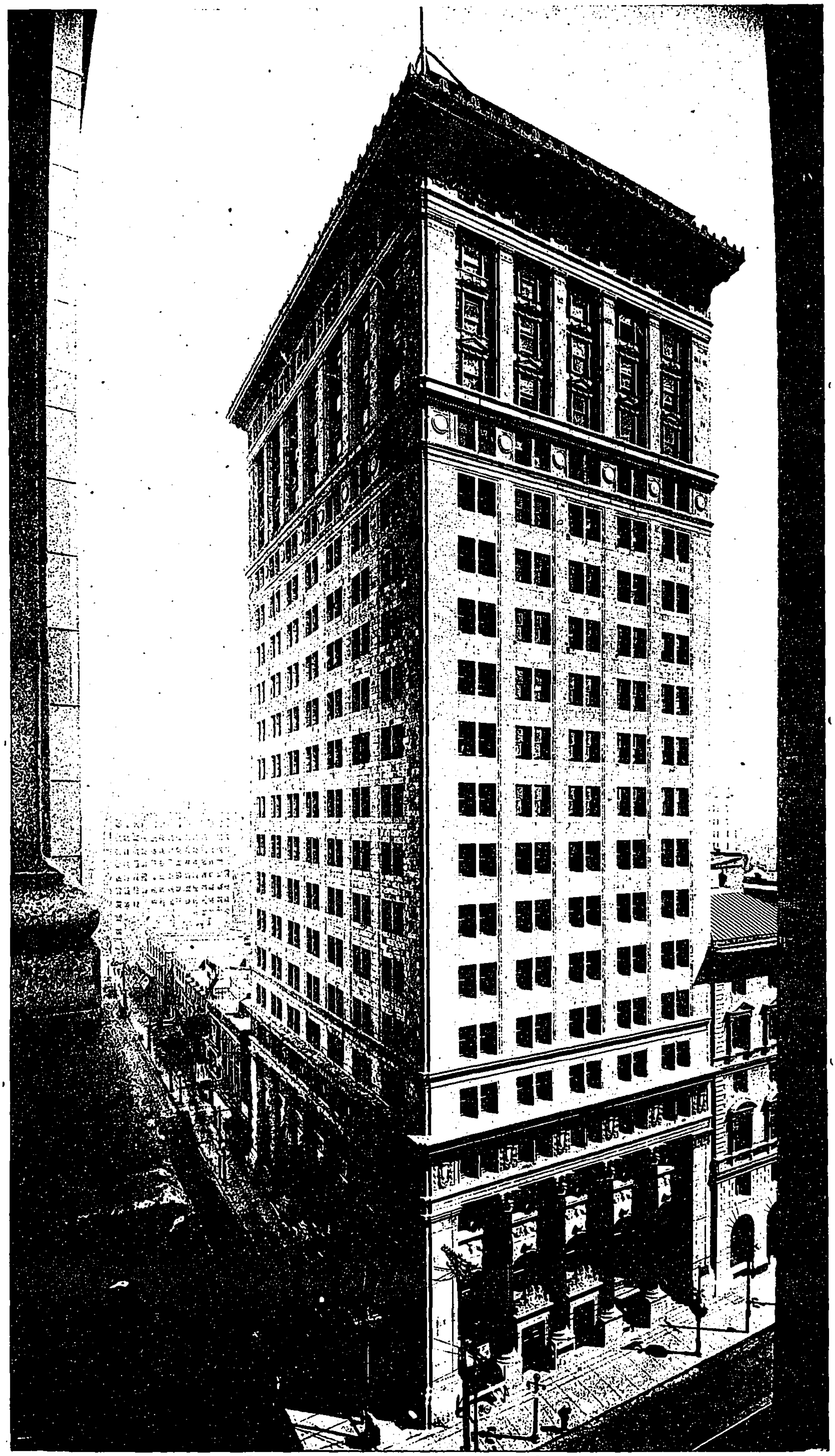


THE ROYAL BANK BUILDING, TORONTO.

ROSS & MACDONALD, ARCHITECTS.

Letters of Merit

THE ROYAL GOLD MEDAL, 1915

The President and Council of the Royal Institute of British Architects,

Gentlemen: I was more than surprised when your Secretary's letter arrived informing me that the Council of the R.I.B.A. had nominated me for the Royal Gold Medal for 1915.

The bestowal of such a signal honor, unlooked for and totally unexpected leaves me at a loss to express adequately my thanks and appreciation of the compliment paid me—and through me to the profession of which I am a member and to the country of which I am proud to be a citizen.

As a Canadian born and bred and an Imperialist from the bottom of my heart I welcome everything that tends to bind more closely together the Mother Country and the great Dominions beyond the seas, and can think of nothing better calculated to help bring about in its own way such desirable results than this gracious action on the part of the Institute. That a body of such eminence as the R.I.B.A. should have singled out Canada as the first of the overseas Dominions to receive the Gold Medal will, I know, be valued by the architects of this country as a very great honor paid to a profession not hitherto overburdened with public recognition though striving manfully to uphold, often against very adverse conditions, the standing and dignity of the profession. As to myself you value, I fear, too highly whatever I may have done in this direction.

As for my architectural work, surrounded as you are by the masterpieces of our art, I have to thank you very cordially for the kind and lenient eyes with which you have looked upon it. You do me gentlemen, far too much honor.

I wish very much I could have seen my way clear to have gone across and received the Medal in person. In not doing so I trust you will acquit me of any discourtesy, but as you all know only too well, things are not normal and the world is out of gear and I find it quite impossible to manage it.

Again I have to thank you for your kindness in electing me an Honorary Fellow of the Institute—an honor I deeply appreciate and highly value. To be a member of the Institute is a distinction I have long coveted.

Yours very faithfully,

(Signed) Frank Darling.

The letter of acceptance by Frank Darling, of the Royal Gold Medal is indicative of the wise selection made by the R.I.B.A. This reward is an acknowledgement of Mr. Darling's consistent endeavors in the sane progress of Canadian architecture; of the gradual evolution towards an esthetic art and of the spirit which permeates the entire working corps of the profession.

PROTEST AGAINST PROJECTING SIGNS

To His Worship the Mayor and City Council, Toronto.

Sirs: At a meeting of the Toronto Chapter of the Ontario Association of Architects held on the 18th instant, it was resolved to memorialize the City Council regarding the question of projecting signs.

It will be conceded by anyone who has the slightest regard to appearances that the streets of Toronto are fast becoming a hideous nightmare of street signs.

The effect upon visitors coming from places where some control of the appearance of streets is in force must be startling in the extreme.

The growth in the nuisance has been so gradual that we, perhaps, do not realize the full significance of these obstructions and obsessions.

The competition of these signs has become so great that new installations are increased in size, till, in some places, the view up or down the streets is practically blocked, and the value of adjoining signs nullified.

The result is that the older and smaller signs are practically blanketed and useless, and persons looking for a particular shop are only confused in their search. People agitate for the removal of telegraph and telephone poles but tolerate quite as evil a disfiguration of our streets in the nature of projecting signs.

We would respectfully suggest that the Council shall exercise its authority (clause x by-law No. 5514), and that at the expiration of such license or a reasonable time thereafter, it be not renewable.

We also suggest a regulation that a limit be placed on the size of signs and that they be not allowed to project more than nine inches, or one foot in front of the building. This would give ample room for the installation of electric lights behind signs placed on the fronts of the buildings, and would, moreover, put all parties on an equal basis.

We also suggest that some regulation be devised looking towards the more sightly arrangement of marquises or awnings. At present there is no uniformity or attempt to align adjoining erections.

On behalf of the Chapter,

(Signed) Isadore Feldman, Secretary.

That this protest is worthy of commendation is felt by practically every individual in Toronto, with the exception perhaps of those who know no pleasure except in the acquirement of wealth. Surely the artistic temperament of our people should not be seared by the constant view of street signs which are absolutely foreign to the design of the buildings themselves and which are conducive to traffic congestion as well as the destruction of life and property.

THE ROYAL BANK BUILDING, TORONTO.

In showing the Royal Bank Building we have illustrated the last of the three tall structures recently erected at the junction of King and Yonge streets, Toronto. This edifice is the highest building in the British Empire, and naturally brings up the much-argued question of the advisability of constructing skyscrapers from an economical, sanitary and artistic standpoint. It must be admitted that scarcity of land has had little or no influence whatever in the final decision as to the height in Toronto, since so much space is available within a very short distance of the site in question. Even in cities like New York, Chicago and Philadelphia, where land is worth fabulous sums, action is being taken to limit the height. In New York City an ordinance was proposed with three hundred feet as the maximum for the main building, with the privilege of extending twenty-five per cent. of the floor area as high as desirable. Some streets are to have the right to erect structures twice the street width, and when a greater height is necessary the building is to be set back, step fashion, one foot laterally for every four feet in height. In Pennsylvania an act has been drafted to allow cities a maximum height of two hundred and fifty feet, and they may provide for greater elevation by receding certain distances from the building line of the street. These deductions have been carefully arrived at, and if the reasons for such conclusions are just, then it would be well for us to formulate laws which could not be set aside at will by corporations of influence and wealth.

RESTORATION OF LOUVAIN LIBRARY.

The John Rylands Library at Manchester, England, is making a careful selection of books, with the intention of presenting same to the Louvain University as a sympathetic expression of their feelings towards the institution, as well as an effort to assist in restoring this once famous library. The books are to be held until such time as it will be safe to forward them to the university. It is to be hoped that this worthy action will interest other libraries and rich benefactors to assist in making the new collection as large and valuable as possible.

LACK OF PATRIOTISM.

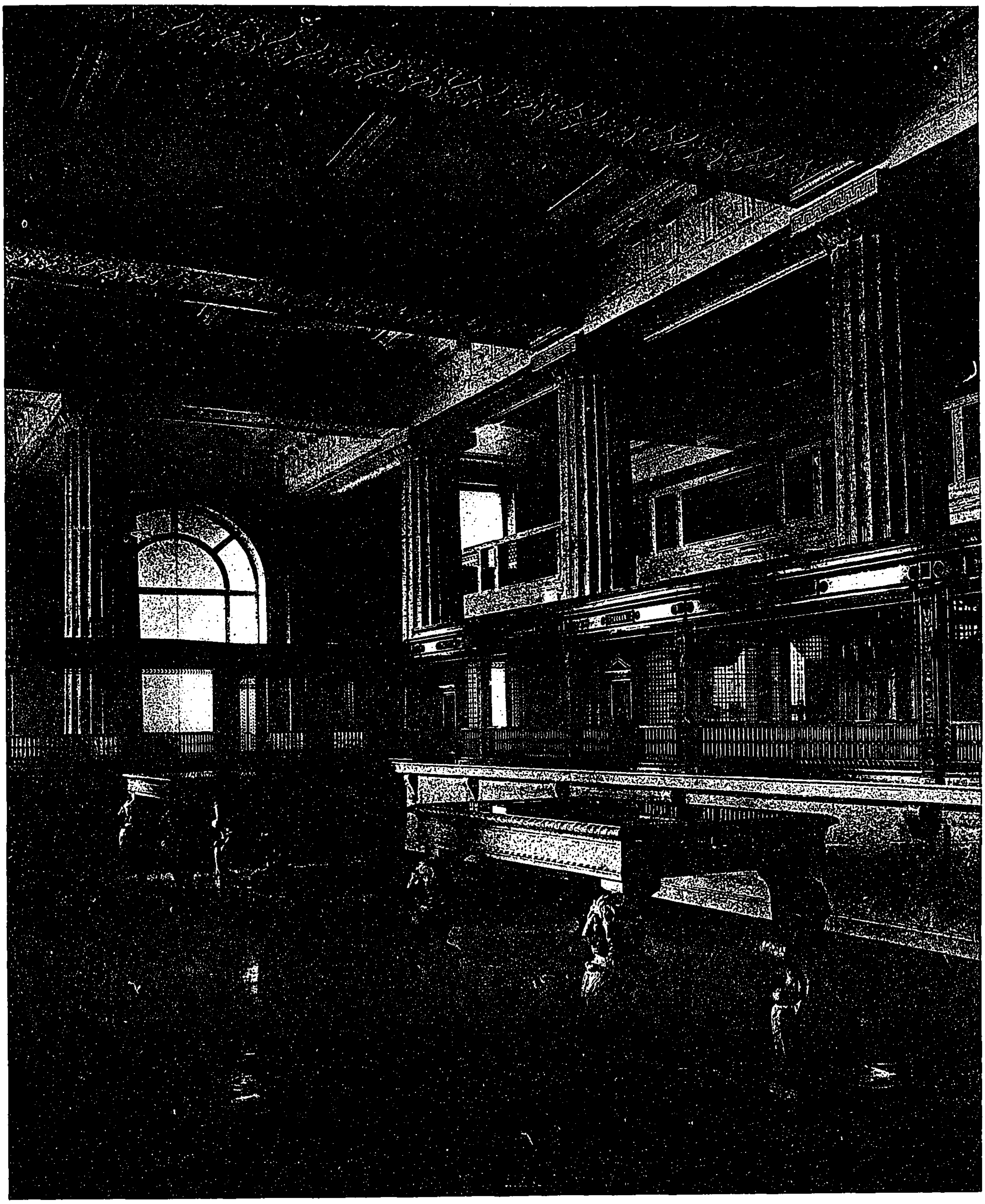
Considerable space has been devoted to the "Build Now" slogan, urging people to take advantage of the cheap materials and labor. This advice is good, and should be given all the consideration which it merits. But the fact must not be lost sight of that the banks and loan companies are not willing to advance the necessary capital for the client to push ahead various projects. Everyone is heartily in sympathy with making the statement "Business as Usual" a reality, and such would be the case if the work already contemplated could be executed. Canada is not undergoing a money stringency according to the bank statements, which leads to one conclusion. In view of the truth that building materials have dropped materially in price, the allied trades are anxious to render service at greatly reduced prices, the architects have plenty of work held up by lack of loans—in view of all this we can only attribute a lack of patriotism to the financial institutions, who refuse to encourage legitimate building.

A FALSE IDEA OF AUTHORITY.

An interesting point has been raised in the investigation of the Manitoba Parliament Buildings. F. W. Simon, architect of the work, was ordered by Hon. G. R. Coldwell to provide caissons instead of concrete piles for the foundations. Contrary to his better judgment, Mr. Simon ordered the drawings made in England, but on account of the need for haste they were cancelled and made in another architect's office. Desiring to see that his plans were properly executed he asked of the Government the privilege of supervising the construction, and was informed that he had as much right as any other citizen to draw the Government's attention to any flaws in the work. It would seem to be a misuse of authority if officials in high standing were allowed to prevent an architect from supervising the work for which he may be held responsible. This is a matter of considerable import and should not be passed unnoticed.

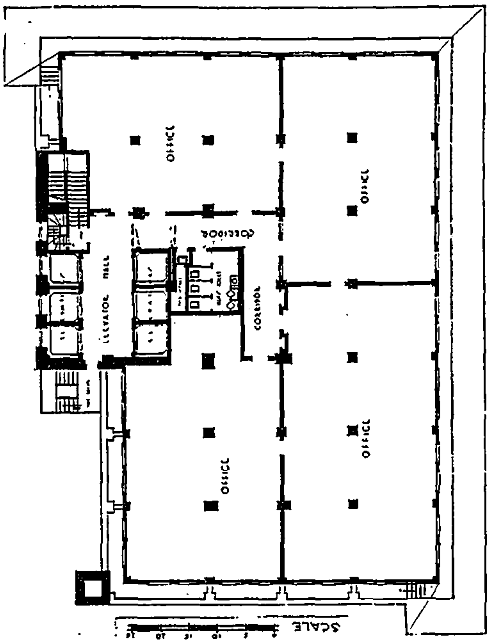
DEATH OF RENE P. LEMAY, ARCHITECT.

The architectural profession will sincerely regret the death of Rene P. Lemay, whose consistent efforts have been felt in the upbuilding of his native city, Quebec. His work has reached out beyond the field of architecture, having been on the City Council for six years, during which period he showed a marked interest in civic affairs. Among the many buildings credited to Mr. Lemay may be mentioned Quebec Technical School, Caisse d'Economie, Merger Building, St. Patrick's Church, St. Roch's, Chicoutimi Cathedral and Seminary. His early training was received under the direction of F. X. Berlinguet, of Quebec, and other professional men in the United States. His exemplary life and devotion to the high ideals of art should prove an inspiration to the younger men, who will be called upon to maintain the high standard already established by him.

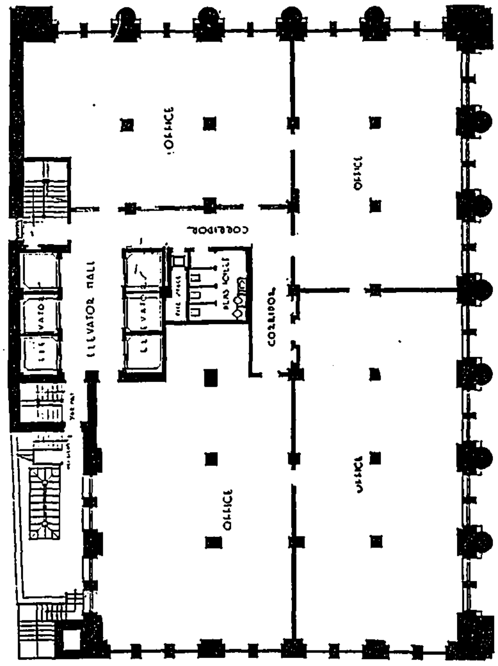


THE ROYAL BANK BUILDING, TORONTO.

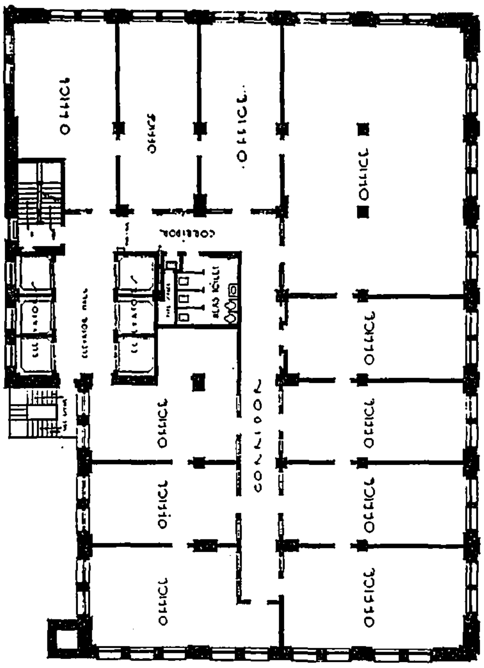
BANKING ROOM DESIGNED BY
CARRERE & HASTINGS AND
EUSTACE G. BIRD, ARCHITECTS.



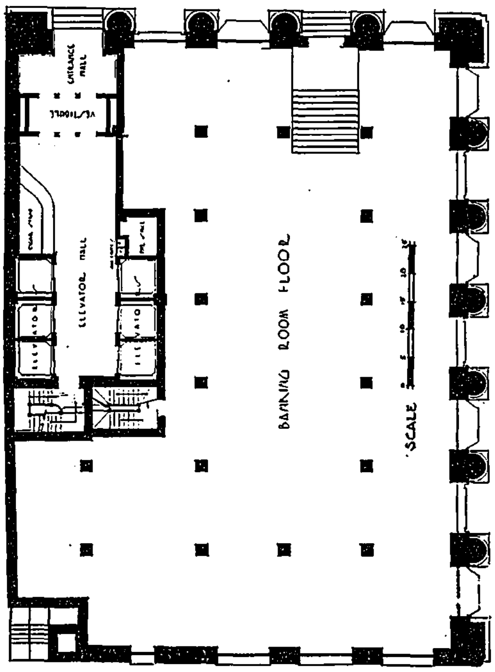
TWENTIETH FLOOR PLAN.



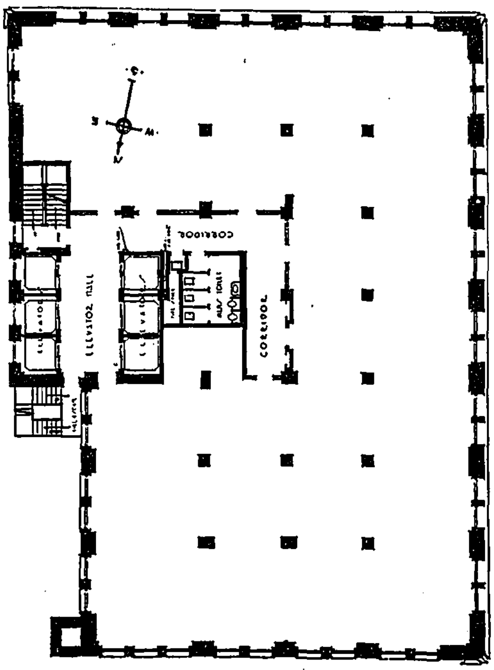
SECOND FLOOR PLAN.



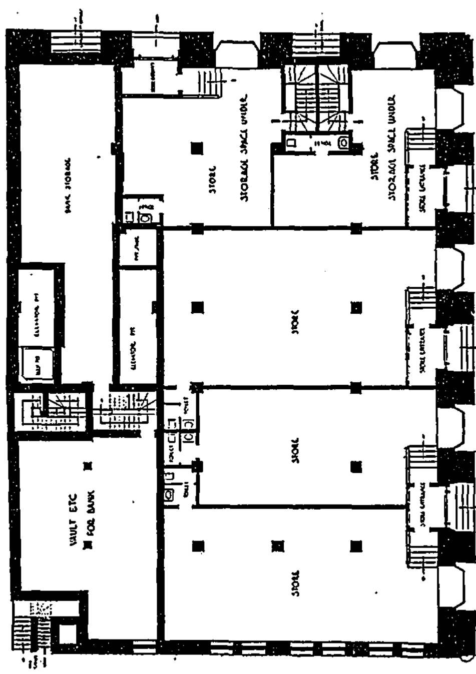
TYPICAL OFFICE PLAN.



FIRST FLOOR PLAN.



TYPICAL FLOOR PLAN.



GROUND FLOOR PLAN.

THE ROYAL BANK BUILDING, TORONTO.

ROSS & MACDONALD, ARCHITECTS.

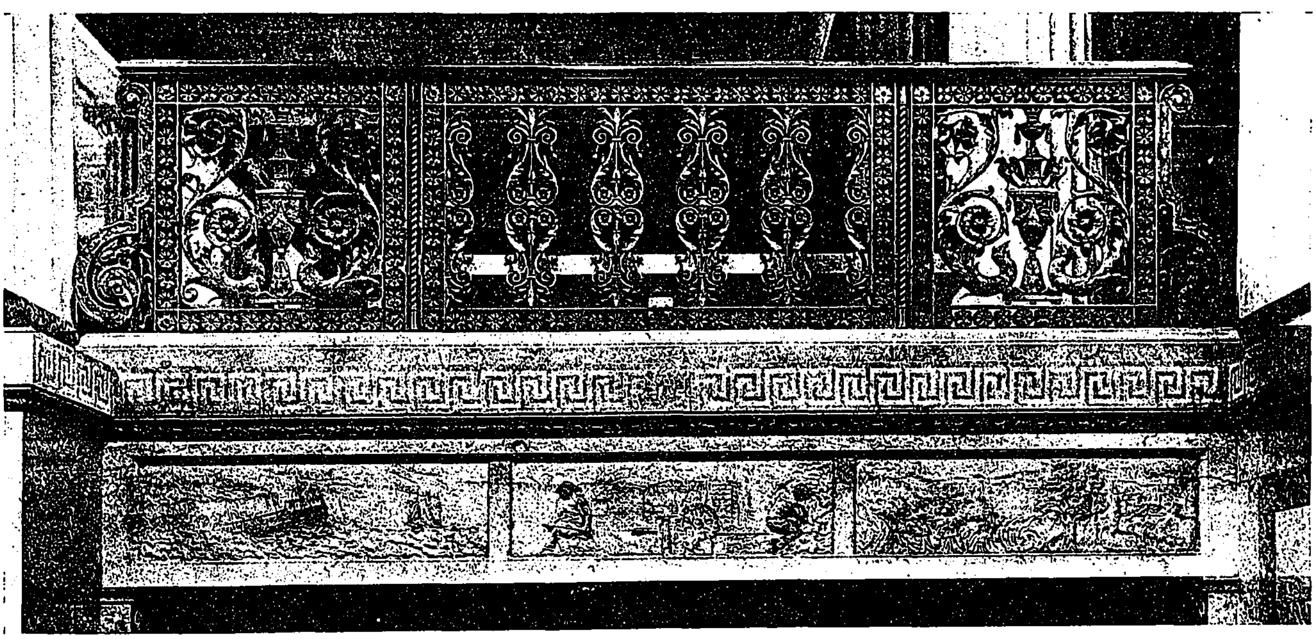
The Royal Bank Building, Toronto

THE progress in skyscraper construction is nowhere better exemplified than in the Royal Bank building, Toronto. Exceeding all other structures in the British Empire in height, it bears such distinction with an air of dignity through its severe commercial aspect. The lower stories especially are worthy of careful observation. Here the main banking space has been preserved in the exterior treatment while still retaining the retail value of the site for shops and stores. The junction of Yonge and King streets represents the centre of the commercial district, and demands the utilizing of every available square foot. In order to preserve an unbroken design for the banking room and still provide a series of stores with entrances from the street, the first floor is reached by a monumental stairway, while the shops are accessible by steps descending to the ground floor. The latter are arranged so as not to interrupt the harmony of the general appearance and still have sufficient definition for the purpose for which they are intended to serve.

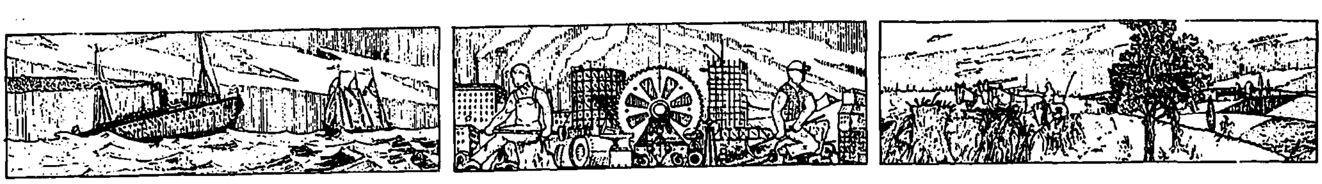
The building proper, which rises two hundred and fifty-five feet above the sidewalk, is surmounted by a twentieth story set back from the street line and a pent-house, bringing the total height to three hundred feet. The two main elevations facing Yonge and King streets consist of the customary divisions, the base course being grey granite with the columns of Indiana limestone, the shaft and cornice finished in a light cream-colored semi-glazed terra cotta. The rear elevations are treated in a pressed brick harmonizing with the general tone of the principal facades. All limestone is finished with a rubbed face and the granite with fine axed face excepting washes, jambs, soffits, sills, mouldings, etc., which are chiselled; while the back of the stone is plastered to a minimum thickness of one-quarter inch with non-staining mortar.

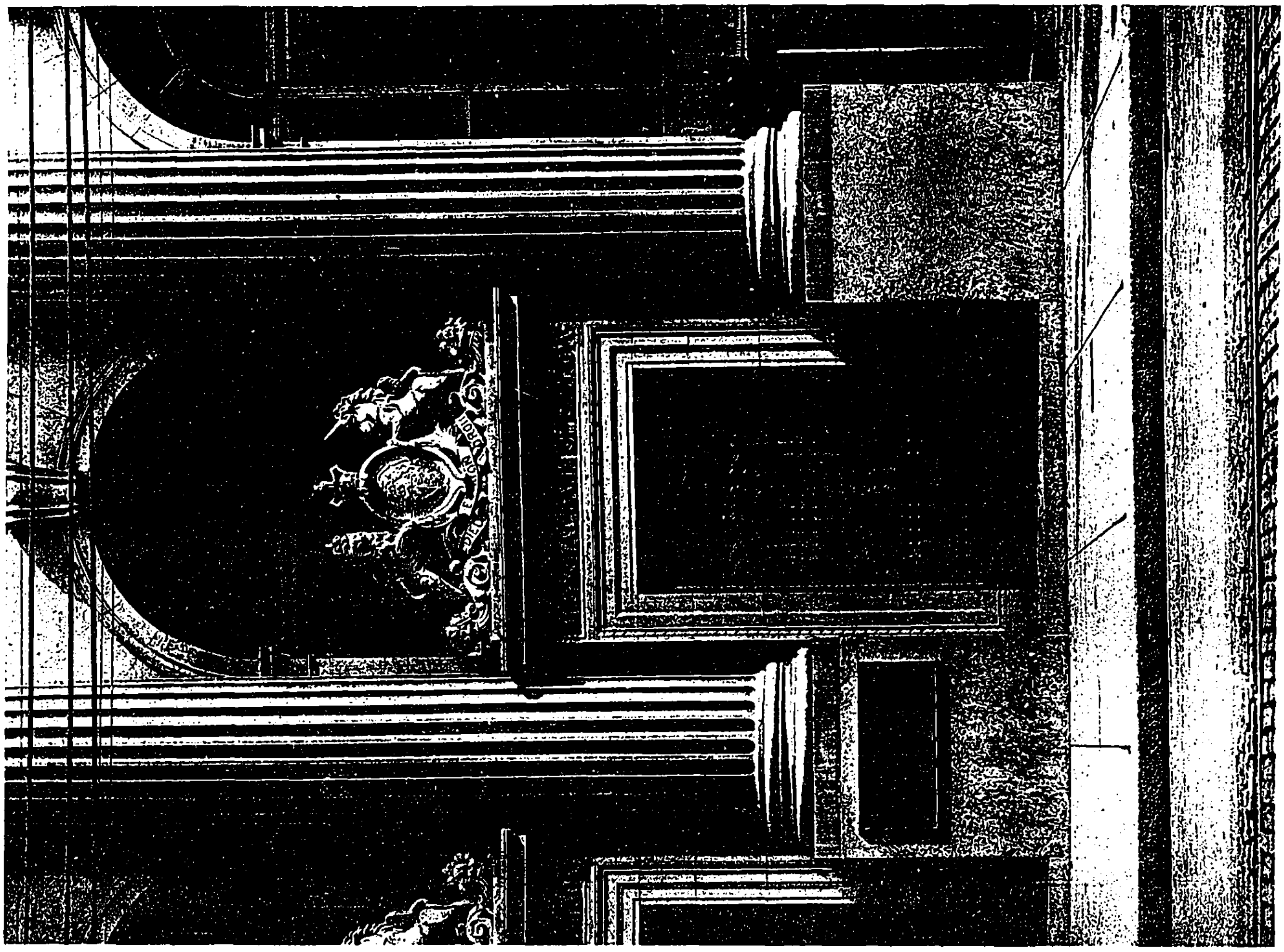
The Guardian Realty Company, who have leased the first floor for a period of years, will enjoy a banking space of unusual merit both in appearance and comfort. The rooms are accessible from King street through two public entrances with solid bronze doors three inches thick, and from the elevator hall. The arrangements between the main exchange banking room and the savings department below are so adjusted as to form practically a unit with perfect circulation. The offices of the manager, assistant manager and accountant are all en suite and open directly on to the public space. Connected with the savings department is a ladies' room.

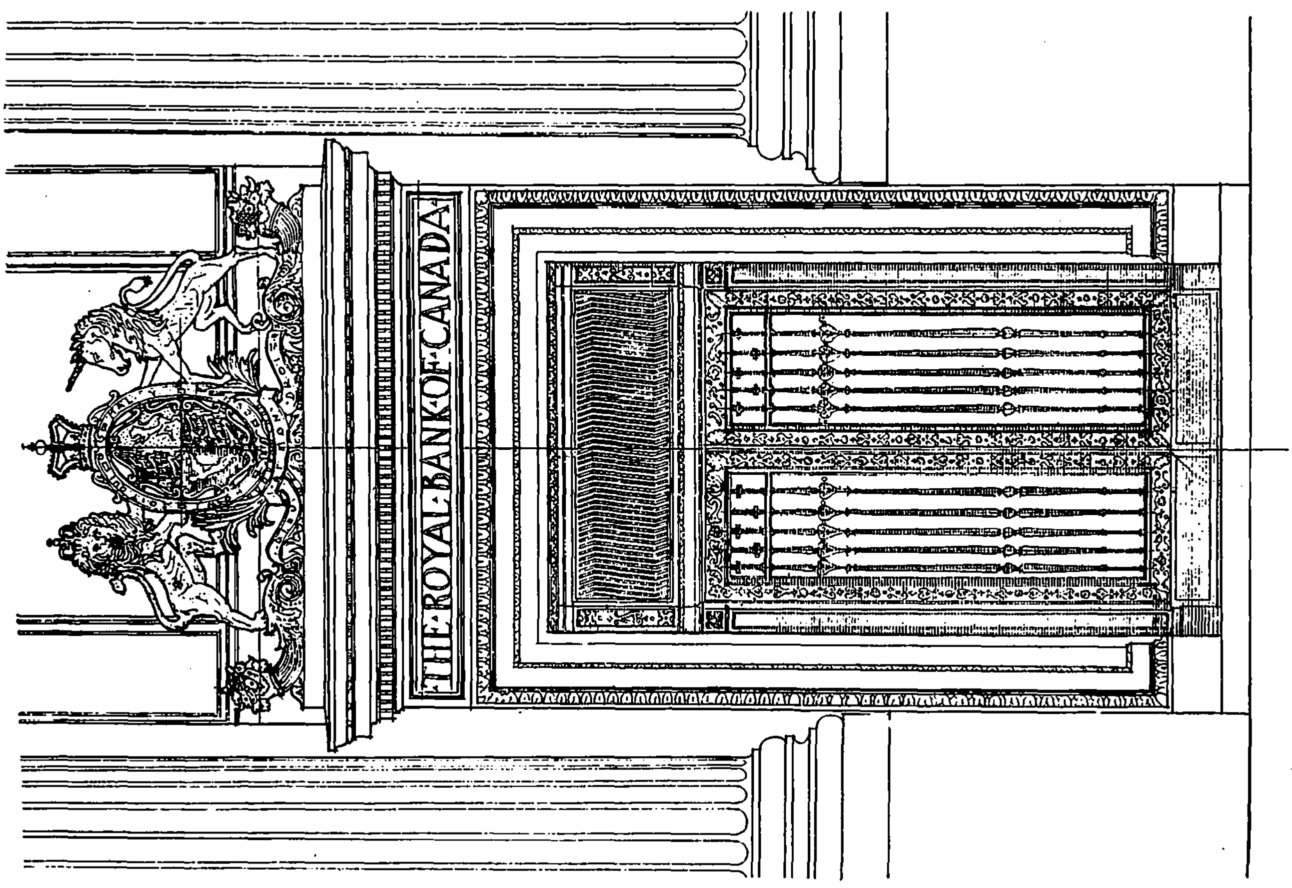
Marble enters extensively into the treatment



DETAILS OF FRIEZE IN MAIN BANKING ROOM OVER STAIRS LEADING TO THE SAVINGS DEPARTMENT.



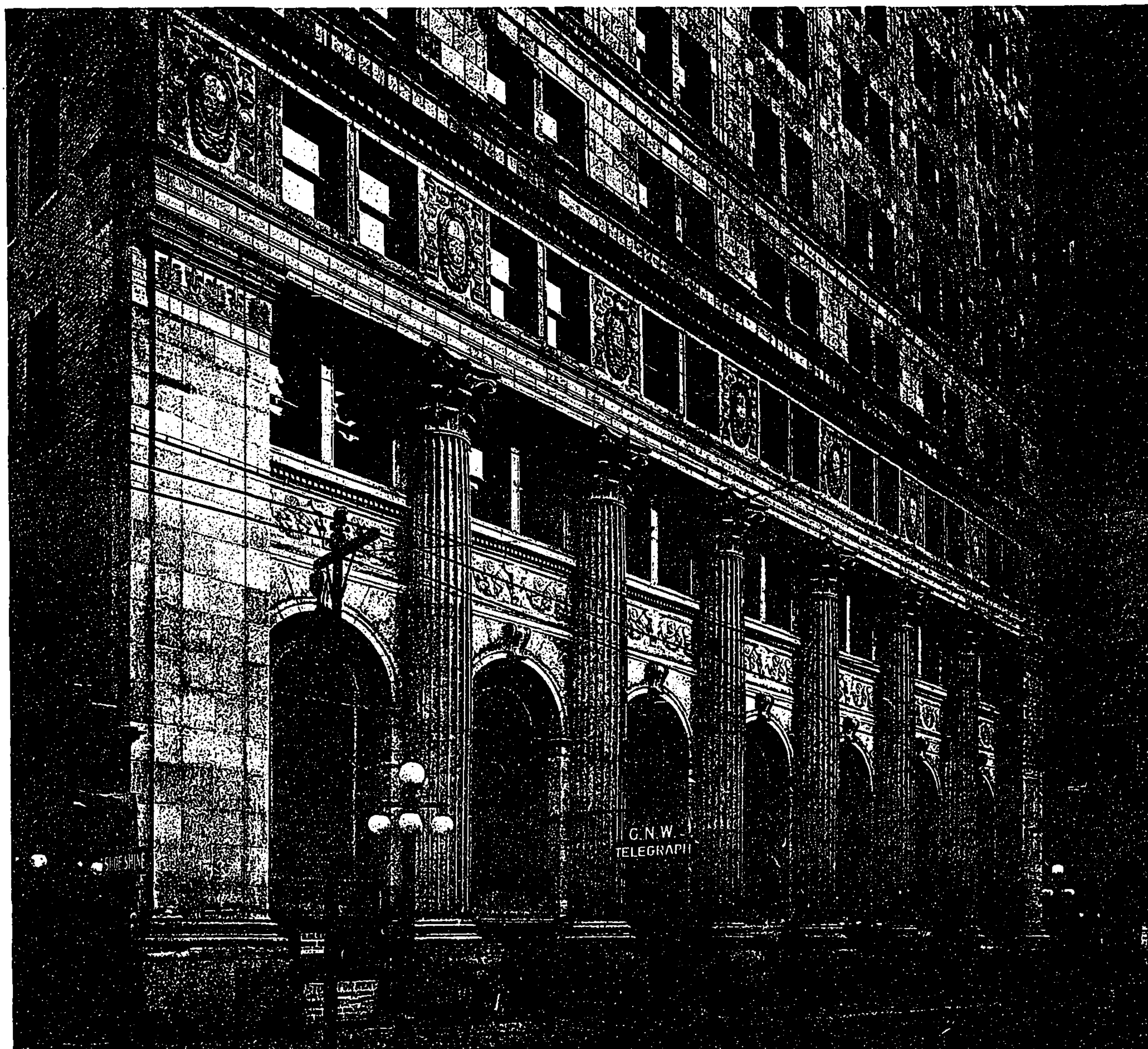




ENTRANCE DETAILS TO THE ROYAL BANK BUILDING, TORONTO.

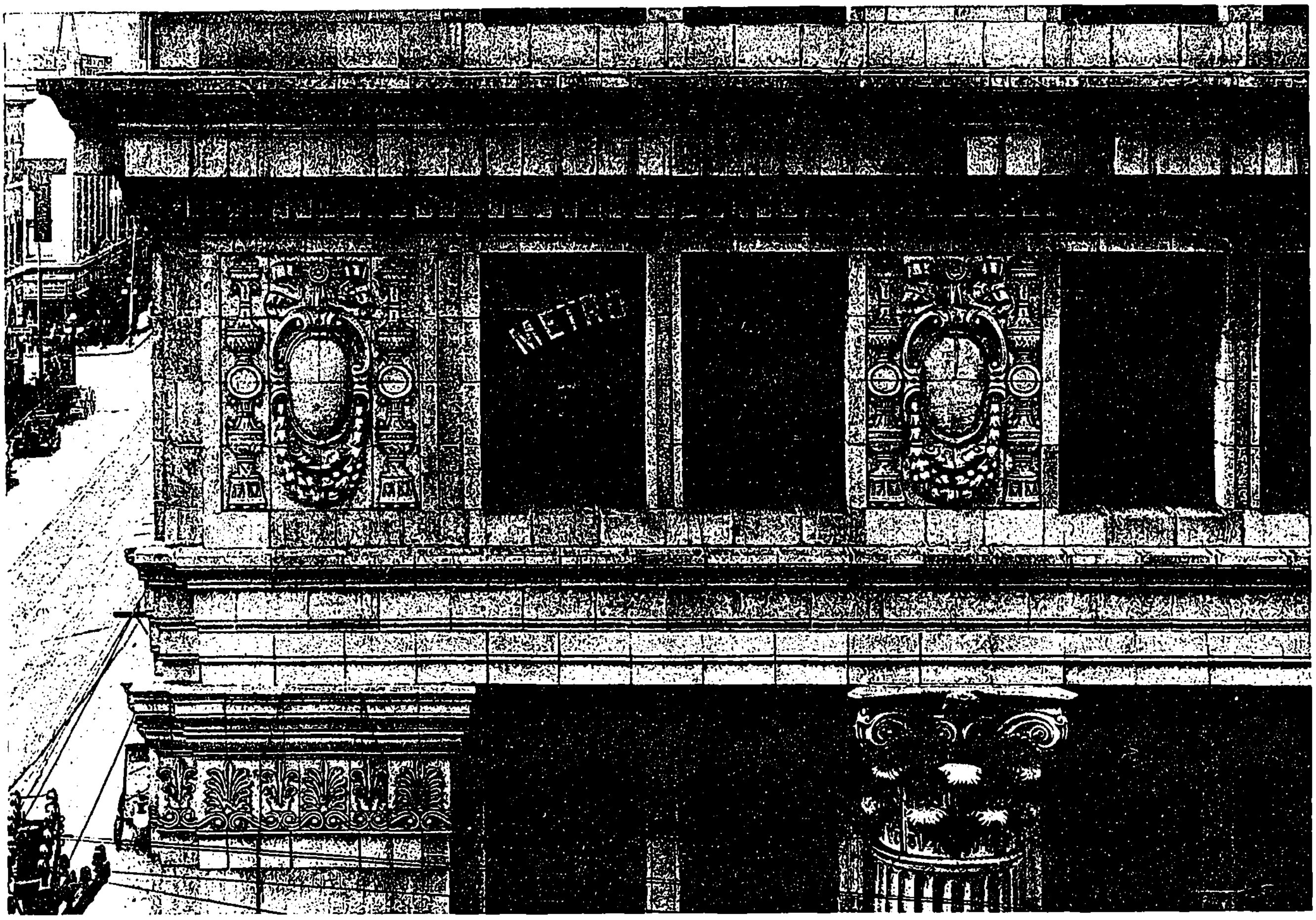
of the banking room; the walls, columns and floors being treated in highly polished Tavernelle marble with the inlaid work from a different strata and furnishing a necessary feeling of warmth. The main stairway is of solid Bassville marble, while the base around the entire room as well as the plinths of the columns is of black and gold. A Canadian marble has been used throughout the vaults, hallways, cloak rooms, etc. The public cheque desks and seats are of solid Istrian marble, the legs being modeled after the well-known table in the Vatican at Rome. Overhead is an elaborate plaster ceiling, which, with the "old statuary" bronze in the stairs, screens, balcony and doors, lends to the tout ensemble a rich and artistic treatment.

The entire banking suite is heated by direct and indirect steam under thermostatic control and ventilated with a system of mechanical ventilation which ensures fresh air at all times. Sterilized and cooled water is run to various fountains at different points for drinking purposes from a sterilizing apparatus. A plunger elevator is installed for easy access to the silver safety deposit and book vault, the automatic control in connection with this device being tool-proof. For the convenience of the customers has been installed a safety deposit vault, security vaults and book vaults, lined with three-inch steel, while each of the doors and vestibules weigh twenty-five tons. The general lighting of the room is accomplished by concealed indirect reflectors so arranged above the counter screen to ensure the best architectural effect as well as the practical lighting of the premises. The lighting of the counters is likewise accomplished by indirect reflectors.



DETAIL OF YONGE STREET FACADE.

Passing from an outside lobby of Indiana limestone six by eighteen feet, the elevator hall is entered through a small vestibule with a series of plain bronze doors. In addition to the main stairs, cigar stand and steps leading to the main banking room are six direct-connected electric elevators operating approximately seven hundred feet per minute. The walls have a ten-foot marble dado above which is a chaste and ornate plaster ceiling; the floors are of light marble with dark border of same material. The corridors throughout the building have plaster



DETAIL OF FRIEZE AT SECOND FLOOR.

walls and ceilings of cream tint, "Tanguile" mahogany woodwork, and floors of small marble tile laid in pattern.

Next to the main banking room in general interest are the floors accommodating the Toronto Board of Trade. This organization occupies the nineteenth and twentieth stories as well as other rooms in different parts of the building. After the roof had been built the Board decided to occupy the two top floors, which necessitated quite a change in the structural scheme. In order to adequately provide suitable quarters, five columns had to be removed on both floors. This threw additional loads on the adjoining columns, which were reinforced down to the eleventh floor by encasing them solidly with concrete, at which level the regular construction was able to assume the extra load. In this operation the large assembly room with a sixteen-foot ceiling height was obtained with no columns to obstruct the general view. The entire floor is covered with a cork carpet on cement with walls and ceiling of tinted plaster. Aside from the assembly room, the nineteenth floor contains the general office, the board room, market suite, committee rooms, private luncheon booths and council chamber. The last room accommodates nicely the long mahogany table with nineteen seats upholstered in deep brown leather. The walls are tinted a light green with carpet to match and fireplace, above which is an elaborate carving of the coat of arms.

The twentieth story sets back eight feet from cornice projection, providing a lounging promenade on all sides with excellent views over the city and across the bay. The floor is covered with red tile blocks and protected by awnings extending full length, which also add additional comfort to the dining, reading and lounging rooms of the club. In the dining-room are thirty-four small tables, which seat one hundred and thirty. The furnishings in French gray, the cork flooring in green, the walls tinted a light green, the general woodwork in mahogany, and the ten hanging semi-indirect ceiling fixtures all combine in making this room unusually attractive. The silverware, dishes and table linen have the crest of the board; while the walls are relieved by paintings of Toronto as it existed in 1820, 1842, and 1854. Opening into the dining-hall are the lounging and reading rooms, covered with heavy Canadian Wilton carpets of conventional design in green and deep blue. The wicker chairs and divans are uphostered in a floral pattern with subdued tints in perfect harmony with the other furnishings. One of the interesting features is the kitchen with its gas range, vegetable steamer, stock pot, broilers, steam tables, plate warmer, refrigeration equipment, and washing table constructed in tiers and provided with vegetable trucks underneath.

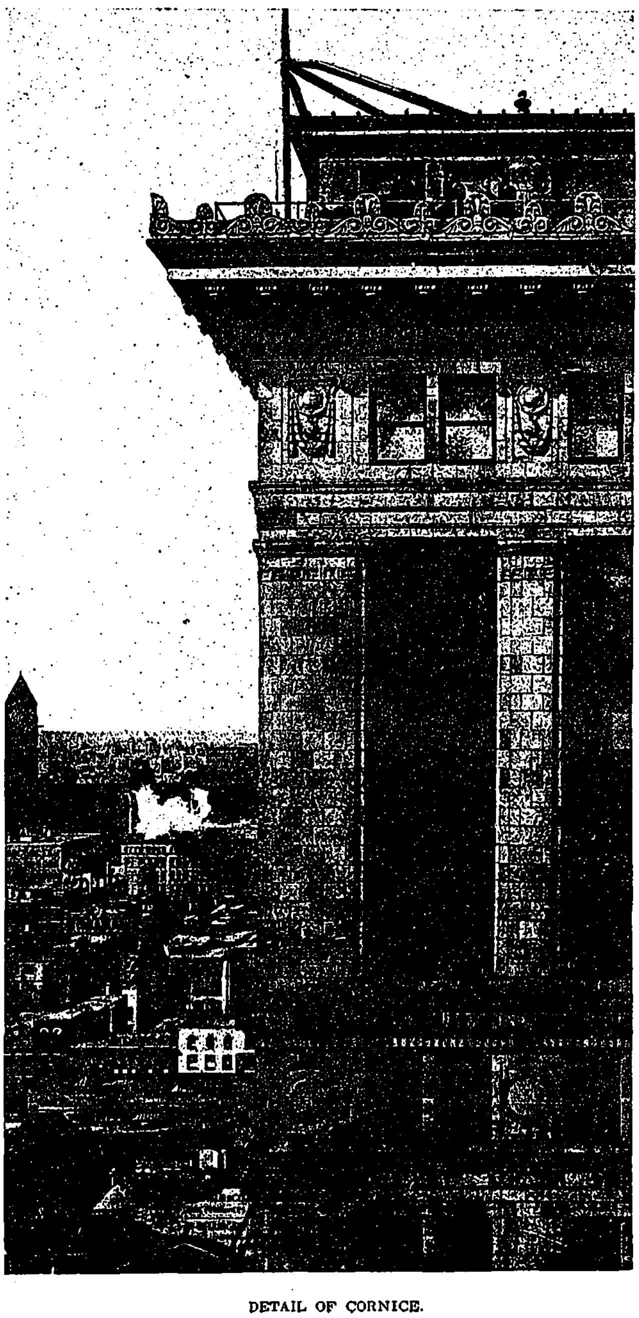
In order to insure ample protection from fire the window frames, mullions, transom bars, etc., to the first floor and in the elevator shaft are of steel, while the remaining are of cast iron; the floors are all of hollow terra cotta arches set between the steel beams in lasting cement mortar, excepting ground and basement, the latter being concrete with top cement coating divided into squares measuring twelve inches; the partitions are porous terra cotta four inches thick if less than fourteen feet high and six inches if over; the stairs from elevator hall are of iron with marble treads and risers to the second floor level; the fire escape from the ground floor to the roof at the rear of the building is of wrought iron. All toilets are finished with white marble wainscot seven feet high and floors of one and one-eighth inch marble tiles.

In the basement are located the boiler rooms, motor and fan rooms, engines, condenser for cooling water from boilers, sump pump which is operated by automatically controlled electric air compressors.

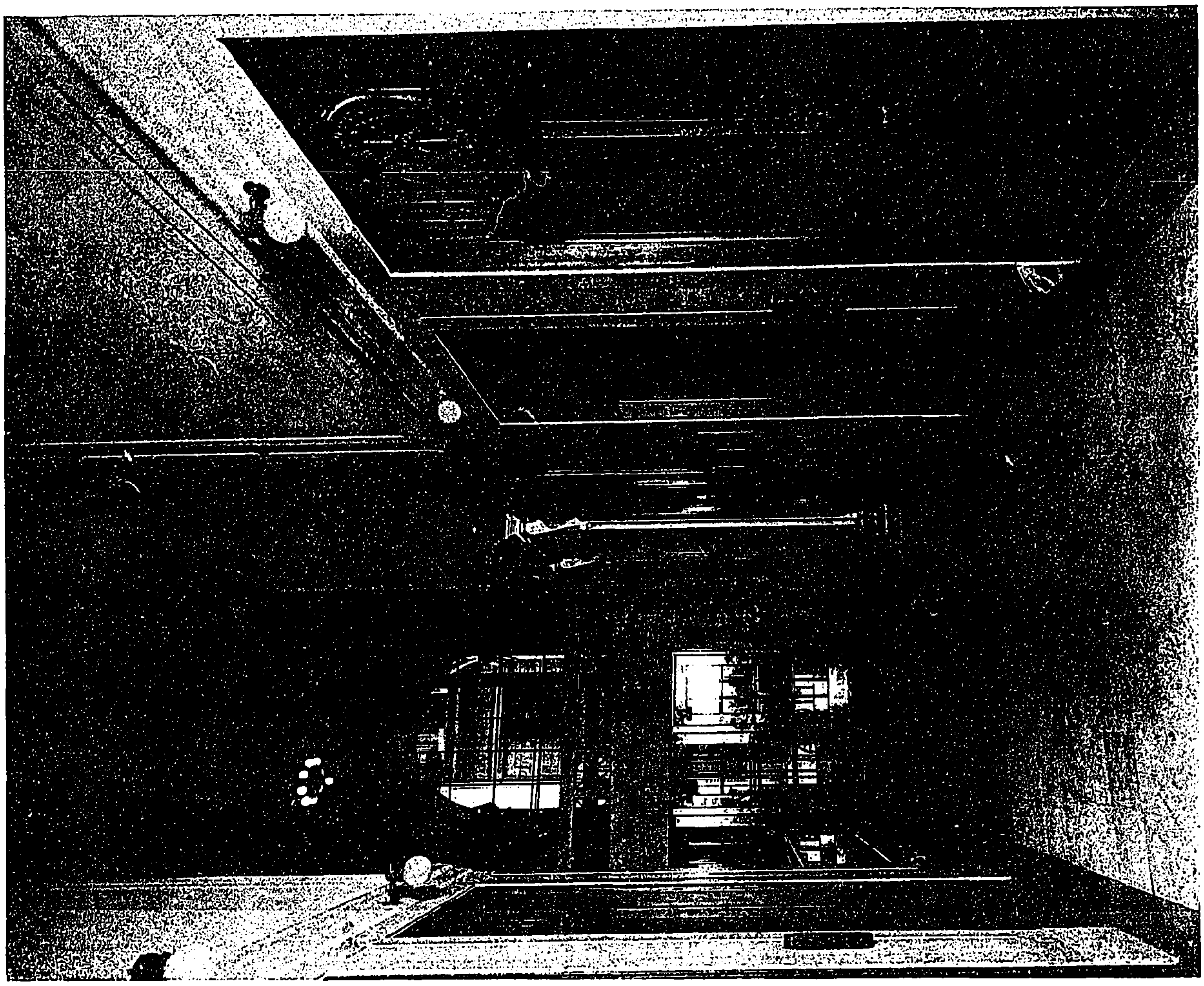
The machinery is located on a floor higher than the boiler-room, which contains also a pair of direct connected centrifugal pumps driven independently by two forty horsepower electric motors, which furnish the domestic water supply to all floors above the tenth story, the ten lower floors being furnished with water direct from the city mains. In connection with these pumps there is a large auxiliary supply tank in the basement in case the city pressure should be turned off. On the opposite side to the pumps is a large air washer and conditioning apparatus, which not only washes but also warms and humidifies the air. This is provided in connection with the system of indirect heating, all of which is used only in the banking premises, which requires approximately three thousand square feet. The remaining portion of the building has twenty-two thousand square feet of direct radiation heat. Over five miles of piping was used for the heating only. The ventilation system, which included all the local vent from the lavatories, required over twenty-five tons of galvanized iron, in addition to five tons of black sheet iron used in the fans, air washers and smoke stacks.

There are two steam tubular boilers of one hundred and twenty-five horsepower, sixteen feet long and seventy-two iches in diameter, each suspended by four heavy hangers with steel plate pads riveted to the boiler. The grates are cyclone self-locking and required to maintain a temperature of 70° with a five-pound head of steam when it registers without ten below zero. The system installed permits of shutting off any section of risers by connecting the steam mains to the boilers with a pair of heaters.

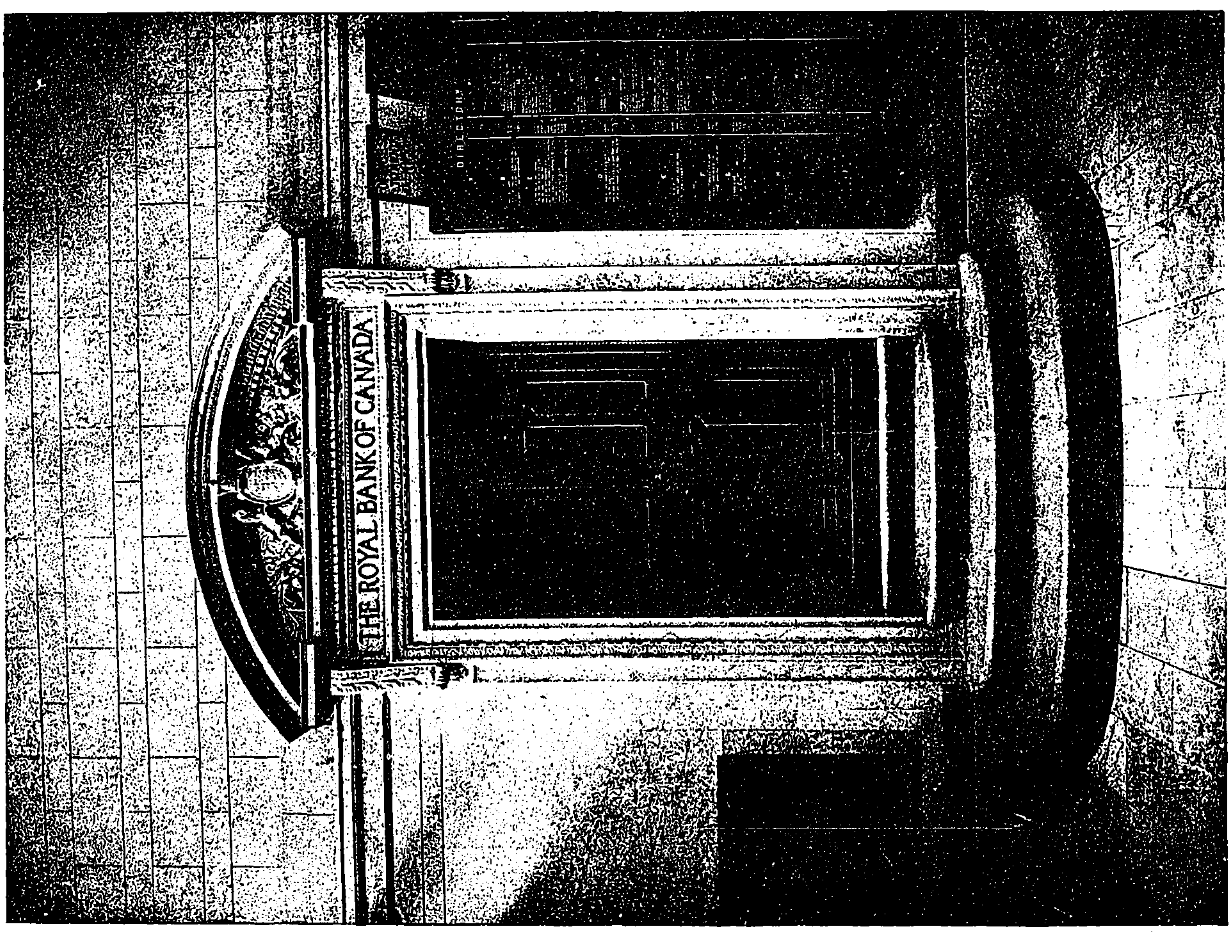
In ventilating a fresh air supply fan furnishes 8,725 cubic feet per minute to the basement and first floor, the banking room receiving slightly over half the amount through fifteen inlets. The fresh air is drawn into the building through a cold air chamber supplied with tempering coils, air washers and reheating coils. The supply fan, twenty-seven inches in diameter, rotates four hundred and seventy feet per minute, sending the air across the ceiling of the basement from where the vertical branches take it to the respective rooms. The exhaust fan



DETAIL OF CORNICE.



ENTRANCE FROM KING STREET.



ELEVATOR HALL DETAILS.

THE ROYAL BANK BUILDING, TORONTO.

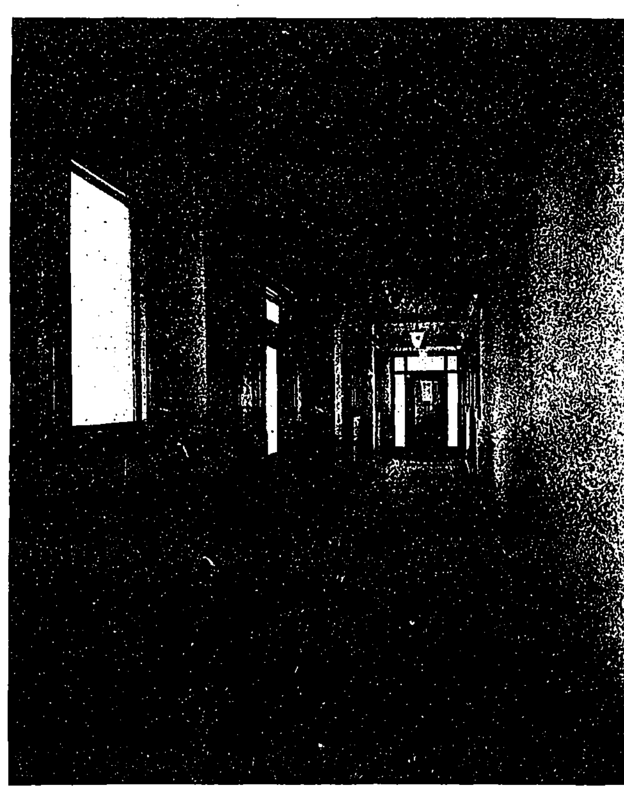
located in the pent house on the roof, with a rotation of four hundred and eighty times per minute, expels the foul air from the main duct, thirty-eight by twenty-four inches through a thirty-inch square discharge cap of thirty-two ounce copper. The material used for the supply and discharge pipe is 18-gauge galvanized iron.

SAVINGS DEPARTMENT.

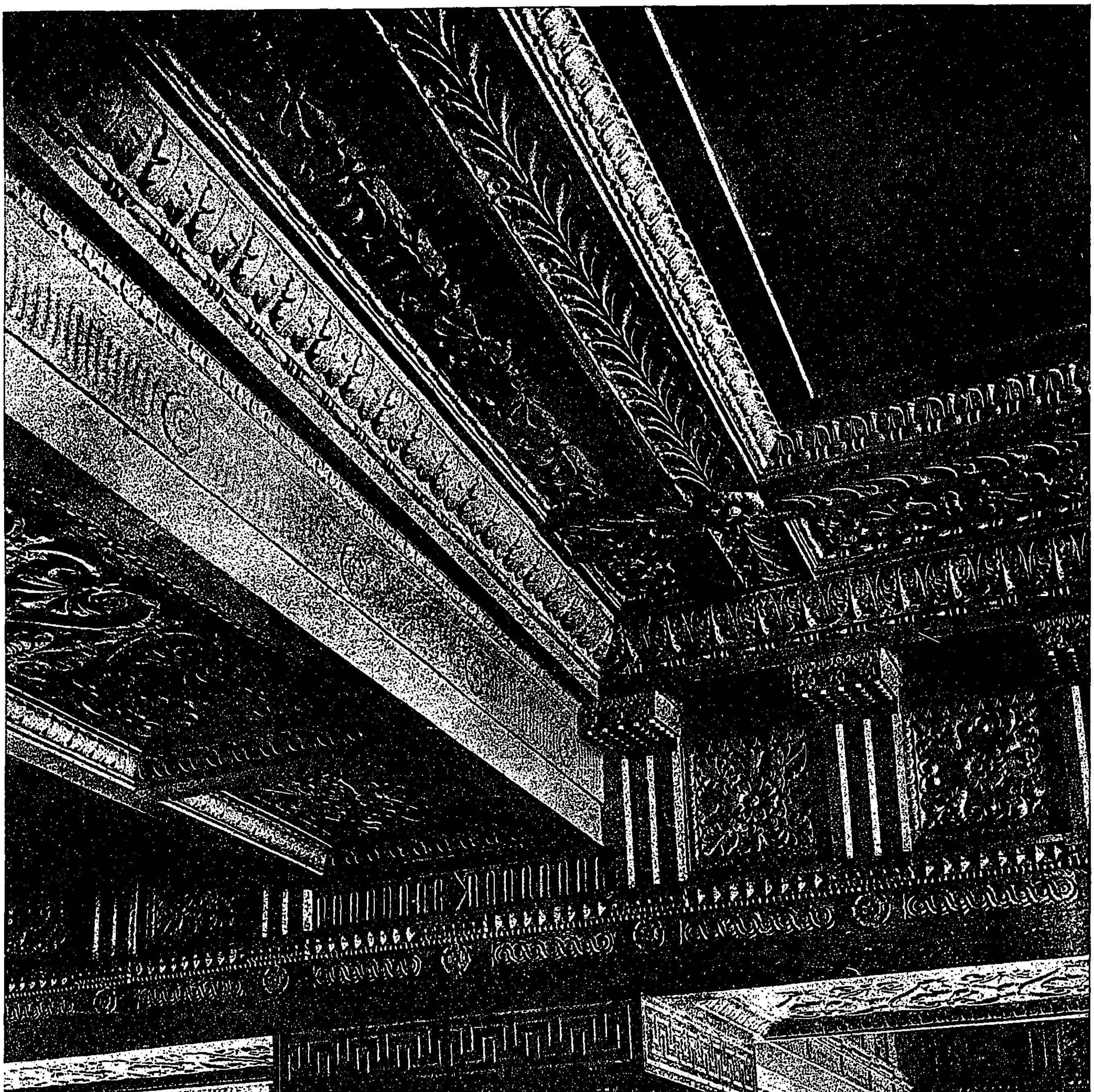
In excavating, the soil was found to consist of an upper layer of clay extending to a depth of thirty feet, covering a three-foot layer of hard and scaly clay, which in turn topped a deep strata of very dense shale, resisting in test a load of seventy tons per square foot. The excavation was started September, 1913, the steel work in February, 1914, and the stone and terra cotta in the following April. In referring to the constructional features of the Royal Bank the Canadian Engineer states, that as no part of the basement is excavated down to the shale, caissons were sunk through the clay until bed rock was reached at each of the forty-one points where a column foundation was required. Each column is carried upon a separate pier, with the exception of those which are carried on cantilever girders, or on plain girders. All piers, with the exception of those along the extreme north end of the building, are circular in plan, and vary in diameter from 4 ft. 4 in. to 6 ft. 8 in. at the top, according to the proportion of the load that is transmitted to them. These piers are increased in diameter at the bottom by an additional two feet in each case, the enlargement tapering through a height of three feet. On an average, each pier carries a load of about fourteen tons per sq. ft. Owing to the nature of the soil, in sinking for piers it was found unnecessary to use any form of hollow caisson or piling, as the clay walls were self-sustaining. Consequently these excavations were made exactly of the size and shape required, and on bottom being reached, were filled in with concrete to the requisite height to take the grillages. The concrete used was of a 1:2:4 mixture, the stone being about 1½-in. gauge.

The grillages were composed of steel I-beams varying from 10 in. of 30 lb. to 24 in. of 100 lb., those for the main columns being composed of two sets of four 15-in. of 50 lb. I's, and each set of four beams being connected by means of ¾-in. through-bolts with pipe separators between the beams. One set was placed at right angles to, and above the other upon the concrete piers. They were carefully levelled up and the whole then grouted in level with the top of the uppermost grillage.

Each of the piers constructed as above are capped with a heavy cast iron column base. These bases were cast from tough grey iron. The actual test made on coupon bars one inch square in section and twelve inches long, loaded at the centre, gave on an average a breaking load of 30,000 lb. The upper surface of the cast iron bases is planed true and parallel to the lower surface, and holes are drilled for bolts to connect the columns to bases. In designing these bases provision was made for one inch of grout between the base and the steel grillages. In setting, small wooden wedges were used under the corners of the castings, by which means the bases were set dead level, and raised or low-



TYPICAL CORRIDOR.

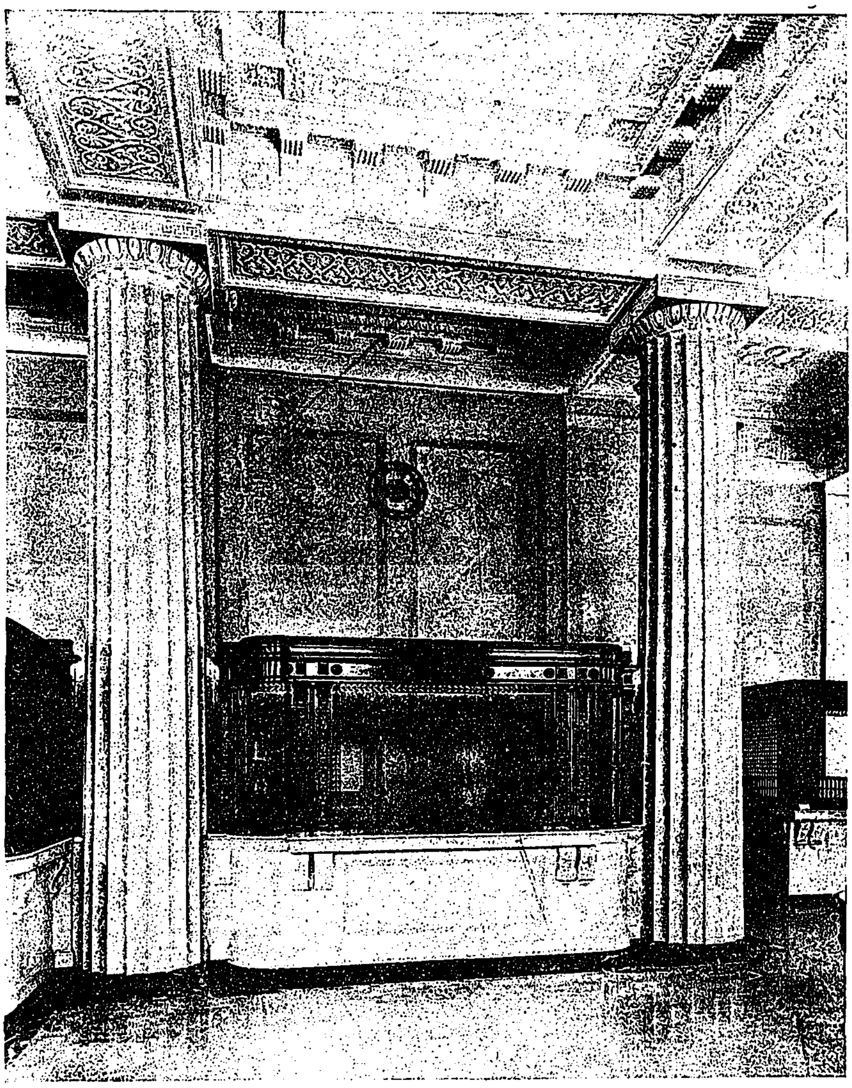


DETAIL OF CORNICE,
MAIN BANKING ROOM,
THE ROYAL BANK
BUILDING, TORONTO.

ered to the exact elevation required. Grouting was then introduced through vertically cored holes at the centre of the casting, and by this means the space between grillage and base was thoroughly filled in. The wedges used in levelling were not removed, and, being of wood, will give under any compression to which they and the grouting may be subjected, thus insuring even distribution of the load over the whole surface without damage to the castings.

All piers are circular in plan, with the exception of those under the five columns along the north end of the building, and the two columns carrying the smokestack at the northeast corner of the building. The five columns are each carried by four plate girders bolted together as one, and running parallel to and under the north wall. Owing to the depth of the basement at this end of the building, bed rock is not more than ten and eleven feet below the column bases, and it was not necessary to use cantilever girders to carry these five columns. Instead, a trench was cut along the extreme northern limit of the lot, extending inwards about three feet, and downwards to bed rock. This trench was filled in with concrete to the requisite height, diagonal tie rods being inserted, which later formed part of the horizontal reinforced concrete struts running at right angles to the girders. On this concrete wall were placed the plate girders already referred to. Twisted steel anchor rods were then hooked into the projecting plates provided on girders, and laid in a trench 2 ft. 6 in. wide by 5 ft. deep, extending out at right angles to the girders and butting on to the caissons of the next row of columns. The girders, and trench with rods, were then filled in with concrete, the outer girder being grouted with neat cement flushed in to lot limit. The girders are surmounted by cast iron column bases, levelled and grouted as previously described.

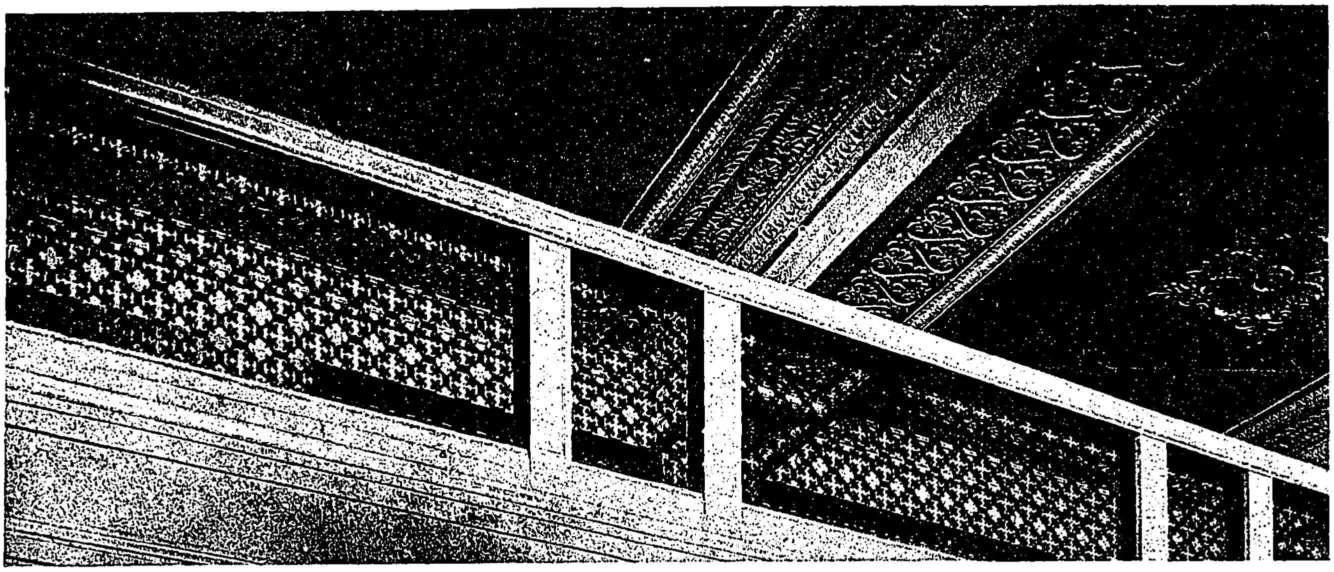
The foundations for the two columns constituting the main and auxiliary columns at the southwest corner of the building are worthy of special mention. The main column runs up to the full height of the building, but the auxiliary stops at the third floor level, and carries the wind bracing up to that point. Above the third floor the wind bracing is carried by the main column. The pier for these columns is circular in plan, and is surmounted by a special grillage composed of a bottom course of five and an upper course of six 12-in. to 40 lb. I-beams, the latter course laid at right angles to the lower. It will be noticed that the beams in the upper course are carried diagonally towards the centre of the building, to form a base for the auxiliary column. The weight thus applied would cause an eccentric loading upon the pier, the load centre approaching towards the inner wall



DETAILS OF MAIN BANKING ROOM.

of pier. To overcome this eccentricity of loading, the position of the pier has been moved diagonally inwards by 2¾ in., thus concentrating the combined load about the centre of the pier.

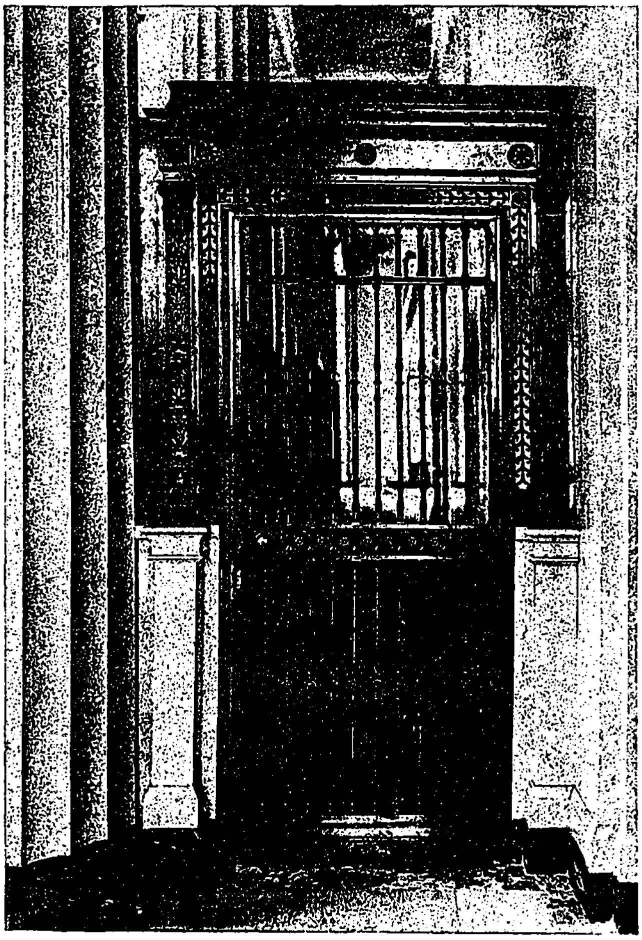
The five columns on the east side of the building abut on an existing structure, and commence from a level considerably above the rock (as very little basement excavation was required under this portion of the building). They are carried upon cantilever girders, which are each carried in turn by two circular caissons surmounted by single grillages composed of four



RAILING AT MEZZANINE FLOOR OF BANKING ROOM.

15-in. I-beams. The girders are each built in three longitudinal sections, and are bolted together through diaphragms after being set in place. The spaces between the girders are filled with concrete, and are also encased in the same material. A cast iron column base is set at both ends of each girder and grouted in.

It is interesting to note that twenty-six hundred tons of steel was used, one and one-fifth million common brick, and approximately two hundred and sixty-six thousand face brick. The over all dimensions are one hundred and twelve feet on Yonge street and eighty-one feet on King. Each typical floor has a rental space of six thousand two hundred and fifty square feet. The completed structure, including all fees, cost $1,250,000.



ENTRANCE IN BANKING SCREEN.

PROGRESS in building construction is nowhere better illustrated than by the three substantial buildings that have succeeded each other on the site of the Bankers' Trust Building in Wall Street, New York. In 1880 the Manhattan Trust Company erected a fine up-to-date eight-storey commercial building on this corner, equipped with the very latest devices that only a wealthy concern can afford. Within the space of eleven years the building had g rown so out of date that it was removed and the twenty-six storey Gillender Building erected.

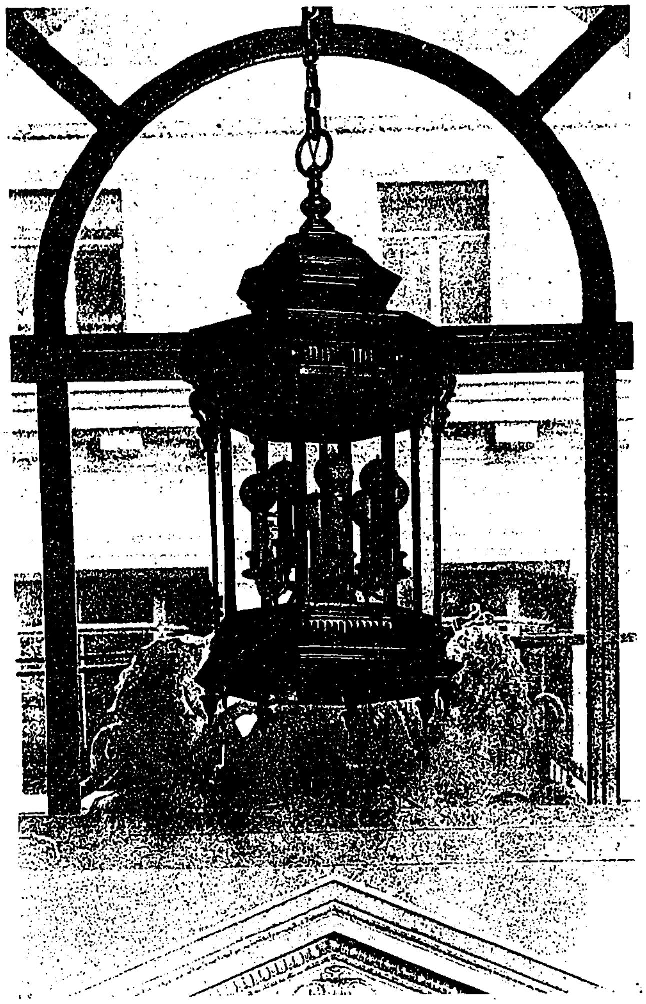
This skyscraper was built in the best manner of the time and equipped with every known convenience with the prospect of standing for centuries, yet in two decades it was demolished, thrown into the scrap-pile and the present Bankers' Trust Co. Building of a height of thirty-eight storeys erected in the place. Nor is this exceptional; the Thorley Building in New York, a modern steel structure, was demolished to make place for the present New York Times Building, and the Rand-McNally Building in Chicago, one of the early marvels of tall building construction in that city, has given way to a taller, more modern structure.

With the skyscraper approaching the age of thirty years, we find the first generation, so to speak, passing away. It seems scarcely credible on looking on the pictures of the larger American cities for thirty years ago that the marvelous change in the skyline all occurred in the span of one generation. And there is no indication of a slackening or decline in this activity. New York is still building enormous high buildings at an accelerated rate averaging about one each month of the year. The seemingly incredible point is now reached where a few of the earlier tall buildings are being removed to make place for higher ones. Structures regarded a score of years ago as destined to stand for centuries, as structures of such rivetted strength and erected with such travail that it would be well-nigh impossible to take them down, are now old-fashioned, and eligible for the scrap-pile. Such is the pace of building progress in the metropolis.

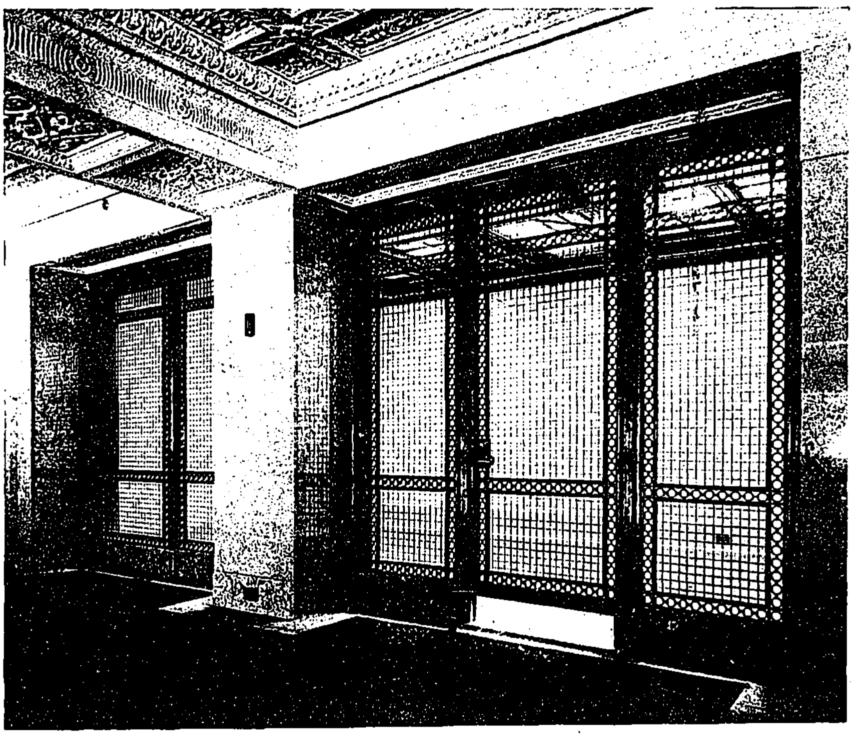
In 1915, it is literally easier to cut down a steel column than to cut down a tree or cut through a block of stone. With a portable oxygen-acetylene flame, steel work is now cut apart in a few minutes with no physical exertion. Indeed an anarchist or lunatic reckless of consequences could, single-handed, cut down any of the tall steel structures in a few hours if free from interference. So does science work miracles of invention and discovery, and from generation to generation multiply the facilities for weal and woe. Let no man attempt to prophesy, therefore, the marvels that the future may hold in store.

As the tall building enters upon its second generation, one naturally inquires,—What of the future? Can they be built higher? What is the limit? Disregarding for the moment the question of legal limitation and artificial restriction of height, it is evident that the answer is bound up with the scientific evolution of the years to come. At no time has the architect been more ready to seize and apply the last word in scientific research. Indeed, it is the price of his success and continued favor and prosperity. The architect who does not keep in touch with building progress and the latest application of science will soon find himself drifting steadily to the rear. Indeed even to stand still is to find oneself moving backward by contrast with the onward current. The modern tall building is a marvel of up-to-date scientific appliances. Without scientific engineering not only could not such buildings be constructed, but they could not be maintained or rendered habitable. It is apparent therefore that radical scientific discovery or invention will profoundly affect the future of these structures.

It is only necessary to contrast a European building with a typical American building to realize the extent to which applied science dominates the latter. Sometime



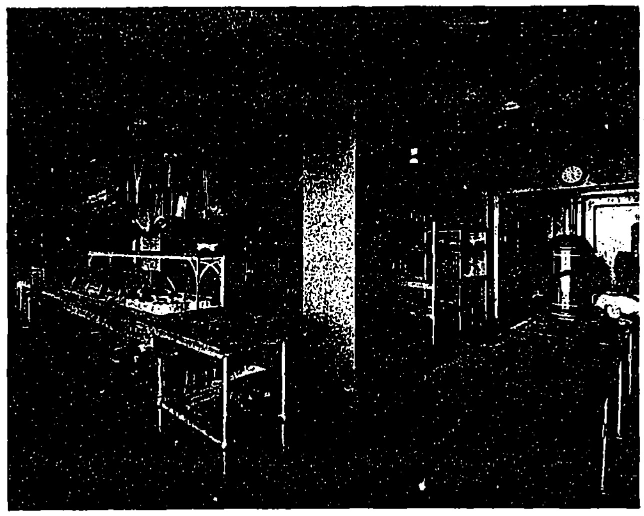
LIGHTING FIXTURE IN BANKING ROOM.



DETAIL OF MEZZANINE IN BANKING ROOM.

DINING ROOM.

BOARD OF TRADE



KITCHEN.

ago while escorting a group of visiting engineers, members of an International Congress of Engineers, through several of the larger buildings in New York City, a Russian engineer said to me, "Science is evident in everything, even in the sweeping and cleaning. Your skyscrapers are dollars invested scientifically!" Later pointing to the S on the dollar-sign, he said, "your captains of industry are the shrewd men who early guessed that that S stands for Science, who imported chemists and engineers to develop by Science the various industries, steel, oil, copper and building materials." Today an architect must know more than art; he must be a scientist or employ a scientific staff.

One has only to call to mind his travels abroad, his experiences with "lifts" that lifted up but not down, with plumbing without back air-vents, and recall the huge porcelain stoves pointed to with pride as marvels of heating and ventilating apparatus, to realize American building progress. The comforts and conveniences that the American accepts as a matter of course are all very new, very recent, and are not to be found in the most marvelous chateaux of France or the most attractive Venetian palaces. Our model tenements far excel the Doges' Palace in fireproofing, sanitation, comfort and convenience. In skilful building construction and marvellously convenient appurtenances, America leads the world.

DETAIL OF BANKING ROOM.

People have been attracted to the larger office buildings, hotels and apartment houses, not because they are large or high, so much as because of the superior excellence of their appointments and conveniences and the guarantee of safety from fire which they give. In a large office building or hotel properly designed with the steel frame fireproofed with baked clay, one is safer on an upper floor than in an old style five-storey building. Every new improvement is costly at first and is to be found only in the larger buildings where the cost pro rata is lessened by the number utilizing it. Thus the larger and higher the building the more up-to-the-minute it will be found to be in catering to the convenience and comfort of its tenants. The size and height of a building is therefore an index of its superiority in all respects.

There is here evident a fundamental natural principle—in union there is strength. There is also safety, comfort, convenience and the superior service and efficiency born of concentration. This explains why buildings tend to be high and also in part why they tend to be higher and higher.

Probably as a matter of economy of operation, the limit of height is about thirty-two storeys, but towers of twice that height, no

CLUB ROOM, BOARD OF TRADE

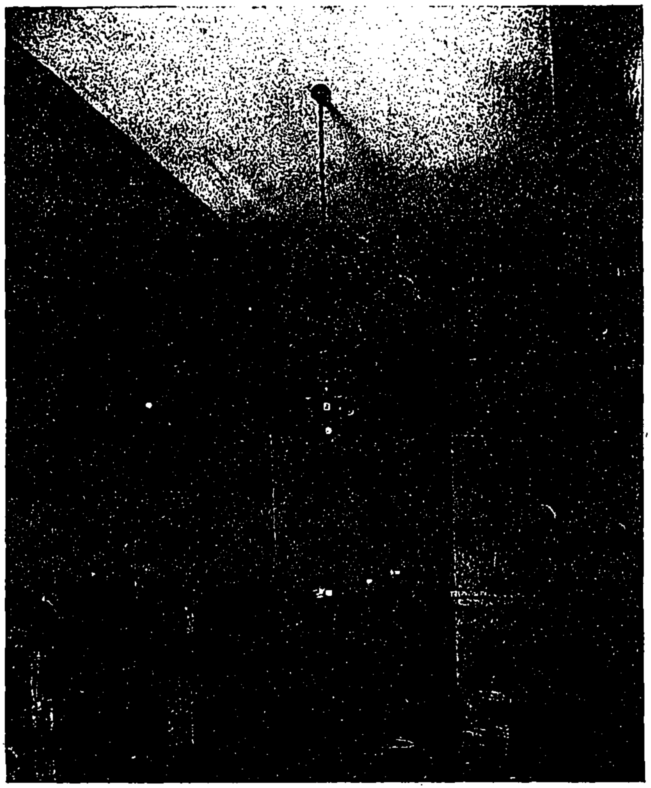
TREATMENT OF TYPICAL OFFICE SPACE.

doubt, will be constructed. There is no engineering drawback to the erection of such a structure or one even higher.

Still, probably no building exceeding fifty or sixty storeys will be constructed for some years. While the general trend is upward, a more detailed study of the statistics reveals a curious wave cycle in very high building construction as shown in our cities. This is probably due to the fact that there is a certain advertising prestige attached to the tallest building in a city, particularly in New York, with the result that there is strong competition for a while for the height record, and then a lull or period in which no very tall structure is projected. There is also the factor of over-production and adjustment after a number of tall buildings are completed and available for occupancy. This gives periods of pronounced activity, and more or less depression in very high building construction about sixteen years apart. New York has recently passed through such a period of competition for the highest record in the construction of the Singer Building, the Metropolitan Tower and the Woolworth Building, and it would seem likely that such a period of culmination will be succeeded by a period of indifference or decline of interest among financiers, engineers and the general public. Even the engineers who have had to do with this point of culmination are dubious; they have strained themselves to exceed the height record of sixten years ago, and for a new cycle a new, younger ambitious generation must be awaited.

That skyscrapers of more modest height are steadily being built in New York is beyond question. One has but to consult the existing records showing the total storeys in high buildings built year by year in New York. While there are evident in the curve times of lesser activity due to financial uneasiness, nevertheless the high building movement in New York has been steadily maintained, and at the present time is culminating in a period of unprecedented activity. Such activity would appear to indicate strongly that such structures are paying investments, for there is apparently no evidence of a falling off in production, even though there are numerous old-style buildings which are not fully occupied. Tenants find it helps business prestige and success to be occupying better office quarters and utilize the latest facilities so that a new tall building soon fills up, drawing the best class of tenants from the low antiquated structures about it.

It is but another illustration of the old business principle, "Quality wins." The commercial man having evolved a superior structure to meet his needs, it was not long before its



ELEVATOR HALL.

advantages led to the promotion of such buildings for quasi-business interests, and ultimately for apartments, hotels and clubs, and even church activities. In the better class of tall buildings the better light, air and service, and the quiet of the upper floors render them most desirable. They can be made absolutely safe against fire. Indeed nowhere does one seem more secluded and remote from the seething town than in a room in the pinnacle of a skyscraper. Here, strange as it may seem, time, space, and the eternal verities steal into one's thought as one gazes o'er land and sea for sixty or one hundred miles and then look down on the ant-like specks below. The poetry and democracy of the skyscraper we must leave to the poet and commentator of the future, confident that, when our cities are as old as Venice and Florence, our buildings will be one of the wonders of the world, and that, the softened record of time forgetting the harshness, the strife of the moment will speak but of the greatness, the glory, the indomitable energy and aspiration of the present hour. Let the architect who deplores modern conditions but turn the pages of the lives of Michelangelo or Benvenuto Cellini for examples of the strife and struggle and actual violence and personal danger that attended the practice of art in the glorious times past. An architect is not now set upon with swords and pikes by the henchmen of a rival, nor does he often bear to the grave a countenance mashed by an angered competitor, as did the great Angelo. It is no longer necessary for an architect to be a military engineer to gain the favor of a prince or be a sturdy man of arms ready to report with armed retainers at the call of his vassal.

ENTRANCE DOORS TO VAULT SPACE.

And yet it is true as ever that he must be in affairs, not in military affairs, perhaps, or in the street broils of the factions of the town, as was the rule in Florence and Venice, but in the larger sense he must be a man of affairs posted on what is going on, and on new methods and materials, their merits and possibilities.

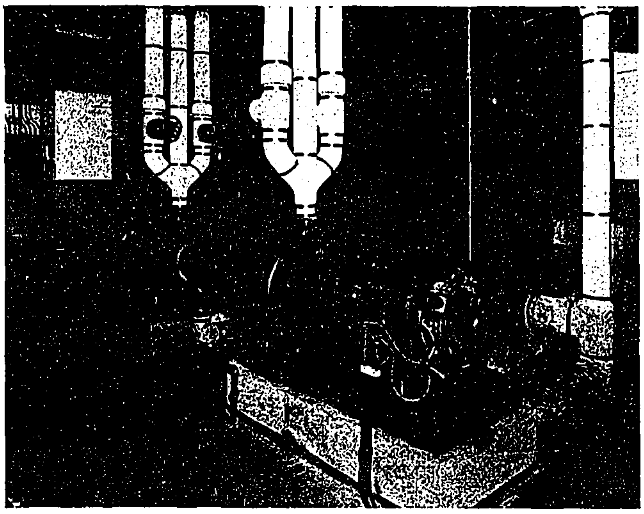
The tall building has succeeded thus far on its merits, which is a typical American proposition. Yankee ingenuity has evolved the best building in history. The practical man and the scientist have each contributed his best efforts to its success. The professor has been hailed in his labortory, called from his calculus. Get us something to do this, stop that, keep down the pressure of the unresting tides, help us weather the tempest's gusts and stand fast against its thrust. Get us an antitoxin for a disease of concrete-steel. Give us better metals.

This century can build taller buildings if called for. America can take from France the prestige of the Tour Eiffel, the tallest structure raised by hand of man, and outdo it in every form and feature. It has but to be called to the test; fresh from the conquest of the Panama Canal, where Gustave Eiffel, builder of the tower, designer of the Liberty Statue in New York harbor, failed ignominiously. Who doubts that the American engineer, successful where the Frenchman failed, can not excel the 300-meter tower of Eiffel?

As for the architecture, the architect must rise to the demands and possibilities of the hour. The dominant Americanism shines forth in many of the older tall buildings despite the drapery of dead forms of the Old World architecture with which they are covered.

Because a sensible Greek or Goth made a thing of beauty out of a waterspout by carving it into a lion's head or a gargoyle, must America forever have copies of these strewn over her buildings? The poverty of imagination and inspiration with which some of our architects have responded to the Gift of Time in the skyscraper is pitiable. Long have they been in learning that art is not something apart, but is the caress of an aspiring imagination to the work of the hour.

In the future the tall buildings will, no doubt, continue to maintain their supremacy in scientific safety and convenience, and when interest



DETAIL OF MECHANICAL EQUIPMENT.

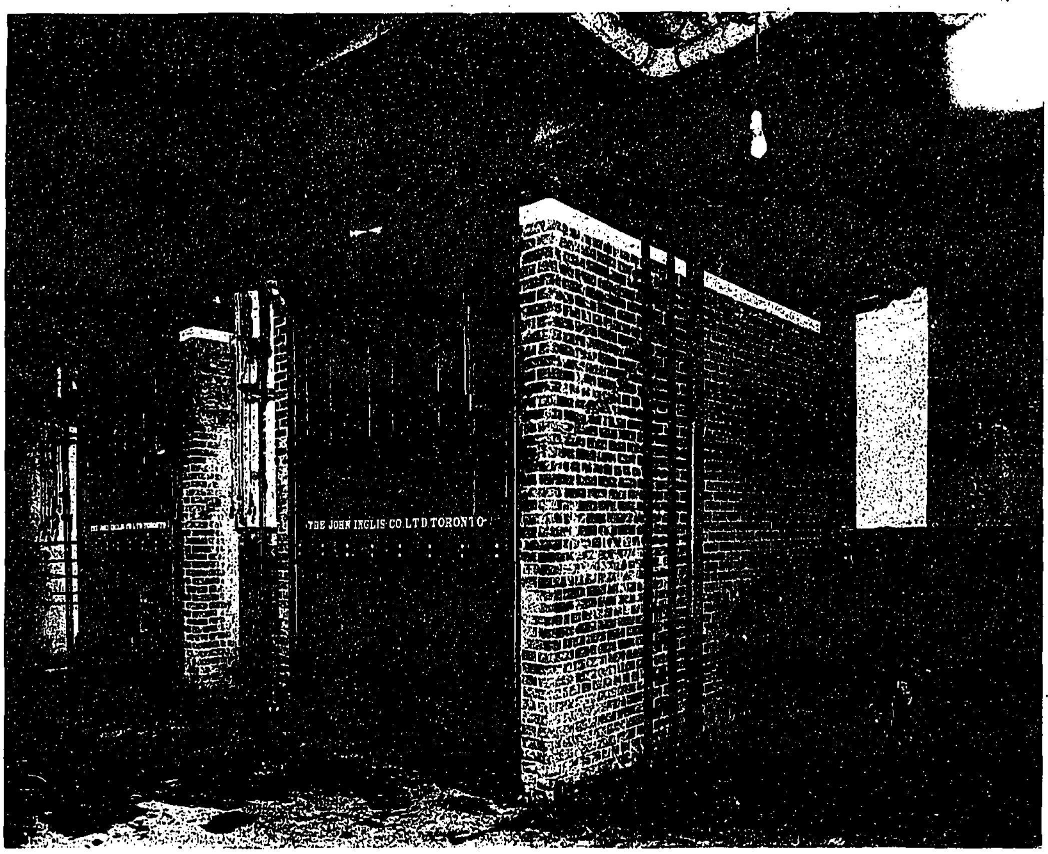
revives in the height record, after a period of rest, no doubt they will go higher still in the form of towers. Now that the scientific side of their development is highly perfected, one may naturally expect to see an effort to make them marvels of art as well as of scientific construction.

To achieve this, the architect must give way to the engineer or must once again gain the common touch, must know processes and products, the vital energies, the laboratory, even the dust of the trades, as did Phidias, Angelo and Leonardo da Vinci.

Then may be expressed the possibilities, the aspiration, the genius of his period, and the transplanted architecture of Europe will appear exotic, and America come into the heritage of Time and of the Ages, — American Art—virile, true, fundamental as the life processes of the nation, characteristic as the glories of her predecessors in the pageant of history.

Then will the tall buildings of the future take place not only among the world's greatest feats of engineering, but become also worthy monuments of the life of their time, become works of art and architecture. — *D. H. Ray, Sc.D.*

IN discussing the height of buildings, D. Knickerbocker Boyd, of Philadelphia, proposes that "any owner who contemplates erecting on any given street a building which will attract more people and more business to that particular portion of the street than it can be reasonably expected to accommodate, or worse still, than it actually will accommodate, should be made to furnish a somewhat adequate amount of space, or rendezvous, in front of it." He therefore suggests that the height of buildings erected on the present regularly established building line be limited to one and one-quarter times the width of the street or open space upon which the structure faces. This would give on a street 50 feet wide a 62½-foot high building (if erected at the usual building line), which would be equivalent to a six-storey building used for residential or office purposes or a five-storey light manufacturing establishment. Any building taller than this initial height should then, he thinks, be so set back that the cornice or top of its perpendicular face shall not extend above an imaginary line, which might be called the "building and height line." If this imaginary diagonal be drawn from the curb of any of these streets, assuming the sidewalk to be one-quarter the width of the street, to the top of any building which is the limit of height above mentioned at the normal building line, and continued into space, it becomes the line of restriction. Thus to go up, one must go back, forcing the face of the building back from the curb.



VIEW OF BOILER ROOM.

Some Possibilities in Ventilation

A. H. BARKER, B.Sc., B.A. *

NO PERSON who has carefully studied the problems of ventilation from the scientific standpoint can fail to have asked himself the question whether the theory of ventilation, as the ventilating engineer now knows it, can properly be called a science. Is there sufficient information on the subject of ventilation to make the application of that word to this knowledge appropriate? Modern practical science is nothing if it does not imply more or less exact knowledge. Some so-called sciences of the philosophical or metaphysical order appear to consist very largely of theories which never can be brought to exact tests. These are doomed by their essential nature to be what they are—namely, speculation more or less interesting and more or less probable, but always matters of opinion.

These, however, are not sciences as the term is understood by the engineer, but philosophies. They do not consist of exact experimental knowledge, but of intellectual theories. All true sciences in the engineer's sense in their initial stages probably pass through a period in which they consist largely of speculation and theories, some of which may or may not be borne out by subsequent experiments. Some of these sciences, such as chemistry or physics, at first consist of theories originally evolved in the effort to explain objective facts. If the facts are only partially observed, understood, or known, the theories will probably be erroneous. As the scientific world becomes better acquainted with the facts as they actually are, theories are modified to suit the known facts. They can be tested by specially-designed exact experiments. When, by a process of trial and error, theories are eventually evolved which will stand all known tests, some totally different in principle from others, and when the existence of facts previously unknown may be correctly deduced from the assumption that the theories are true; then, and not until then, can the science of which they form a part be said to be on a sound basis. There are other branches of science in which the theories cannot be put to exact tests, though their substantial truth is obvious from mathematical considerations.

Other sciences particularly applicable to engineering work are based on exact experimental science, though the conditions of practical application are such that it is in most cases impossible in practice to prove the accuracy of the theories on which they are based. Other experimental sciences, such as physiology, deal with problems of such extreme complexity that, though they are theoretically capable of investigation by exact methods, yet their complexity, and the number of known, though uncontrollable, factors are so great, and the number of unknown factors so doubtful, that it is difficult to obtain self-consistent experimental results to anything like the degree of accuracy which is considered necessary in other sciences.

The theories of the science of ventilation, such as they are, partake, to a certain extent, of all these characteristics. Its theories are at present in pretty much the same condition as were those of physics at the time of Newton. The number of uncontrollable factors is very great, greater than in most other branches of engineering. The number of unknown factors is probably considerable. The results which can be secured do not therefore approach in accuracy those which can be obtained in many other branches of engineering. All who have been practically engaged in the difficult task of securing generally satisfactory ventilation in occupied buildings know that it is impossible to lay down in exact terms the physical conditions which are required to be secured. Most of us could quote examples of buildings on which large sums have been spent in the effort to secure good ventilation, which, from the point of view of the comfort secured have been total failures. The reason for these failures are not always easy to define.

The science of ventilation, properly so called, has as its first duty to elucidate all such matters. All of those who have thought on the subject, and have had some practical experience, have their own theories. The special peculiarity of this branch of engineering is that it is exceedingly difficult to bring any of these theories to a crucial test. It is the first duty of the science to overcome this difficulty, which is partly inherent in the subject itself, and partly arises from the fact that the criterion of success is at present very indefinite. The only object we can specify at present is to produce feelings of comfort and a healthy climate. We cannot at present lay down the conditions necessary to secure this end in terms of physics and chemistry. Our knowledge is only general, not exact; qualitative, not quantitative. How can one get a measuring instrument which shall indicate, for instance, the feeling of comfort, especially having regard to the fact that what is one person's comfort is another's discomfort? A refreshing breeze to one man is an ear-aching draught to another man. A bald-headed man is not on the same basis as a person with a shock of hair. Still

*Extracts from lecture delivered at the University College in England.

more difficult is it to experiment on the effect of different conditions on health. The result, experimentally observed, does not arise perhaps for several years after the experiment is made, and it is complicated by the existence of a large number of other conditions which have a decided effect on the total result. Similar difficulties always must occur in any experiments on a human being.

I wish to consider the general direction of modern theories on these subjects, and the character of the investigations which we have in view for this year in this department for the purpose of putting some of them to the test.

In the first place, so it seems to me, the science must direct itself to the investigation of the fundamental question, which is as yet far from being decided. How can we lay down quantitatively in terms of physics and chemistry the objects for which we are striving? It is only recently that it has been borne in upon us that all the old-fashioned theories about carbon-dioxide, organic poisons, and the like, have been blown to the four winds by such experimentalists as Dr. Leonard Hill and Dr. Haldane. In place of them we have had theories of ventilation, according to which its function has practically nothing to do with the elimination of carbon-dioxide and the chemical purity of the breathing air. Instead, its object is said to be to remove heat from our bodies, and water vapor which we have breathed out; in general terms to prevent us from getting too warm.

That is one group of questions which must be settled definitely—to what extent efficient ventilation consists merely in the adequate removal of heat from our bodies and organic smells and water vapor.

I do not think it is possible for any impartial person, who has critically studied the mass of experimental evidence in support of this view, to avoid the conclusion that if it is not the whole truth, it is, at any rate, very largely true that what Dr. Leonard Hill calls "heat stagnation" is responsible for many, or, perhaps, most, of the effects to which we have been accustomed to refer as those of defective ventilation.

For my own part I am, however, equally sure that this fact cannot be the whole truth—that there is something in ventilation over and above the loss of heat and the suppression of smell. I am quite convinced that all air of the same temperature, pressure, humidity, and velocity, has not the same effect on the human organism That there is some quality other than temperature, humidity and velocity in the air itself which makes some air different in effect from other air. What it is can at present only be conjectured. From experience I believe that air loses that quality, whatever it is, which, with present knowledge, we can only describe as "crispness," when it passes over accumulated dirt, or into close contact with metal, or through a long underground pipe channel, or when it is heated by hot surface, and that this quality of crispness is not merely a matter of temperature, humidity, smell or velocity. Invalides feel the air of one place has a different effect on them from that of another place. If it were not so there would be no justification for sending people away to a special climate. It is important, however, not to lose sight of the fact that one cannot draw definite scientific conclusions from the sensations of any person, especially an invalid. Many of the sensations of every person are due to imagination and psychological influences, and not to objective facts, and these are most unreliable as a guide. There are persons not unduly sensitive, imaginative or susceptible to differences of climate, who find certain places or certain buildings of which the air, hot or cold, damp or dry, moving or at rest, has a stimulating effect on them, and other places or buildings which have the reverse effect. So far as it is possible to tell, this is not a subjective effect at all. I am sure from observations I have personally made that such differences are not merely due to differences in temperature, humidity or velocity.

Leaving out of count, however, for the moment the question whether or not it is the whole truth, I think we may provisionally accept the theory that temperature, humidity and velocity of air in a room are points of a very great importance in ventilation, of far greater importance indeed than chemical composition, and that one of the chief, but not the only, reasons for this importance is that they determine jointly the rate of heat loss from the body.

Let us consider where the acceptance of these facts leads us to in practice. If we accept the view that the object of controlling the temperature, humidity and velocity of air is *solely* to regulate the rate of heat loss from the body, it will be evident that the only instrument we require to measure the effect of ventilation is one which will enable us to determine the joint effect of these three factors so far as they affect the abstraction of heat from the body. On this assumption the possession of such an instrument at once raises the science of ventilation to a higher plane, for it enables us to measure the success of a scheme of ventilation objectively. At present we rely on the expression by individuals of subjective sensations. Up till recently no instrument has been available which enables us to measure this illusive quantity objectively. Air analysis is well known to be most fallacious as an indication of the feelings of comfort. Professor Hill himself has devised two instruments, which have for their object the determination of the degree of joint influence of the surrounding conditions in abstracting heat from a surface as nearly as possible approximating to the condition of the skin of the body. The simplest of these, which Professor Hill calls the "katathermometer," is in essence a delicate calorimeter consisting of a thermometer with a large bulb. The instrument is read by noting the rate at which it falls when it is raised approximately to the temperature of the human body and placed in the conditions or surroundings which it is desired to investigate. This instrument appears to contain the essential principle of what is required, although, so far as I can judge from the little experience I have had of it, the theory of the instrument needs to be worked out more fully than it has been up to the present.

The second instrument is the joint invention of Professor Hill and Professor Griffiths, to which they have given the name of the "caleometer." It is an electrical instrument, the object of which is to determine the amount of electrical energy required to maintain a coil of wire at the temperature of the human body in the given surroundings. Fundamentally this instrument has essentially the same object as the katathermometer. Both of these instruments will, I think, need careful calibration, and perhaps development in some details before they will be generally accepted by the ventilating profession.

Let us consider for the present only those factors which have an obvious effect on the heat lost, although with the reservation that the joint effect of the three factors in regulating the heat lost is probably not the only effect of importance which the individual factors have. One cannot avoid the conclusion that movement of air has a pronounced effect, quite independently of its effect in promoting loss of heat. Let us examine the physical effect of different volumes of air in cooling one individual. An ordinary human body may, perhaps, be taken to give off heat at the rate of 350 B.T.U. per hour. Of this total quantity something like 200 B.T.U. is given off in the form of radiation and convection together, and 150 B.T.U. is evaporization from the surface of the skin and from the lungs. If, therefore, we rely on the passage of air over the body to remove this heat and this vapor, we must examine the effect of these quantities on different volumes of air at, say, 60 deg. Fahr. and 65 per cent. humidity. It should be noted that this is a purely physical result, dependent on definitely known, though somewhat variable, factors. It will be noticed that I have included the heat radiated from the body with the total heat. In fact, some of this radiation will be absorbed by the walls, and will not be communicated to the air. The amounts are difficult or impossible to determine. I have therefore thought it best to include the whole of the radiated heat with that convected, in order to derive the maximum possible effect. It is evident that if we fix as an arbitary limit a rise in temperature of 3 deg. and a rise in humidity of 5 per cent., both above our arbitrary standard, we shall find that not less than 3,500 c. ft. of air per hour per head must be supplied, as a minimum for satisfactory ventilation on this basis, or roughly 1 cub. ft. per second per head. Let us take this as a provisional value for satisfactory ventilation. It is at least three or four times as much as is commonly now considered tolerable ventilation.

Let us now consider the possible different ways of introducing the air. It may be imagined to be introduced in a vertically upward direction, the fresh air coming in uniformly round the person's feet and being removed at the ceiling. That is a state of things which is described in my book as being pure upward ventilation. There are very few buildings ventilated in this manner. The best known example is the House of Commons. In spite of the enormous volume of air passing through that chamber, the bad ventilation is notorious. It is clear that the effect of this method of introducing the air must be to drive the heat and vapor given off by a man's body up into his face, so that his face gets the hottest and most humid air, and his feet the coldest and driest. This condition is the exact opposite of a desirable state of things. I believe that physiologists are all agreed that the rate of loss of heat from the face and hands ought to be far greater than that from the feet. This would seem to indicate that from this point of view downward ventilation, as it is called, is superior; and it has certainly been my experience that well-designed systems of downward ventilation cause less trouble and complaint than do those in which the direction is upwards.

But let us consider the effect of passing this quantity of air vertically in either direction over a man's body. Suppose each man occupies a floor space of 6 sq. ft. Taking his own mean cross-sectional area as 1 sq. ft. this leaves 5 sq. ft. for the passage of the air. The mean upward velocity of the air over this space will be about 2½ in. per second. The air in actual contact with his body being entangled with his clothes will have a considerably smaller velocity than the mean. The heat from the body may cause a local circuit similar to a vortex-ring, but in any case the velocity of the air close to the body can never exceed a very few inches per second if the direction of the ventilation is either upwards or downwards. As this is absolutely insufficient, it is my own belief that neither pure upward nor pure downward ventilation is desirable; and this was the point of the chief criticism of the present ventilating arrangements of the House of Commons. Neither the one nor the other represents Nature's method of ventilating the human body. This is in all cases done by a horizontal velocity of wind. My own view, which I hold very strongly, is that a horizontal velocity must also be produced before indoor ventilation can be regarded as satisfactorily accomplished.

For one reason, a vertical current does not admit of a sufficiently high rate of heat removal. It does not prevent the heat from stagnating round the body. I believe also that some horizontal velocity of the air is necessary, either to stimulate the nerves of the skin or for some other physiological purpose, quite independently of the loss of heat from the body. The reason is, of course, a question of physiology. Of the fact itself I am quite sure as a matter of experience—namely, that a generally satisfactory draughtless ventilation is a contradiction in terms.

If it be granted that a satisfactory feeling of freshness cannot be secured without some horizontal movement of the air over the face, the question at once arises—what movement of air is necessary? If we are engaged in the difficult task of ventilating big spaces where a large number of people are crowded, and where the air is very hot and moist, what velocity of air are we to aim at producing? As practical persons we can only answer this question by laying down that it is to be not greater than a velocity that all people will endure without complaining. If we produce a greater velocity than this, then sensitive persons will complain of draught, and we shall find ourselves in trouble. We must therefore find by experiment what is the maximum velocity which people will endure. That question can only be decided by elaborate experiment.

What one would desire to be able to do in this connection is to prove that a certain person could endure without discomfort in humidity conditions represented by, say, 65 per cent., an air current at a temperature of, say, 60 deg. and a velocity of 18 in. per second, but that a current at the same temperature and humidity, with a velocity of 22 in. per second, would begin to be felt as an uncomfortable draught. This condition would represent that person's maximum. The same person in the same conditions might find a velocity of 12 in. per second perceptibly refreshing, whereas a velocity of 9 in. per second would begin to be felt as rather stagnant and stuffy. This, therefore, would represent that person's minimum.

It will be evident that as these figures merge into one another by imperceptible degrees, and as the only possible measuring device is the sensation of the person under test, a correct determination will be of extraordinary difficulty. Such figures obtained from one person would not be sufficient. It would be necessary to subject as large a number as possible of persons of different physique to the same experiment, and take as careful note of the effect in each case as possible. By this means we may conceivably arrive at a certain medium velocity of air of suitable temperature and humidity, which should not be perceptible to anyone as an uncomfortable draught, while in all cases it produces a feeling not of cold, but of refreshment. This is the velocity of air which the ventilating engineer should aim at producing. This velocity must depend, to some extent, both on the temperature and the humidity of the air. For instance, a velocity of 18 in. per second, which, for want of a better, we may take as a provisional standard, would produce quite a different effect when the air was at 60 deg. and the humidity at 65 per cent. than when the temperature was at, say, 65 deg., and the humidity, say, at 80 per cent. To make our experiments complete, we should have to develop a set of equations showing the relation between the value of the three variables in respect of their effect on the sensations of the human being. For instance, possibly it might be found that an increase of 2 per cent. or thereabouts in the relative humidity might approximately neutralize a drop in temperature of 1 deg. at or about the standard temperature. I have no doubt that if such experiments were carried out it would be found that all persons could endure a velocity of air possibly 6 in. per second greater at 65 deg. and 80 per cent. than at 60 deg. and 65 per cent.

In determining, therefore, what is the desirable air velocity in a room, we must take count of the existing conditions of temperature and humidity. Let us assume the following rule for satisfactory ventilation so far as such can be secured by the control of three conditions: That the air temperature should be, say, 60 deg. Fahr., and the humidity 65 per cent., and the general horizontal velocity should not be far from 18 in. per second. Present knowledge properly applied would enable us to ensure that the first two of these conditions were maintained—that is to say, a competent person could design a plant which should deliver any desired supply of air at 60 deg. and 65 per cent. humidity. We have now to inquire how far it is possible to secure the third condition—namely, that the horizontal velocity should not be far removed from 18 in. per second. In what way can this horizontal velocity be secured in practice? We may imagine air driven over the audience from front to back or from back to front, or from one side to the other. My own view is that the best method would be from the front to the back.

It is a general maxim that fresh or cold air must be introduced at a certain height, say 8 ft. or so above the floor. Even on this we are not agreed. There are persons who do not approve of the introduction of air overhead for fear of producing what is called a "down-draught" on people's heads. That there is something in this view cannot be denied. If one chief function of ventilation is the removal of heat and moisture, then it is clear that we can only ventilate a room by introducing air colder and drier than the average air of the room. The body of each person present in the room is continually warming and moistening the air, and this heat and moisture must be dispersed by the introduction of colder and drier, and the drawing-off of warmer and more moist, air. But air which is cold and dry is of necessity heavier than that which is warm and moist. It therefore follows as a mathematical certainty that if cold, dry air is introduced overhead it will fall to the floor so soon as it is free, and is surrounded by air which is warmer and more moist. In other words, it will produce a down-draught. This would only be tolerable if it were practically imperceptible. It could only be imperceptible if it were introduced not in a mass, but in finely divided streams. This implies that at least a large part of the wall through which it is introduced should consist of gratings. Any air which we introduce overhead must be at such a temperature and humidity that it does not cause a current round people's heads greater than the allowable maximum. We ought, therefore, to be informed under what precise conditions cold air can safely be introduced overhead. This is a matter quite capable of exact investigation, and we ought not to be compelled to rely on guesswork, as we are at present.

Let us consider then the practicability of a scheme for driving the air from the front of a room to the back. I will take a concrete case of a room in the country in which I was lecturing some time ago containing about 100 persons. The size of the room was about 20 ft. wide by 40 ft. long and 11 ft. high. This allows about 8 sq. ft. of floor space and 88 cub. ft. of air space per person. It would not be possible in practice to cause a horizontal current to occupy a shallow layer just over the heads of the audience, and keep the air more or less stagnant at a higher level, where, of course, the current is useless as far as its direct effect on the audience is concerned. We can only assume that the current must occupy the whole of the vertical cross-section of the room between the heads of the audience and the ceiling. If we are to imagine that a uniform current of 20 in. per second is maintained over this audience over the whole cross-section from front to back, the amount of fresh air called for even in this low room would be about 1,320,000 cub. ft. per hour, or about 150 interchanges per hour, or 13,200 cub. ft. per head per hour.

There are few persons who would advocate the spending of so large an amount of money necessary in order to secure theoretically perfect ventilation for a room of this size, and I am sure there is not an architect in the world who would willingly consent to the whole of the front of the room being occupied by gratings in full view of the audience. Of course, if the audience were larger, the requirements would be proportionately heavier. An audience of 2,000 persons would require at least ten of the largest size of multivane fans now catalogued by makers, each standing 12 ft. high. The total power required to work the fans would in this case be not less than 80 horse-power. The fan-power would, of course, be required whether the air supply were all fresh or were recirculated. If we are to imagine the air recirculated, it is clear that, in order to keep the humidity down, it would have to be de-humidified as it passed through the underground trunk.

The only practical way of de-humidifying the air to an exact value at present known is to cool it to such a point that, when it is absolutely saturated at that point, it contains the requisite amount of absolute humidity. It is then warmed up to the desired temperature. Now, the plant for this apparatus would be very expensive indeed. In order to kill the possible smell of human beings in the air, it would be necessary not only to de-humidify, but also to pass it through a spray of disinfectant, such, for instance, as a solution of permanganate of potash, which would probably kill all the smell.

We have now to inquire whether any smaller requirements would serve the purpose. It will be remembered that, calculating from a certain arbitrary allowable rise in the temperature and humidity, we deduced the allowance per head per hour as 3,500 cub. ft., whereas calculating from an arbitrary velocity over the audience in a room 11 ft. high, we arrived at 13,200 cub. ft. per hour. If we could reduce the height of the stratum of moving air, we could reduce the quantity of air in proportion, and still maintain the standard velocity. But it is impossible to conceive a large room for 100 persons less than 11 ft. high. If we have a higher room—such, for instance, as the Albert Hall or the House of Commons—even such an allowance as 13,000 cub. ft. per head per hour would of necessity be quite lost if we attempt pure horizontal ventilation. The main stream of air would follow the line of least resistance. In ventilating a room of this kind, therefore, it seems that the only practicable solution is a combination of horizontal and downward ventilation when such is attainable, so as to pull the main stream of air into contact with the audience; otherwise it will be lost above the heads of the audience.

One of the main effects which the modern theories of ventilation will have on our practice, if they are carried out, will be to produce a sharp difference of opinion between the physiologist and the heating engineer in regard to the method of heating by means of hot radiators and pipes. The main effect which radiators and hot surface generally have on the condition of a room is to raise the temperature of the air, and, worse than this, they make the upper strata of air warmer than the lower.

The modern view which physiologists take of this matter is that the breathing of hot air is distinctly deleterious, in that it causes the membranes of the nose to get into such a condition as easily to absorb the germs which produce the disease known as cold in the head and other respiratory diseases. Within limits, the cooler the air breathed, the better it is from the point of view of pure hygiene. Physiologists also take the view that it is extremely undesirable that the temperature at head level should be higher than at foot level, since it causes certain movements of the blood in a contrary direction to what is desirable. It is quite obvious that since warm air is lighter than cold air, there cannot fail to be a tendency for the temperature at high level to be greater than at low level when the heat is introduced by warming the air. This effect is always found in a radiator-heated room. From this point of view, radiator-distributed heat may be regarded as undesirable from the point of view of hygiene. The effect is well known to be influenced very largely by the temperature of the radiator. The higher the temperature of the radiator the greater is the difference between the upper and the lower layers of air in the room.

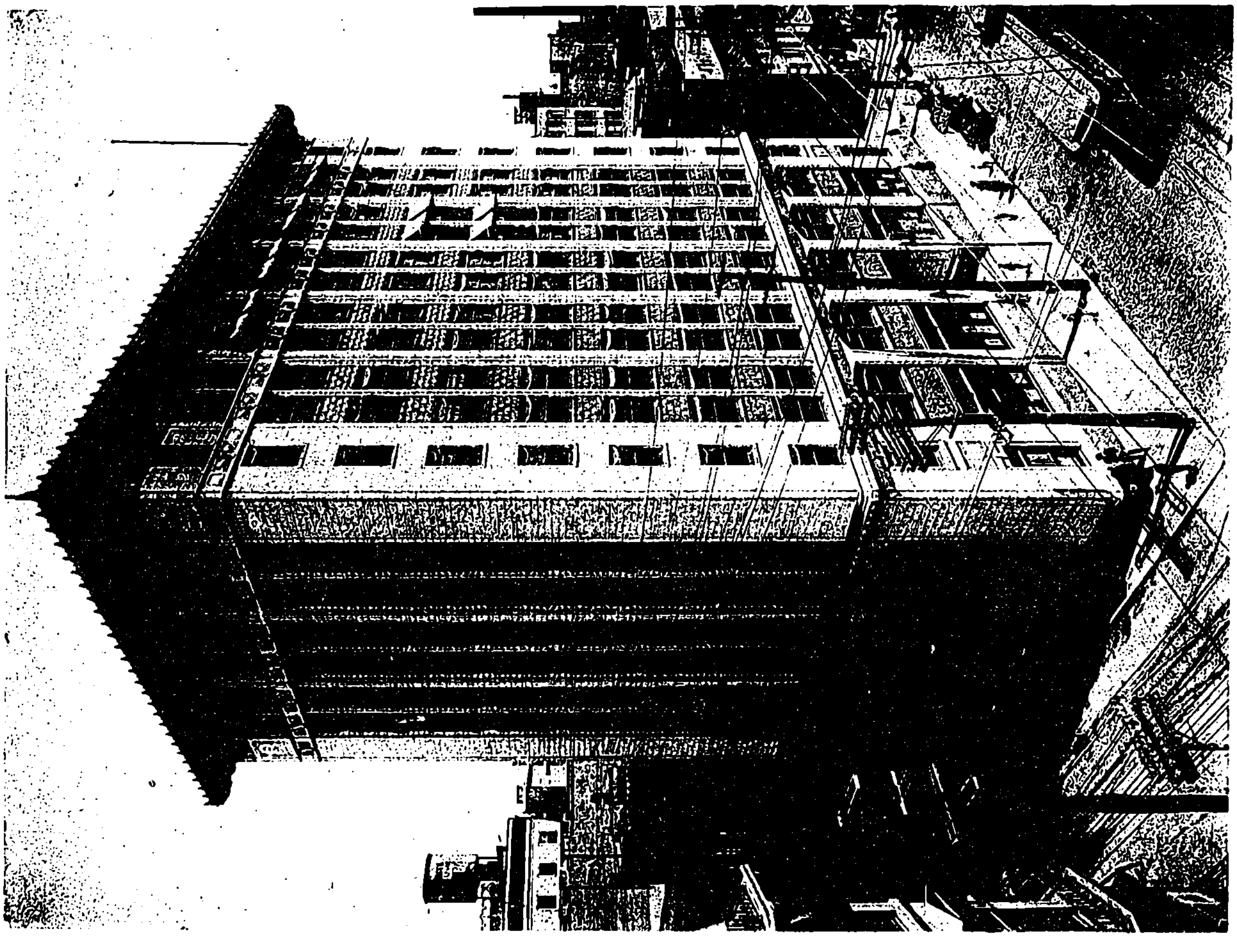
The distribution of heat by radiators is, however, so convenient that it is impossible as a practical proposition to recommend its abandonment whether or not it conforms strictly to the requirements of hygiene. It is for this reason very desirable that the necessary amount of heat should be communicated to a room by large radiators at a low temperature, rather than by small radiators at a high temperature. It is also necessary that the feeling of warmth in a room should be properly maintained, but it is also very desirable in the interests of the individual that he should accustom himself to living in a relatively low temperature.

The only means whereby this feeling of warmth can be secured apart from the warming of the air is by increasing the amount of energy in radiant form passing through the room. This radiant energy is always expensive to maintain, firstly, because a large part of the heat given off from a radiant body is always converted heat, and because a large part of that which is given off as radiation at once passes away through the window glass and the cold walls of a room, and is thereafter largely lost, so far as its effect on the inhabitants is concerned. On the other hand, heat communicated to the air of a room is not only easier to produce, but also remains in the room as heat for a much longer time. This is one reason why an open fire is so extravagant, desirable as it is in many ways. A large part of its heat is sent up the chimney as hot air. That part of the heat which is given off as radiation, unless it impinges on the body of the person in the room, is immediately lost, either by absorption or transmission through the window glass. It is difficult or impossible to obtain a correct balance-sheet of the heat given off when coal is burnt in an open fire, for the reason that the heat radiated is so illusive that it cannot easily be measured without very elaborate appliances.

It will be seen, therefore, that the modern theories of ventilation, which at first sight appear to render possible a reduction in the heat cost of ventilating a room, in reality have a very marked tendency in the opposite direction. They increase to a very large extent the practical difficulties, the amount and expense of the plant required, and they increase also the cost of upkeep. If they are to be carried into practice they will call for something like a transformation in methods of building, and they will certainly be regarded with acute disfavor by every architect who is interested in the interior appearance of a large room.

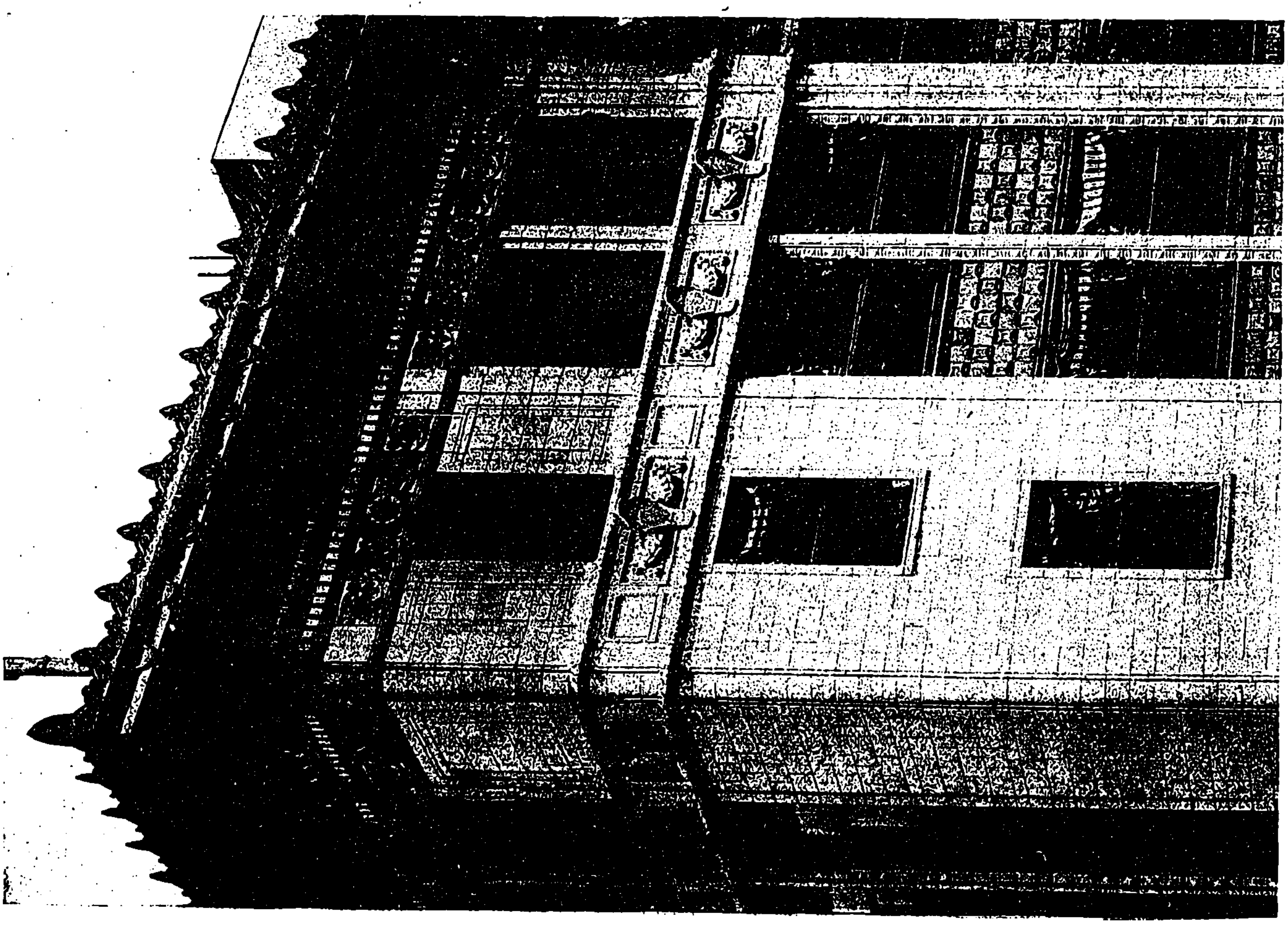
I will summarize now the observations which appear to me to be necessary in order that we may get a complete idea of the state of the ventilation of any given room. We must have the wet and dry katathermometer readings. We must know the absolute temperature of the air, and the mean radiant temperature. We should have readings indicating the velocity of the air at all parts of a room when the room is full. We should have also the analysis of the air, and particularly know what amount of organic products and dust exist in the room. We should take the electrical readings, and determine the degree of ionization of the air of the room.

It will be seen that this is a sufficiently formidable list. It would not be possible for anyone to take all these readings with any sort of care even for a small room under a couple of hours' hard work. He should also be provided with very expensive and elaborate apparatus. I am not, of course, suggesting that such a series of observations would be possible in practice when a room is occupied, but it merely shows what a very extensive subject we are dealing with, and how little anyone would be justified in concluding that the subject of ventilation can be treated in a cut-and-dried manner.



McGILL STREET BUILDING, MONTREAL.

R. E. BOSTROM, ARCHITECT.



Wind Bracing in Tall Buildings

R. S. PATTERSON, B. A. Sc. *

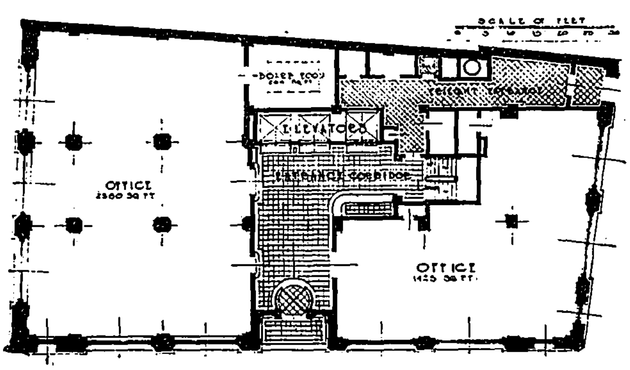
THE question of wind bracing in tall steel buildings of the skeleton type has evoked considerable discussion as to methods and design in the last few years. One class of structural designers has made ample provision in the steel frame for lateral stiffness based upon direct computations of wind stresses; while on the other hand, another class has ridiculed all mathematical treatment, and used "rule of thumb" methods for design. The exact treatment of this part of building design would lead to hopeless intricacy whether diagonals, knees, or portals are employed to transmit the lateral wind pressures. Although an exact determination of stresses is difficult, if not impossible, it does not follow that a mathematical analysis is useless and without any rational basis. The investigation of the stability of a steel frame building subjected to wind pressures must be solved in accordance with the fundamental laws of mechanics and strength of materials as determined from the theory of flexure.

In very tall buildings the calculation of wind stresses and the design of frame work to afford the most rigid and economical resistance to them, while conforming to architectural requirements, are matters which sometimes have relatively large dimensions in both directions, the inertia of the building, the stiffness of walls and floors and the inherent strength of the beam and column connections generally used, may afford sufficient rigidity, and precise calculations are often omitted.

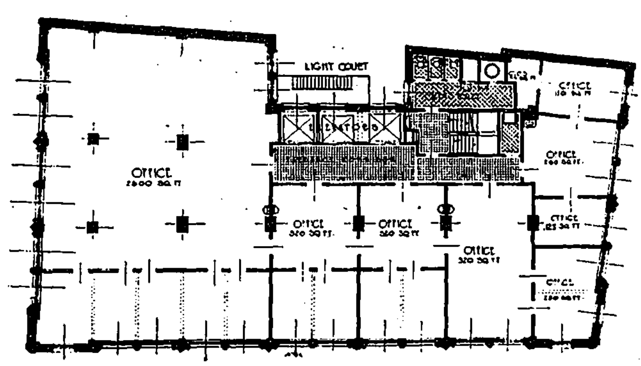
When the building is comparatively tall and narrow the elasticity of the steel frame makes it necessary to make definite provision against horizontal forces in at least one direction, the steel skeleton being usually considered as a vertical cantilever exposed to horizontal wind forces in every direction, in the upper part at least, and sometimes for the entire height of one or more sides not protected by adjacent buildings. In the usual case of a transverse bent of several columns it is impossible with the means of analysis at present available to determine how much of the vertical loading on these columns is transferred by the wind pressure from each column at windward side to each column on leeward side, although it is absolutely certain that such a redistribution takes place. This condition makes it impossible to determine with certainty both the horizontal shears transmitted through the columns and the bending moments to which columns and girders are subjected.

The design of the steel frame of high buildings must certainly include as one of its main features suitable effective provisions for wind loads whose effects run through the entire height of the structure, and by which the transferred loads influence materially the foundation pres-

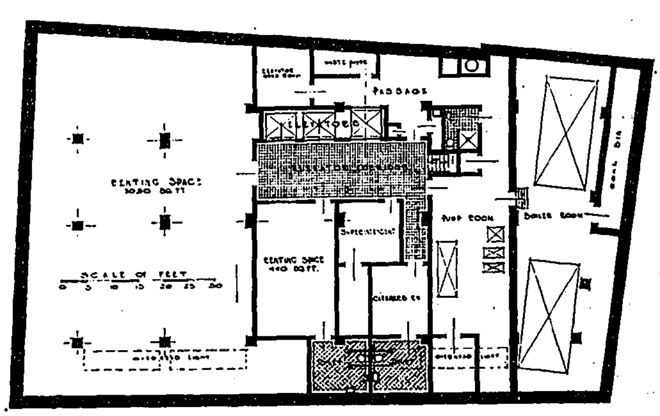
*Written for *Applied Science*.



GROUND FLOOR PLAN.



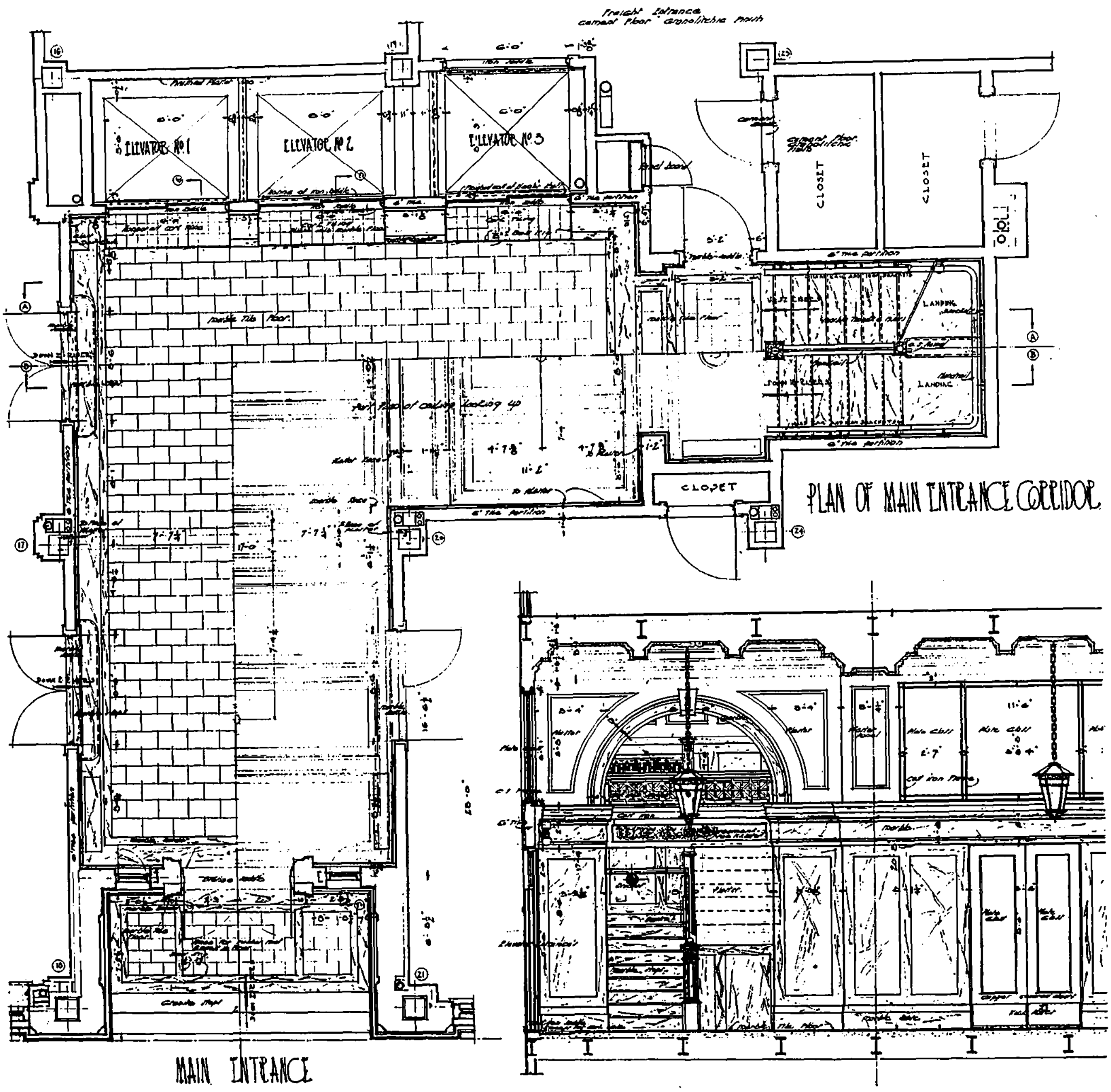
TYPICAL FLOOR PLAN.



M'GILL STREET BUILDING, MONTREAL.

R. E. BOSTROM, ARCHITECT.

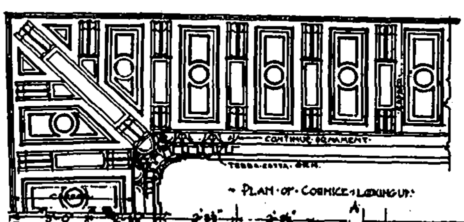
BASEMENT FLOOR PLAN.

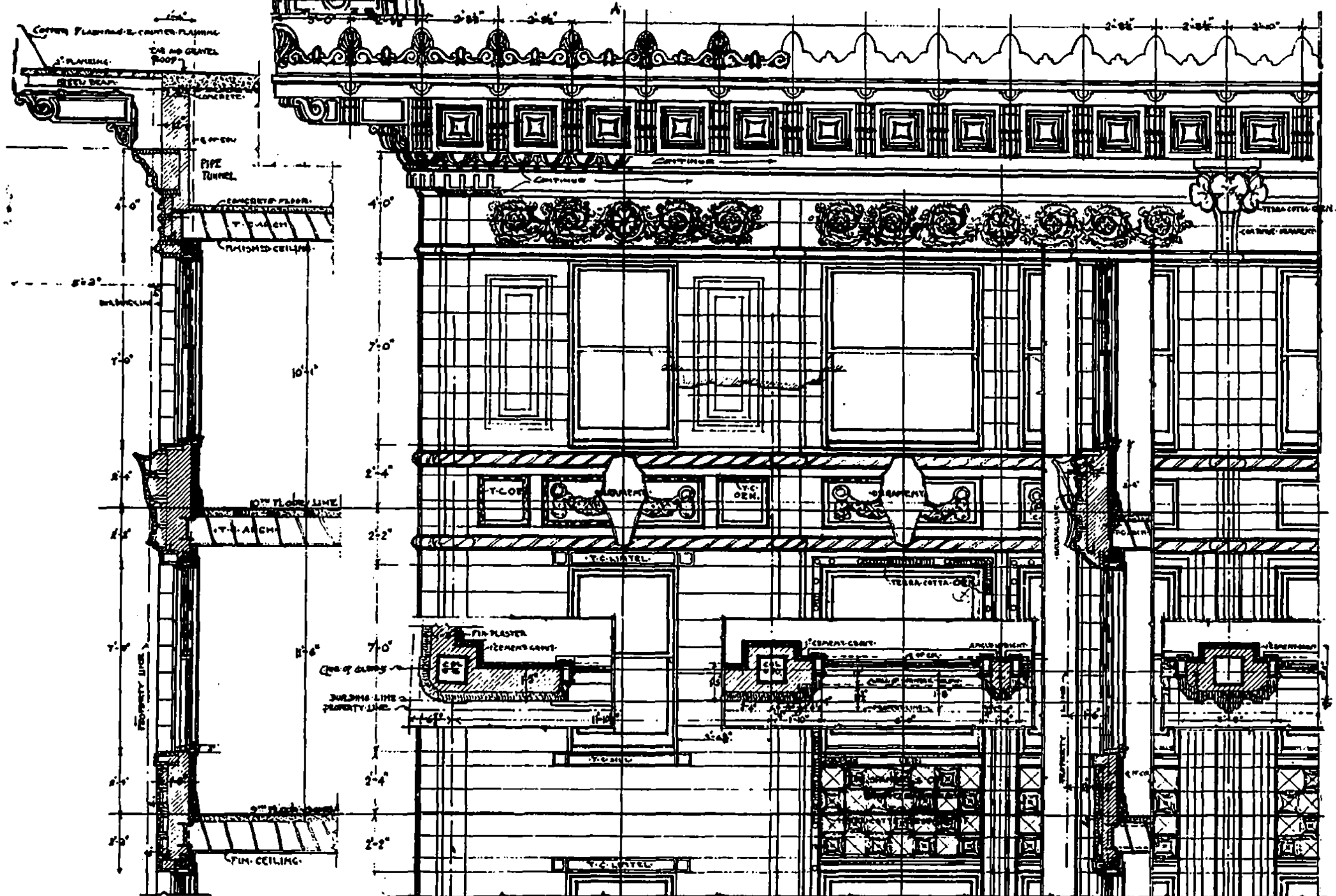


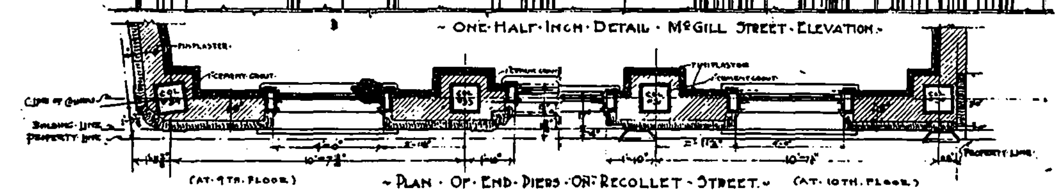
DETAILS OF MAIN ENTRANCE CORRIDOR, M'GILL STREET, BUILDING, MONTREAL.

sures if satisfactory results are to be obtained.

Wind Pressures:—Wind pressures on small surfaces have been recorded as high as 50 pounds per square foot, but it is doubtful if such pressures exist on large surfaces, as sides of buildings. A few of the influences which affect the intensity of wind pressures will be summarized briefly: Effect of Altitude on Wind Pressures.—Since air is lighter in greater altitudes the wind pressure will also be less. In addition to and quite distinct from this, it is also clearly recognized that the pressure varies as the distance above the general level of the surrounding territory, increasing towards the top of the structure. Effect of Temperate Changes.—W. H. Whitten made a careful study of the effect of temperature changes, and his conclusions were: (1) That the pressure increases as the temperature drops, if the velocity is constant and barometer readings normal; (2) that the pressure increases and diminishes as the barometer rises and falls. Effect of Suction.—Rapidly moving air produces a suction on the leeward side, there being a partial vacuum developed in the constant vortex or eddy on this side. Professor Albert Smith reduces the following laws with regard to suction: (1) Increase in height tends to increase relatively the average amount of suction on the leeward wall; (2) the relative amount of air flowing around the end of building increases as the height increases. Effect of Gusts.—The maximum wind pressures are of short duration, probably only for a second, but sometimes occur at intervals, and thereby tend to set up an oscillation in structures they are capable of influencing. To some extent the wind impulses are absorbed in overcoming the inertia of the structure, being exhausted in internal work. Should the wind come in gusts, overcoming the inertia of the







EXTERIOR DETAIL OF CORNICE, M'GILL STREET BUILDING, MONTREAL.

building, and causing the building to oscillate, and if the oscillations and wind impulses act together, the vibration would be increased and there would be danger of the building collapsing. Existing experiments tend to indicate the period of vibration of a tall building is several seconds (about 2 to 4 seconds), and thus the likelihood of such an agreement taking place does not seem possible. It seems advisable that the increased pressure due to gusts should be considered in designing tall building frames.

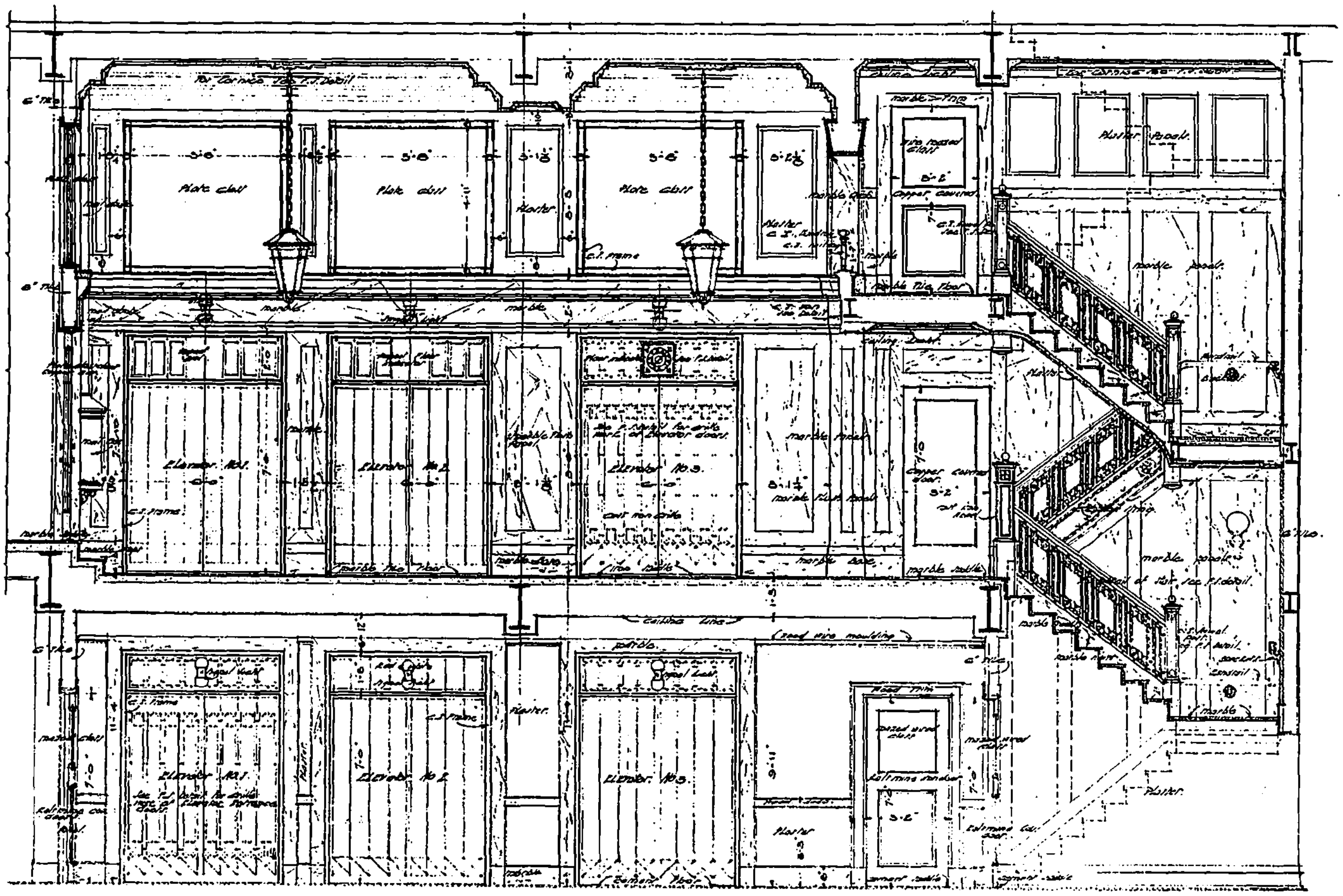
Effect of Wind on Buildings:—The effect of wind pressure tends to overturn the building on its base. In tall narrow buildings this overturning effect must be investigated, and if necessary, provision made for it by anchoring the columns of the foundations. Common specifications state that if the overturning moment exceeds 75 per cent. of the moment of stability, anchorage for the columns must be provided. From the footing plan the column loads and their point of application can be taken off and by the principle of moments the point of application of the resultant weight can be found. Knowing the magnitude and point of application of the resultant weight, the moment of stability can be readily computed.

It may give way in a horizontal direction under the influence of shearing forces either by lateral displacement from its foundations or by buckling of its various members on account of their weakness to resist these forces. If the buildings were safe against overturning it would ordinarily be safe against sliding bodily, and for the sliding tendency to be considered the width of the base must be two-fifths or more of the height. The tendency to shear the connections is one of the most important features of wind pressure. Special attention should be given the column splices and the connections of floor girders to columns. The details should be sufficient to develop the strength of the main part of the member and to give the required rigidity at the joints.

Deflection in a bent to leeward due to wind pressure will be the result of a combination of three actions—first, the elongation of the tension columns and the shortening of the compression columns; second, the deflection of the floor girders; third, the deflection in the columns, Factors affecting the amount of deflection are the sizes of the columns, their unsupported heights, and the number of columns in a cross section. In buildings in which the ordinary beam connections are used with no special bracing, as the connections are capable of transferring only small bending moments, the deflections will be large. It will be seen that if the girders cannot take care of any bending at the connections, and there is no other factor to resist distortion, then the frame must simply close upon itself under lateral forces.

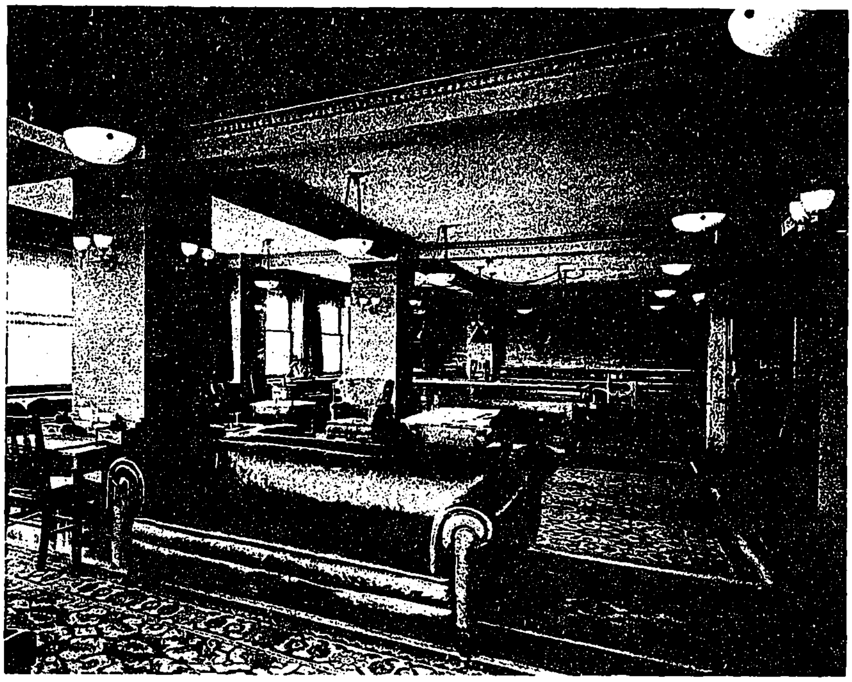
The few experiments on the deflection of tall buildings seem to reveal the fact that the actual deflection is less than the computed. Experiments on a seventeen-storey building by Dr. Melick show that walls and partitions reduce the deflection about 40 per cent., and they seem to be secondary and not primary agencies in resisting distortion to wind. His conclusions were that, when proper account is taken of the velocity and pressure of the wind, vibrations and deflections computed on the basis of the steel frame resisting all the pressure, will be only slightly in excess of those actually existing. A twisting as well as a direct deflection will be induced in the building if the bracing is not symmetrically disposed with respect to the centre line of the building.

Necessity of Wind Bracing:—The New York building by-law requires that all buildings exposed to the wind (except those under 100 feet in height, in which the height does not exceed four times the average width of the base) be designed to resist wind pressure. This may be regarded as representative of the type of building requiring no bracing. In structures of the skeleton type which have relatively large dimensions, the dead weight of the building, the stiffness of the walls, partitions and floors, and inherent strength of column and girder connections may afford sufficient rigidity, and precise calculations are often omitted. The relative merits of each of the elements mentioned in the above statement for resisting wind pressures will be discussed in detail. The stability of a steel frame building must depend upon its dead weight or its steel framework. The weight of the building affords some resistance, but it is not altogether a dependable quantity. The greater the weight the greater the moment of stability. The moment of stability may be computed as previously outlined under "Effect of Wind on Buildings." Distortion may be resisted by the compressive strength of the curtain walls, but as they are usually cut up by numerous windows they cannot be relied upon to act in conjunction with the steel frame.



DETAILS OF MAIN ENTRANCE CORRIDOR, M'GILL STREET BUILDING, MONTREAL.

Partitions as ordinarily constructed are too thin to resist shearing stresses, and their location is never definitely and finally known to the designer, in as much as they are liable to removal at the will of the tenant. They are often omitted permanently on the first floor, and in many cases are not put in the upper floors until rented, when the tenants' wishes as to subdivision can be learned. Mr. Purdy states that if partitions be omitted on one floor it is nearly as bad as if they were omitted on several. It is doubtful if much reliance can be placed upon partitions for cross framing to transfer shearing stresses into vertical reactions.



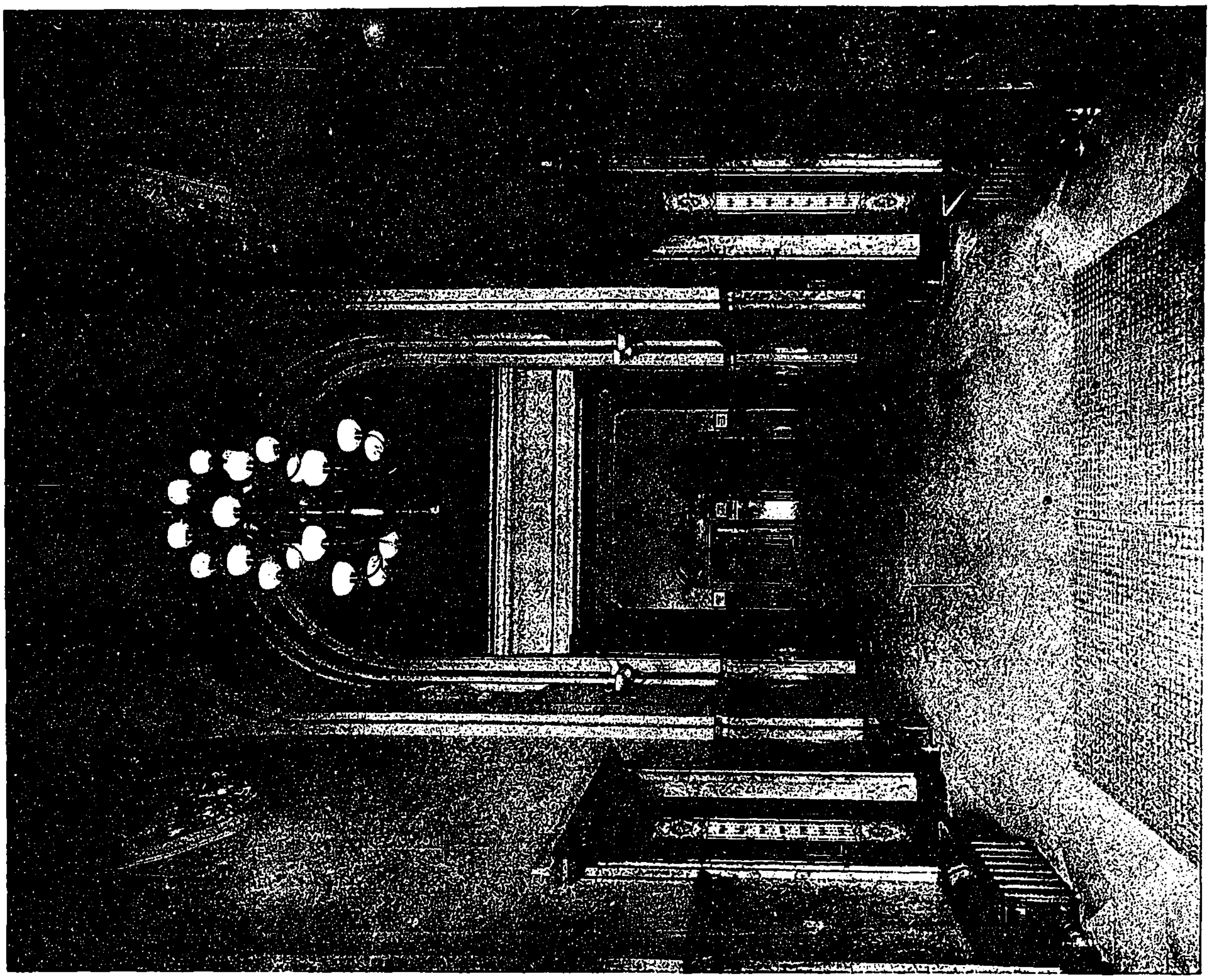
ONTARIO CLUB ROOM, M'GILL STREET BUILDING, MONTREAL.

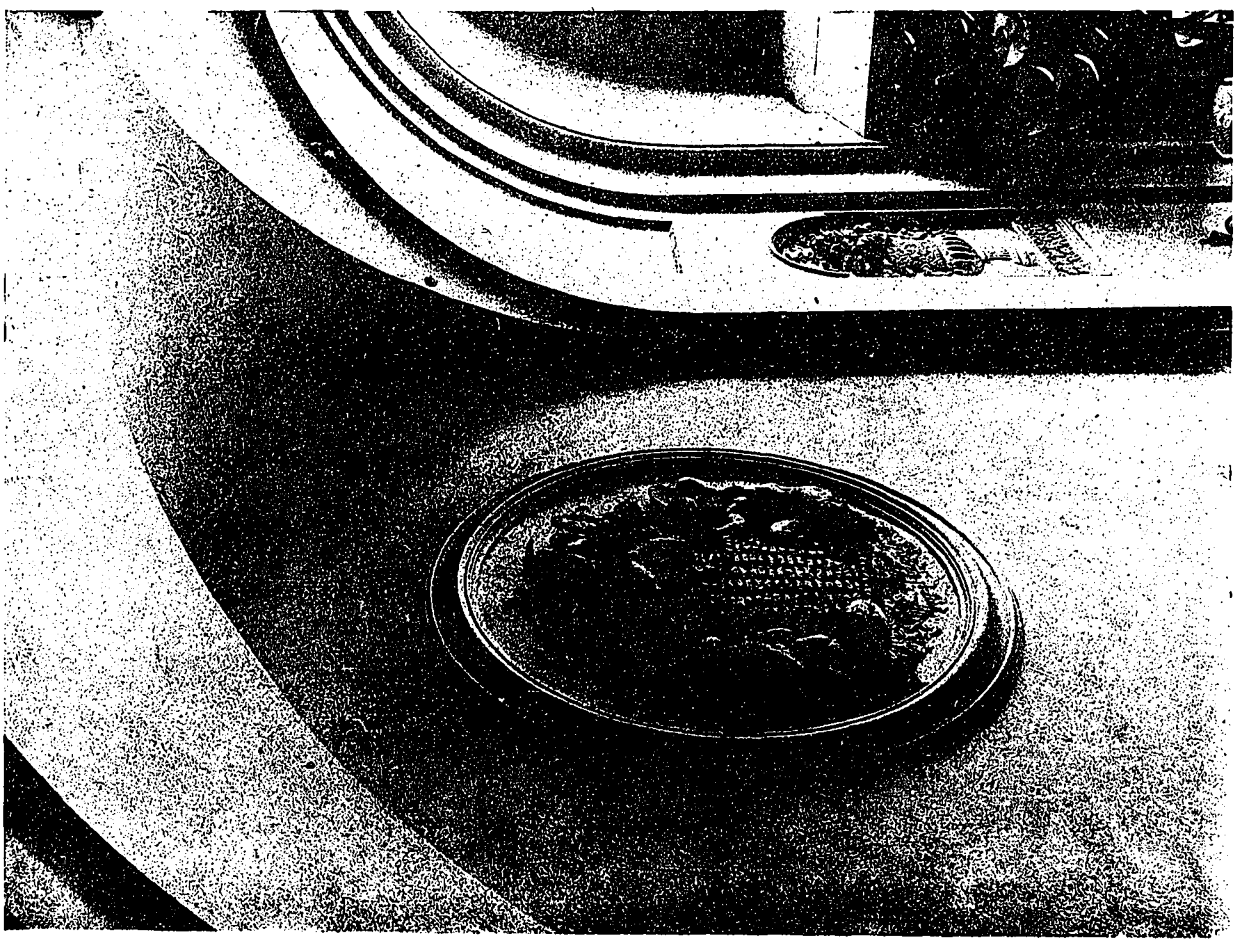
Floors are effective in producing a redistribution on wind stresses from the windward to the interior and leeward columns. Tile arches assist the wind bracing of the structures, because they fill the total depth of the steel beams, and act as horizontal bracing for the entire structure. In comparison with this, concrete floor slabs rest only upon the upper third of the beams and are usually one-third the depth of tile arches. They cannot efficiently transmit the horizontal stresses, and, by reducing the efficiency of the floors as braces, increase the amount of steel necessary to provide against horizontal stresses. There is also some resistance to lateral strains combined through the various connections of the beams, girders and columns, but it is proportional to the details employed in such connections.

The above considerations will not readily admit of calculations and in using them much will depend upon the experience and judgment of the designer. It may be said that partitions, walls, floors, etc., as ordinarily constructed, cannot be relied upon to act in conjunction with the steel frame in resisting wind forces, and there will be a limit beyond which the steel frame can take up such forces. Modern steel office buildings as built to such great heights, especially in proportion to their width, are so destitute of the ordinary means of resisting wind forces that it is necessary to give the subject much more consideration. The designer cannot rely upon the elements of strength, uncertain in value and irreducible to calculation. He must make provision in his design of the steel frame to resist these horizontal forces and reliance must be placed upon some form of metal bracing to carry wind stresses. This may be obtained by means of rigid connections and special bracing members. In many high buildings, for example, the Woolworth Building, the entire wind stresses are carried by the wind bracing, no reliance being placed upon walls or partitions, except parallel to the long side of the building. The tower was designed independently, as if standing alone.

The steel frame is generally run up ahead of the walls and partitions. In several instances the frame work has been wrecked during erection; in other cases it was found to sway under wind pressure, making it necessary to put in temporary bracing to stiffen the framework. The steel frame of a building should be treated as an independent structure the same as the towers of a viaduct, and should be able to resist the wind forces on all surfaces exposed during erection. This should be accomplished by substantial bracing or by designing the column and girder connections so that they may be able to

ONTARIO CLUB ROOM, M'GILL STREET BUILDING, MONTREAL.





ENTRANCE HALL, NEW BIRKS BUILDING, MONTREAL.

NOBBS & HYDE, ARCHITECTS.

DETAIL AND GENERAL VIEW.

resist the bending stresses produced by wind pressure. C. C. Schneider specifies that the steel framework shall be designed for a wind pressure of 30 lbs. per sq. ft. on all exposed surfaces composing it, and the framework shall be considered as an independent structure without walls, partitions or floors. In proportioning the members of the structure for these temporary wind strains it is permissible to use higher unit stresses than for permanent work, *e.g.*, 20,000 lbs. per sq. in.

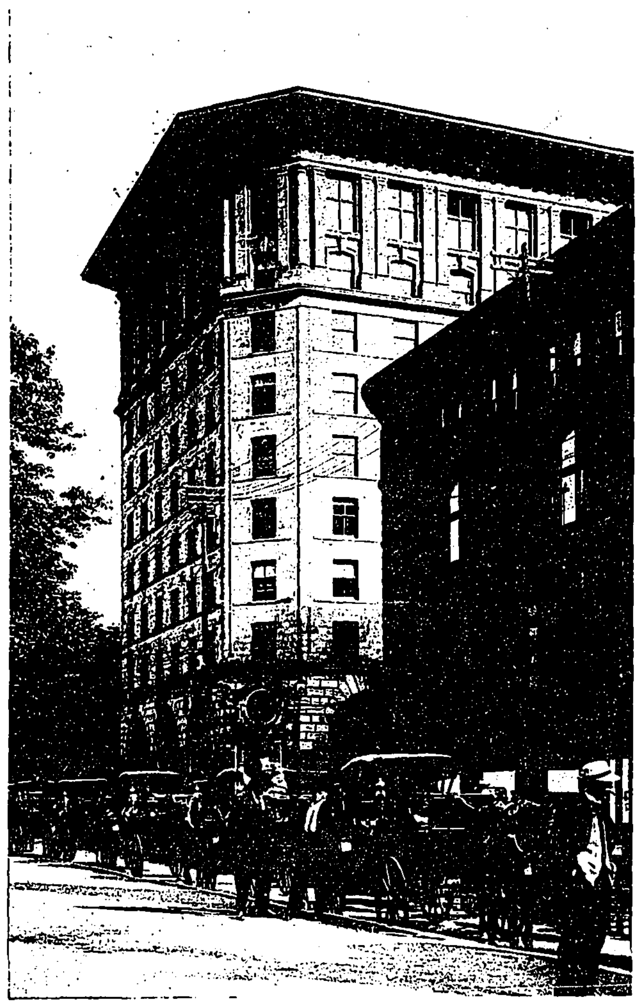
The Municipal Building, New York, is twenty-five storeys high, and has large lateral dimensions. No special bracing was used, but reliance for resistance to wind pressure was placed on its inertia, the stiffness of its girder connections, and the strength of its hollow tile floors. The curtain walls were begun several storeys up from the curb. After the curtain walls had been placed in for a few storeys above this level the framework began to sway under wind pressure, and it was necessary to fill in the lower storeys before erection could be continued. This shows that the steel framework must be proportioned for wind stresses during erection.

Observers will have noticed cross sections of buildings of similar dimensions and almost identical in character and general planning—where one structure is made to depend upon cross-partitions, end walls and the ordinary girder connections, with columns for transferring horizontal stresses to the foundations, while the other has a distinct system of structural bracing capable of caring for similar forces. It would seem that either one owner was put to unnecessary expense or that the other has not proper insurance on his structure. The question naturally presents itself, whether modern steel buildings are being constructed with the same factor of safety against the various forces to which they are subjected, whether vertical, horizontal, or otherwise. From an engineering standpoint it seems reasonable to provide for each of the destructive forces to which it is subjected to a degree at least proportionate to their probabilities.

Disposition of Wind Bracing:—The bracing, no matter which type is used, should be vertical and reaching down to some solid connection at the ground. It should be arranged in some symmetrical relation to the outlines of the building. For example, if the building is narrow and is braced crosswise with one system of bracing it should be braced midway between ends of the building. If two systems are used they should be equidistant from the ends. The symmetrical arrangement is necessary to secure an equal service of the systems and prevent a tendency to twist.

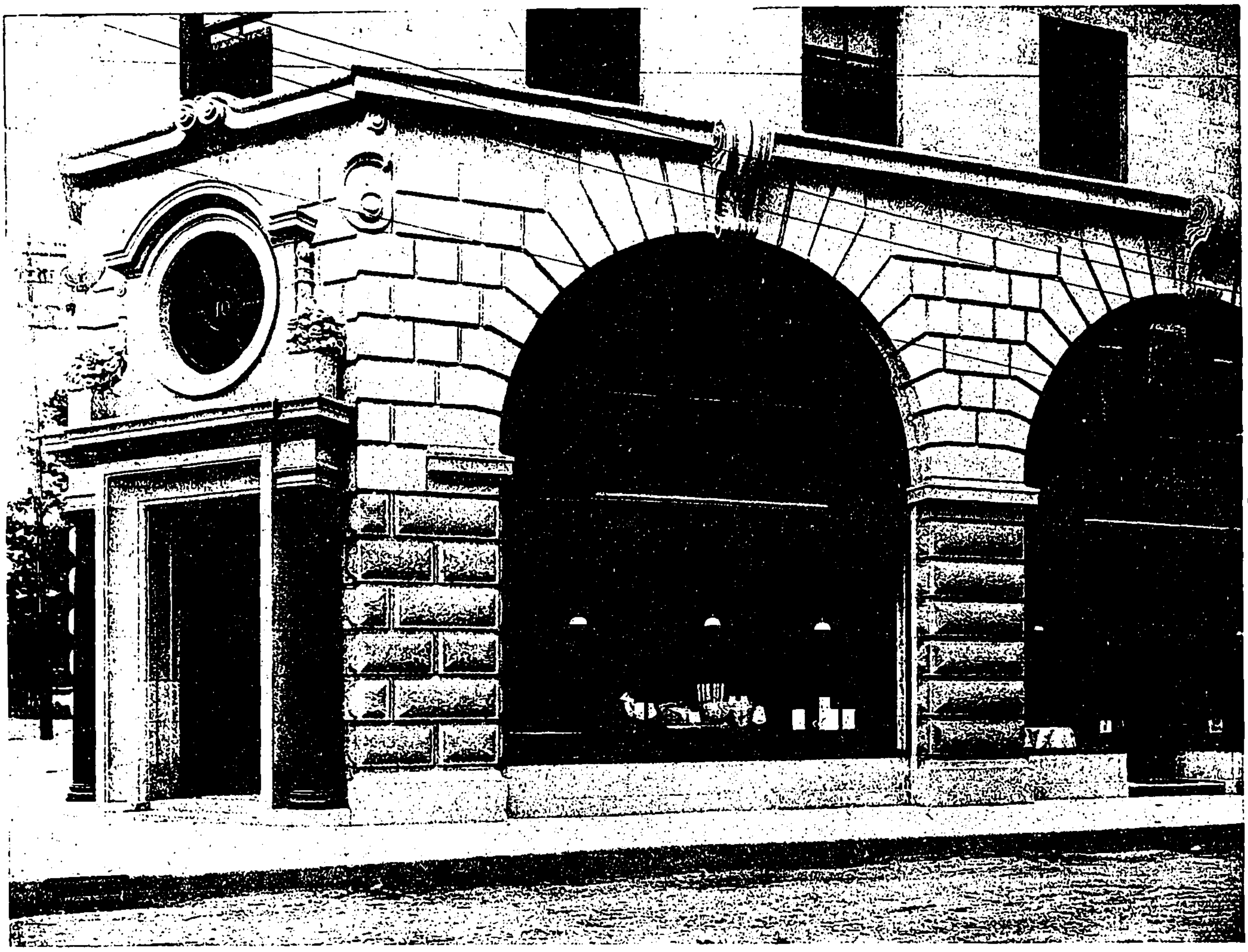
It is believed to be economical to brace each transverse bent. The girders must be designed to act as win bracing, and the columns proportioned for both axial and bending stresses from wind. If the ordinary girder connections are used in a transverse bent, it does not seem likely that the columns on these sections can receive any appreciable wind stress, either axial or bending. Each braced bent must be designed for the full force of the wind contributory to the area under its influence. The proper selection of sections for the economical disposition of wind bracing must remain a matter of judgment.

Wind Bracing by Rigid Connections Without Diagonals, Knees, Gussets or Portals:—In



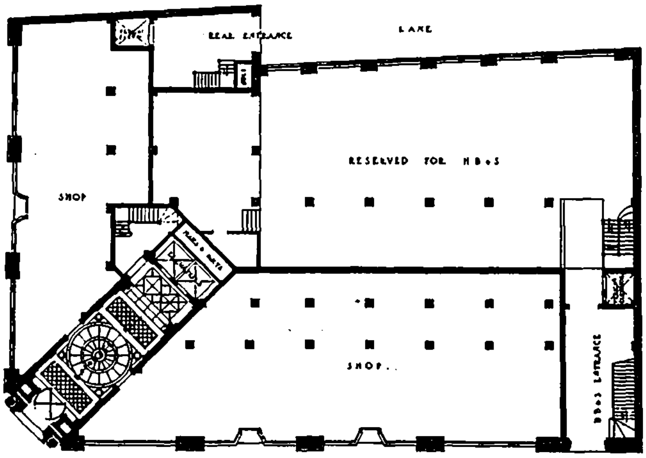
NEW BIRKS BUILDING, MONTREAL. NOBBS & HYDE, ARCHITECTS.

buildings of relatively large dimensions, in which the ratio of height to width is small, sufficient lateral stiffness to wind pressure may be secured through rigid column and girder connections without introducing special wind bracing in the steel frame. The following types are effective in producing greater rigidity at the joints and connections: Type 1.—Continuous column splices.—Considerable stiffness may be secured by using continuous column splices, where the columns are made in two-storey lengths and staggered as to splices, *i.e.*, only every alternate column is spliced at a floor. In present practice, however, all columns are usually spliced at the same floor, thus facilitating



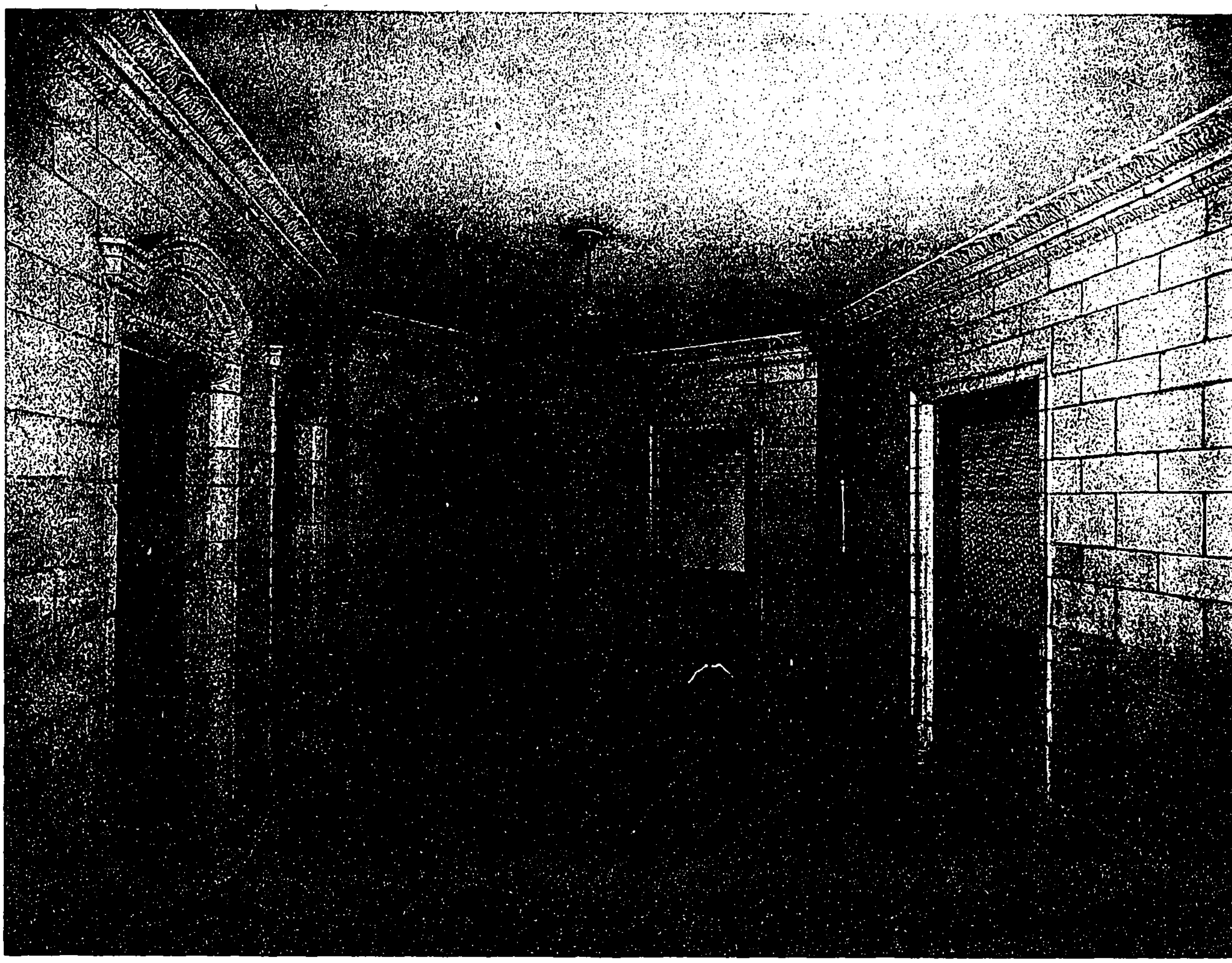
ENTRANCE DETAIL, BIRKS BUILDING, MONTREAL.

erection. When column splices are properly made they made be considered stronger than the main section of the column. The splice should be of sufficient strength to take the shear and flange tension due to bending. Type 2.—The use of beam connections in framing beams and girders to columns.—The ordinary method of framing beams and girders is by means of shelf angles and column brackets. This does not stiffen the frame to any extent. A much more effective method is secured by using the ordinary beam connections in framing the beams and girders to the columns. This type of bracing was used in the upper eight storeys of the Dominion Bank Building, Toronto. The beam connections stiffen the frame during erection as well as after the building has been completed. A stiffer frame will result if the beams run transverse to and the girders parallel to the longest dimension of the building. A beam should come at each column in order to give lateral stiffness to the frame. Type 3.—Greater rigidity may be secured by using beam connections and also rivetting the flanges of girders and beams to the columns by means of corner angles. The usual corner angles are 8 x 6 in. or 8 x 8 in. Buildings are not ordinarily figured for wind longitudinally; this type seems to be amply suited for bracing the building in that direction. This method has been employed in the United Fire Companies Building, New York, and the Continental and Commercial National Bank Building, Chicago.



FIRST FLOOR PLAN, BIRKS BUILDING, MONTREAL.

It is known that beam connections are capable of transferring only small bending moments, and that the columns can take only a small wind stress, either axial or bending. Mr. Forchhammer states that beam connections are not rigid but flexible. As to whether rigid or flexible connections are preferable in steel frameworks is a matter of some importance. The rigidity ob-

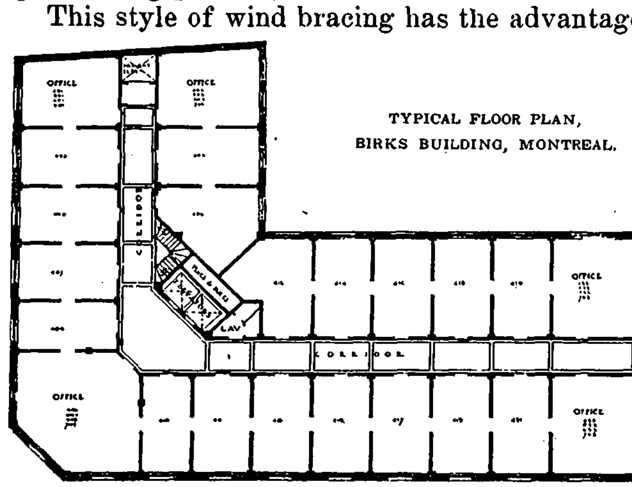


LOBBY TREATMENT, BIRKS BUILDING, MONTREAL.

tained by rigid connections is followed by the uncertainty of statically indeterminate structures. The stresses due to uneven settlement of columns, for instance, may run very high in rigidly connected frameworks. Mr. Forchhammer favors the use of rigid connections at the side columns and flexible connections at the inside columns. However, to concentrate all the wind resistance in the outside columns does not seem advisable as the effect of uneven settlement might be more serious in this case, for in the outside, columns in which the whole stiffness of the frame lies might be seriously over-strained. It would seem that a stiff connected frame is the only proper and practical solution of the problem.

Type 4.—By deep web connection angles.—Sometimes it is advantageous to obviate special bracing as diagonals or knees, which tend to obstruct the clear floor space, and which require difficult connections. A good substitute may be had if floor girders and beams are web-connected to the columns so as to give very deep and rigid joints that can be relied upon to develop sufficient stiffness to resist distortion from wind pressure. In the City Investment Building, New York, deep heavy connection angles were shop-rivetted to the columns and field-rivetted to the webs of the I-beams. Type 5.—Continuous wall girders.—In this type the wall girders are made continuous across the face of the column for the whole length of the building. The webs of the girders are carried past the flanges of the columns, the inner flanges being cut flush with the web. The connection between the wall and the girder is made by a deep gusset plate rivetted across the face of the column and serving both as a splice plate and a knee brace against win stresses. The gusset plates are usually connected by heavy connection angles to the outside of the column flange, the gusset plate being parallel with the column web.

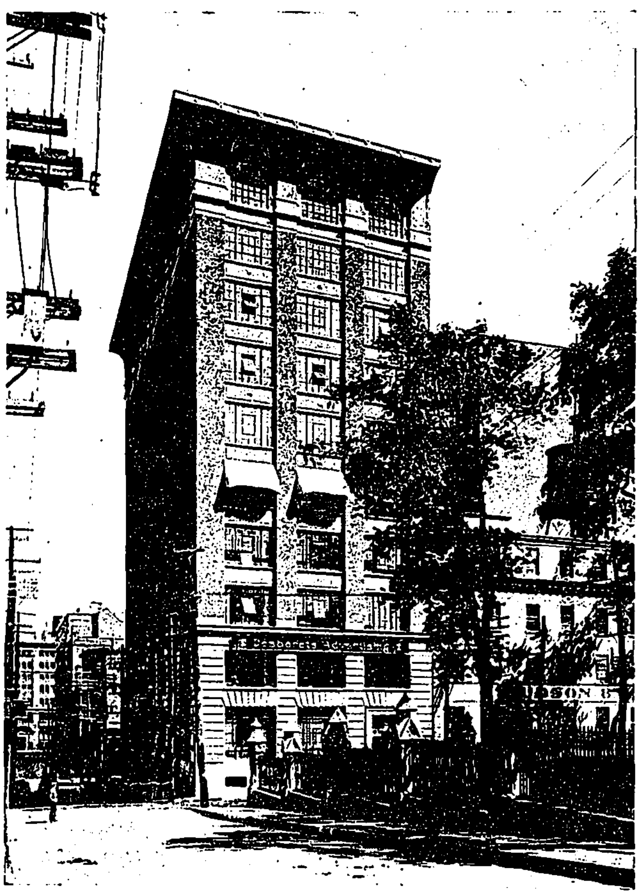
This style of wind bracing has the advantage



TYPICAL FLOOR PLAN,
BIRKS BUILDING, MONTREAL.

of avoiding all tension on the head of the rivets and transmits the stress entirely through direct rivet shear. It is, therefore, theoretically advantageous and proves easy and cheap in construction and erection. In a thirty-five-storey office building in Seattle, rigidity against wind stresses is given to the building by a continuous belt of 30-inch wall girders running around the entire building. The gusset plate is field-rivetted to the girder webs, and field-connected to the flanges of the columns by heavy connection angles shop-rivetted on the outside of both the column flanges.

Type 6.—Horizontal X bracing or trussing in



UNITY BUILDING, MONTREAL. D. J. SPENCE, ARCHITECT.

the floors is sometimes used to distribute the stresses among the interior columns, particularly if the vertical wind bracing is placed entirely in the exterior walls. The horizontal bracing used on the fourth and the sixth floors of the Commercial Bank Building, Chicago, consists of single and double angles laid above the floor beams and rivetted to connection plates at the columns. In most cases the gussets or connection plates cannot extend through to the columns, and are rivetted, therefore, to the connection plates on the fifteen-inch channels forming the lines of spandrel bracing at these points.

Vertical X Bracing:—The simplest form of bracing is by a system of vertical X bracing in the panels between the columns and floor girders to transmit the pressures developed by the wind pressure to the foundations. The rectangular shape of a building can be effectively and economically preserved against distortion from wind pressure by means of diagonals. For this type of bracing the stresses are statically determinate and the ease with which the stresses may be computed and the design facilitated makes this type very desirable.

Advantages and Disadvantages.—Diagonal braces of structural shapes, either angles or channels, make the stiffest bracing, and should be used in a few bents of a tall building. Metal rods with pin connections have been used, but modern practice shows a preference for structural shapes with rivetted connections. If metal rods are used they should be tight in every connection, for if there is any play or movement possible between members it cannot be very efficient. Architectural requirements limit the use of diagonal bracing, as it interferes materially with the window and door spaces, corridors and other features. A complete system of diagonal braces cannot be placed in the outside walls on account of the numerous windows. It can often be arranged in the interior walls and partitions with no inconvenience to the design of the buildnig.

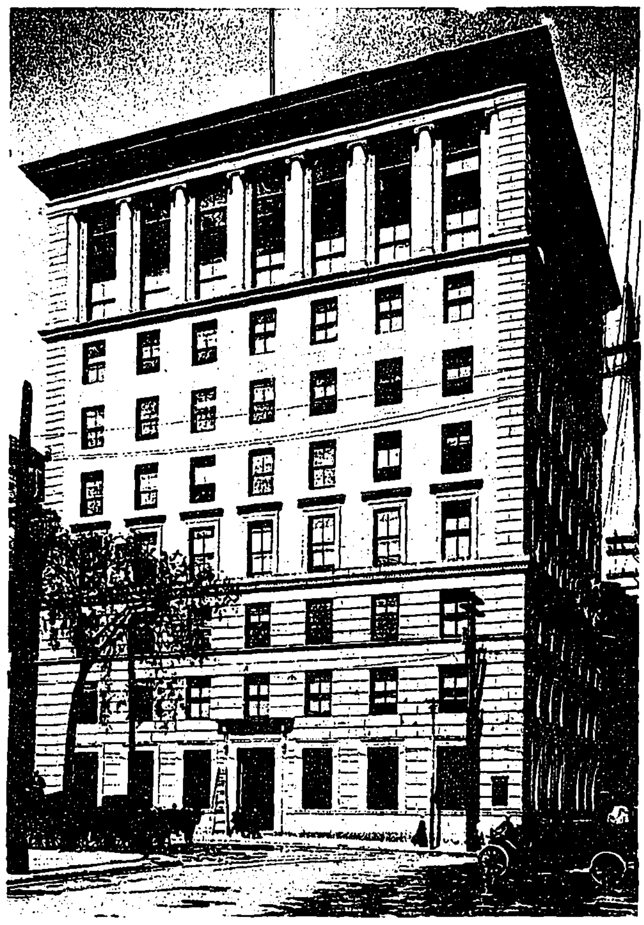
Diagonal bracing imposes the condition that a comparatively thick partition be placed in the plane of the bracing for cover and protection of the steel. In the ordinary office building this condition divides the floor surface into box-like suites, usually of the same shape and size. No large opening, no freedom in the selection of a position for an opening or corridor—in short, no effective architectural medium—can be used for joining adjacent suites through such a partition. Usually the doors must be small and also in the centre of a panel or in one side, according to the type of diagonal bracing used. Corridors must either extend along the wall, thus cutting off a great deal of window light, or down the centre of a panel, creating a row of offices on each side of the hall. These limitations will often result in very shallow offices, and sometimes in no direct communication between suites.

Analysis of Stresses:—Diagonal bracing is essentially a two-column or single panel type of bracing, the usual practice being to brace odd panels rather than a continuous system. Such a braced frame is usually regarded as a cantilever truss fixed at the ground by its own weight. The diagonal members are similar to the web members of a truss and the columns act as the chords of the wind truss. The columns may be either in tension or compression, according to the direction of the wind, and in the later case it is added to the static load. The wind pressure is assumed to act horizontally and applied at the panel points. The exposed area tributary to a panel point is equal to the sum of one-half the story height at the point, plus one-half the height of the storey below, multiplied by the width of the area affecting the bracing in the panel under consideration. From a study of a stress diagram it will be seen: (1) That the compression (or shear as it is commonly called) in any floor girder is equal to the load at that point plus all of the panel loads above; (2) the stress in any diagonal is equal to the shear in the floor girder above multiplied by the secant of the angle which the diagonal makes with the horizontal; (3) The compression in the upper storey leeward column is equal to the vertical component of the stress in the diagonal. The compression in the leeward column of any storey is equal to the vertical component of the stress in the diagonal in that storey plus the compression in the column of the storey above. The vertical component of the stress in the diagonal is equal to the shear in the floor girder at the top of the storey multiplied by tan of the angle between the diagonal and the horizontal. If we denote this vertical component by the term increment, then the compression in the leeward column equals the increment for that storey plus the compression in the storey above; (4) It can be seen that the tension in the windward column in any story is equal to the compression in the leeward column in the storey above; (5) the uplift at the base of the windward column is the quotient of the moment of the resultant wind and the distance centre to centre of the columns. If this uplift exceeds the weight of the frame and its loads, anchorage of the column to the foundation will be necessary.

The column stresses from wind on this type of bracing (diagonal) are direct and statically determinate. In practice the diagonal members frequently cannot be designed so as to have the gravity axis of the columns, girders and diagonal members meet in a common point and some bending stresses result in the columns and girders. The floor girders are usually shallow, and though the connections are rivetted they cannot be said to be rigidly connected, and the bending moments in the columns and girders due to whatever rigidity these connections may have are neglected. With diagonals, the stresses in theory are all direct, and there is no bending, with rivetted connections. However, as is usually the case in buildings, there will be secondary stresses due to the elongating and shortening of the members that take direct stresses.

The tensile stress in the windward column must not exceed the dead load plus a small live load; otherwise anchorage must be provided to resist the upward reaction, and the column spliced for tension. When this occurs the limit of efficiency of the bracing is reached, as it is impracticable to anchor or splice the columns. The dimensions and weight of a building are usually such that, considered as a whole, its moment is sufficient to give it stability against overturning, but in rare cases the margin has been so small that additional security has been provided by anchoring some of the columns to the foundations, notably in the case of the Singer Tower in New York.

Wind Bracing Without Diagonals:—In a steel frame building with rectangular panels, *i.e.*, without diagonals, its stability is dependent on the bending resistance of its various members. A correct determination of the stresses due to vertical floor loads as well as to horizontal wind forces, requires a consideration of the deformations of all the members of the frame. Hence, the stresses are statically indetermin-



ROYAL TRUST BUILDING, MONTREAL.
M'KIM, MEAD & WHITE, ARCHITECTS.
BAROTT, BLACKADER & WEBSTER, ASSOCIATED.

ate and the stresses in each member are functions of all those in all the other members. The rigid solution is too long and cumbersome for practical use in actual designing and approximate methods must be resorted to. For simplicity it is customary to figure the wind stresses independent of the direct stresses from vertical loads. This practice has led to the development of several approximate methods, each with specific assumptions as to distribution of direct stresses and column shears. Some of the assumptions made for determining wind stresses will not hold under vertical loads. No assumptions that can be made will give correct stresses when the columns and girders are proportioned for direct loads and bear little or no relation to the stresses induced by the wind. It is common to consider a transverse bent of a steel frame building as a cantilever beam, uniformly loaded, the columns acting as flanges and taking a part of the vertical reaction proportional to their distance from the neutral axis.

Location of the Neutral Axis:—Before the direct stresses in the columns can be determined it is necessary to locate the neutral axis of the bent. The neutral axis is determined by the column spacing and their sectional areas, and it is found independent of vertical loads. It can be readily computed, if we consider vertical loads, when we know the magnitude and point of application of column loads on the footings. This neutral axis will not be coincident with the centre line of the building, unless the loads are symmetrically applied to the footings. In a steel frame building this is but seldom the case. A heavy spandrel wall on one side and a

ENTRANCE TO ROYAL TRUST BUILDING, MONTREAL.

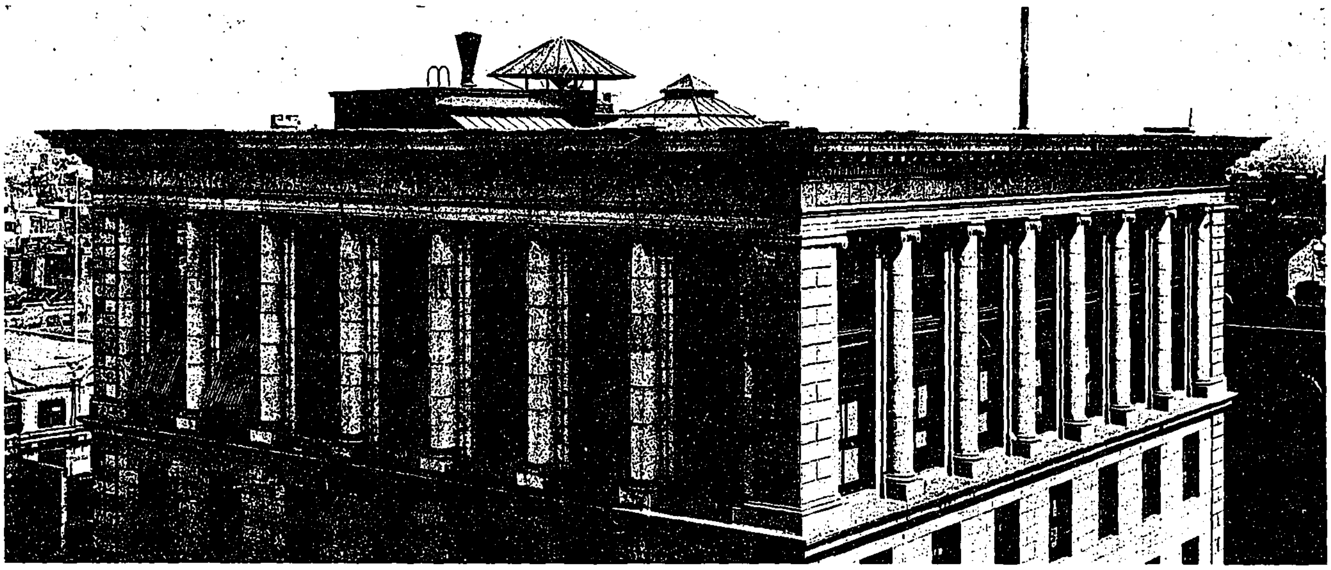
curtain wall on the other, unequal loading due to elevator framing, stairways, vaults, etc., are some of the things which made it necessary to determine the neutral axis for each bent by independent calculations. Since the sectional areas of the columns may be taken as proportional to their loads it will be sufficiently accurate for all practical purposes to locate the neutral axis independent of column loads.

Direct Stresses in Columns:—When the neutral axis has been located then the direct stresses in the columns can be determined. As in a beam under flexure the fibre stresses vary directly as their distance from the neutral axis, so in a transverse bent the direct stresses in the columns will be proportional to their distances from the neutral axis. It is assumed that all columns on the windward side of the neutral axis take a direct stress of tension and those on the leeward side a direct stress of compression.

Column Shears:—A common assumption is that the horizontal shear on any plane is equally distributed among the columns cut by that plane. This is true if each column has the same moment of inertia, but if the moments of inertia are different the horizontal shears taken from the columns will vary as their moments of inertia..

Wind Stresses in Rectangular Building Frames:—The common methods for computing the wind stresses in the main members of a steel frame building with rectangular panels will be given and the method modified later where knees, plate girder, or portal bracing are used.

Cantilever Method.—This method was developed by A. C. Wilson and explained in detail in the "Eng. Record," Sept. 5, 1908. It is slightly modified by R. Fleming in "Eng. News," March 13, 1913. The following statements are taken from Mr. Wilson's article entitled, "Wind Bracing with Knee Braces or Gusset Plates." "If a beam of rectangular section be loaded as a cantilever with concentrated loads, it is possible by the theory of flexure to find the internal stresses at any point. If, however, rectangles be cut out of the beam between the loads, there will be a different condition of stress. What was the horizontal shear of the beam will now be a shear at the point of the contra-flexure of the floor girders, causing bending, and, as in the beam, the nearer the neutral axis the greater the shear. The vertical shear in the beam would be taken up by the columns as a shear at the points of contra-flexure, and the amount of shear taken by each column would, as in the beam, increase towards the neutral axis. The direct stress of tension or compression in the beam would act on the columns as a direct load of either tension or compression, and, as in the beam, would decrease towards the neutral axis. Each intersection of column with floor girders would be held in equilibrium by forces acting at the points of contra-flexure; and to find all the forces acting around a joint at any floor the bending moments of the building at the points of contra-flexure of the columns above and below the floor in question are found, as will be explained later. It is assumed that if a beam of constant, symmetrical cross-section and homogeneous material is fixed



DETAIL OF CORNICE ON ROYAL TRUST BUILDING, MONTREAL.

at both ends, and that if forces tend to move those ends from a position in the same straight line to a position to one side with the ends still parallel, reverse bending will occur with the point of contra-flexure in the centre of the unsupported span. And since this condition exists in all columns and floor girders it will be necessary to find the shears at the points of contra-flexure as well as the direct stresses in all the members."

In order to find all the internal stresses it is necessary to find the total horizontal shear and overturning moment of the wind at the line of contra-flexure of each story columns. After finding the position of the neutral axis and the direct stresses in the columns, the method of finding the column and girder shears and moments will be the same for the general as for the special case in which the sectional areas and column spacing are equal.

Portal Method "A" (Column Shears Equal:—Assumptions:—(1) The bent is assumed to be a series of independent portals; (2) the shears taken by each column are proportional to their moments of inertia. For equal column spacing and assumed equal moments of inertia, the interior columns have their vertical components neutralized by the equal stress of opposite direction caused by the contra-flexure of the columns, and the outside columns take all of the vertical reaction of the bent. If the spacing between columns is unequal, the direct stresses from adjacent panels are unequal. The resultant is a direct stress between the two portals considered. The direct stresses in the interior columns are zero, and outside columns only have direct stresses. The direct stress in the outside columns at any storey is equal to the overturning moment about its point of contra-flexure divided by the width of the bent.

Portal Method "B":—It is assumed that the interior columns take twice as much horizontal shear as the outside columns. This assumption gives a much better distribution of metal and seems to be a more rational assumption than that of method "A." If the building has self-supporting walls and the outer columns carry floor loads only, assuming the moments of inertia of the outside columns to be one-half that of the interior columns, the shear taken by the outside column will be half of that of the interior columns, and the problem is similar to the preceding one. It will be observed the moments calculated by this method compare favorably with those calculated by the cantilever method. A justification of the assumption made in this method is herewith given. In a rolled beam or plate girder it is common to assume the shear as uniformily distributed over the entire cross section. The intensity of the shear at any point is equal to the total shear divided by the area of the web plate. The portion of the total shear taken by any section of the plate would then be equal to its depth divided by the depth of the girder.

Knee Bracing:—Types.—1. Detached knee braces; 2, solid web knee braces, brackets, or gusset plates as they are commonly called. Detached Knees.—Detached knees are usually built of structural shapes, either angles or channels. Where the stresses are small the brace may consist of a single angle or two angles back to back, as in the Dominion Bank Building. For moderate stresses a single channel or two channels back to back may be sufficient. In the lower storeys of tall buildings where the stresses are large, very deep and heavy knees must be used if there is to be any considerable reduction in bending stresses. Solid Web Knees.—A very efficient wind brace member is a deep plate girder at each floor level with a special end connection, either by means of large gusset plates or an extension of the column web.

Discussion on Knee Bracing.—Knee bracing, whether detached or solid web knees, while an effective and efficient method, is not often a practical method of bracing a building, except in the end or wall sections of a building, because of the interference of the knee with the floor space. Knee braces do not appreciably diminish the bending in the columns unless placed both at top and bottom of girder; and for economy double knees should be used. In general no advantage is gained by making top and bottom knees of different depths. If knees are used only at top of storey they should be deep and heavy. The deeper the bracing the greater will be the reduction in bending stresses. If the double knees be deep enough to intersect the column at mid-storey height, the bending in the columns will be reduced to zero. The same is true of the girders if the knees intersect the girder at mid-span. When the solid web knee brace is used, the bending stresses will be carried mainly by the stiffening angles. Although the solid web knees are not usually deep, they are usually stiffened by 3 x 3 in. angles; it is recommended that if the knees are made deep, the angle stiffeners should be made about half as heavy as when they compose the entire brace. The extra cost of the solid web knee brace is warranted, as the extra metal is not lost; it gives a very rigid joint, takes care of the large bending moments at the connections, and besides performs the function of a knee brace.

Portal Arch.—Where exceptional stresses require heavy bracing the portal arch has been used, notably in the Woolworth Building. The Portal arch consists of a solid web plate out of which the arched opening is deducted, stiffened by angles bent to the curve of the opening. The bracing is field-rivetted by means of connection angles to the flanges of columns and girders. In the Woolworth Building the portals were proportioned for the combined stresses due to live and dead and wind load. The portal webs were field-rivetted to the columns through the projecting cover plates of the latter.

Working Stresses for Wind Pressure and Specifications:—The impracticability of using diagonal braces in the majority of buildings makes it necessary to have recourse to solid web or detached knee braces, and deep plate girders to provide the requisite lateral stiffness in at least some directions. When the diagonal is removed its stress is taken up by bending in the columns and floor girders. The columns and floor girders must be designed to carry the resulting and combined stresses.

The method of combining bending with direct stress in such members as columns and floor girders is not simple, involving as it does functions of the correct section (section modulus) and is necessarily a matter of trial. It is difficult to assign judicious working stresses in such a combination, especially as there are practically no experimental data to guide the judgment. It is practically certain that the greatest permissible stress where bending is involved may be greater in a member than where a stress in a member is all direct, for in the former case the greatest stress exists along a line, and not uniformly over the entire cross section. It is an open question that an excess of 10 to 20 per cent. may be permitted.

Most building by-laws have the common specification of 30 lbs. per sq. ft. for wind pressure, on the actually exposed surface, and permit an increase of 20 to 50 per cent. in working stresses for combined stresses due to wind, live and dead loads; but the section shall not be less than if the wind forces be neglected. Chicago and San Francisco specify 20 lbs. per sq. ft. with an increase of 50 per cent. in working stresses. C. C. Schneider, in his "General Specifications for Structural Work of Buildings," calls for a wind load of 20 lbs. per sq. ft., and allows an increase of 25 per cent. for bracing and combined stresses due to wind and loading. Ketchum's specifications for "Steel Frame Buildings" permit an increase of 50 per cent. in working stresses for combined stresses.

* * *

THE McGill street Building, Montreal, illustrated in this issue, is a commercial building of the better class, being devoted entirely to offices. It occupies a small plot of ground 7,000 feet area, facing three streets and giving an excellent opportunity of utilizing on the typical floors a maximum amount of space; approximately 5,000 square feet for each floor. As will be seen from the plans, the elevators are located in the centre of the rear portion of the building opposite a general entrance which allows on the typical floors the shortest amount of corridor space to reach the various offices.

The building is constructed with a steel frame fireproofed with terra cotta. The exterior has a base course of polished pink granite and walls of brick faced with matt-glazed white tile; The spandrels from 4th to 9th floors treated in a bronze-green color terra cotta. The five-foot cornice is of copper; the spandrels at the 2nd floor level and the frames at the 1st and 2nd floor windows being of cast iron painted dark green.

The corridor of the ground storey is floored and wainscoted with marble; elevator fronts designed in wrought iron and glass; typical corridors floored in marble, while the elevator shafts and stairways are cut off from each floor by fireproofed partitions and doors with wired glass. The heating system of the building is a one-pipe gravity system. Accommodations have been arranged on the tenth floor of the building for the National Club of Montreal, one of the popular lunching clubs of the city.

CONSTRUCTION

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

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THE New York *Tribune,* in commenting on the question of tall buildings, mentions the fact that in New York's skyscraper belt, where the buildings run from one to fifty-five floors, their average height is under six stories and a half. Only half a dozen skyscrapers in all the city may fairly be called beautiful, though a larger number are admirable feats of engineering. All the more noteworthy, then, is the calculation of the secretary of New York's height of buildings commission that, allowing for depreciation, the skyscraper's investment return is but 2½ per cent. Nor does this class of edifice profit the community more than the individual. The cost in light and air is supplemented by the fact that skyscrapers burst sewers with their outflow and force the city to install a high pressure system for fire fighting. One often hears arguments against the construction of high buildings based upon esthetics. The most appealing argument is likely to prove that of dollars and cents. Unless as an advertising proposition (which need not greatly concern us), skyscrapers don't pay. New York has found this out rather expensively. The results of the experiment are respectfully referred to all those growing cities in which, as a matter of local pride, skyscraper construction is now so earnestly proposed.

* * *

IT IS not only with iron, steel, and copper that the battles of France are being fought, but with wood as well. And, while the outlays for arms and ammunition are enormous, they do not represent a more oppressive tax upon the French people than will be the net cost to that country of the present reckless destruction of her forests, that, at least, is the view of one Frenchman of note, M. Jean-Paul Alaux, an eminent architect of Paris, who is now at the front, and has had many opportunities to view the devastation that war works in the wooded countries along the battle-front. In *American Forestry* for March he declares the havoc of the European War in this respect to be "without precedent in history," and names the following causes contributing to it: "1. Cuttings by the military authorities for strategic reasons and for permitting the more effective use of artillery. 2. Cuttings for the purpose of building trenches, shelters, and roads. 3. Cutting for fire wood for the military kitchens and for fuel with which to warm the shelters. 4. Cutting by the enemy and the taking away of timber as valuable booty. 5. Damages by projectiles and by fires, whether due to accident or design."

Even as far south as Paris the forests have already been damaged by the war, for in the threatened attack on Paris in the first weeks of the German invasion it was deemed necessary to cut paths in some places for the artillery fire, and to destroy possible ambushes available to the enemy. The forest of Vitrimont has been completely razed, as has the beautiful wood near Neufchateau, before the fort of Bourlemont. In the forest of Champenoux every tree was cut down to a height of three feet. The forest of Maux, the plateau of Amance before Nancy, the wood of Crevie, near Arancourt, and many others, have been either destroyed or terribly gashed.

The French Department of Forestry has already restricted to a large extent the uses that may be made of the larger forests by the military. But it is difficult to enforce these regulations.—*Literary Digest.*

THE following article on Civic Improvement, by H. Purdy, won first prize in the recent Ottawa Collegiate competition, offered by Controller Harold Fisher, of Ottawa:

The impression of a city which its visitors and residents receive is dependent, far more than is generally supposed, upon the appearance of its streets—that is, the street surfaces and fixtures as considered apart from the buildings.

In order that the streets may have the best possible appearance, they should be constructed by competent engineers, and when in use must not be neglected. Repairs should be made at the slightest sign of a break. If the repairs are neglected, the breaks become rapidly larger, with injury to the appearance of the street, and much larger increase in the cost of repairs.

No municipal money is put to a better use than that of keeping the streets in good condition. Accidents and breakdowns are avoided, with the result of saving much expense to vehicle owners.

One of the evils suffered in Ottawa is the constant tearing up of streets for the purpose of laying pipes of various kinds. In streets properly designed, the piping system for gas and water should be provided with all the room that is needed, with a sufficient number of side outlets to take care of future connections.

Curbstones should not be more than six or eight inches above the roadway leading into a yard. The corners of a sidewalk should have a radius of not less than six feet. The sidewalk should have a gradual slope toward the street, and should be as smooth as possible.

Manhole covers in the sidewalk should be exactly flush with the sidewalk at their edges, and should not rise more than an inch at their centres. They should be entirely free from spikes and rivets.

No steps leading upward or downward from the sidewalk should be permitted outside the building line, and no railing of any kind should be permitted on the sidewalk.

No showcases or obstructions of any kind should be permitted on the sidewalk.

The placing of temporary bridging or planking from trucks in the street across the sidewalk to the building should be prohibited. This is an abuse practised in Ottawa and pedestrians must constantly take to the streets to get around these wagons. This should be avoided by constructing recesses into the building into which the trucks could be backed for unloading.

In the construction of new buildings the use of the sidewalk should be preserved at least half its width, and for the remainder, which is occupied by builders, a rental should be paid to the city. A further rental should be paid to the city for the storage of building material in the streets, such as sand, stone, etc., and the use of the streets for mortar and hoisting machines.

Fire hydrants, especially in prominent streets, if not placed against the building wall, should be sunk below the surface, not only for appearance, but to avoid the danger from freezing in winter. Covers for such hydrants should be flush with the sidewalk, and properly marked. Objection may be made that in case of fire such hydrants would be difficult to find, but this is overcome by signs placed on the building, directly over the hydrant, in the form of a red "H," and by other signs with arrows pointing both ways, stating the distance to the fire hydrants in either direction.

Advertising signs, or signs of any kind, should not project from the building unless at least twelve feet above the sidewalk, and in no case should they project more than three or four feet. No buildings should carry any sign except that of the business conducted in it, and the size and design of large signs on the tops of buildings should be approved of by the city hall officials.

The cultivation of shade trees has proved very advantageous in European cities. Not only do trees, in affording shade, increase the attractiveness of the street; they also reduce the amount of flying dust, temper the winds, and improve the air to the healthfulness of the city. Shade trees should be planted from two to two and a half feet back from the outside of the curb, and an earth surface of from two and a half to two feet in diameter left around the trunk for watering purposes. In addition to this, a desirable method of watering is that of gutter seepage, a hole being cut in the curbing, protected by a grating, and the water finds its way through the earth to the tree roots.

I think if you follow my advice Ottawa will be the model city of North America.

* * *

THOMAS ADAMS, in addressing the Board of Trade meeting held recently in Kingston, Ont., said that he was particularly interested in town-planning because it was a means, and the only means, of taking care of a number of things that are bound to arise at a future time as cities grow. In speaking of the necessity of proper sanitation in a city, the speaker said that the country took great precautions to see that every immigrant when he came into the country had no infectious disease. The Government, however, after he was here, did not take any precautions to see that he was kept in good health. Any city depends upon its industries for its growth and everything in the city must be taken into consideration and organized in a business like manner so that the best results would come for the money expended, and to do this properly each branch must work in harmony with the other.

A TOWN Planning Act has been passed into law in Nova Scotia which will revolutionize the methods of developing real estate and controlling building operations in that province. The Act is to a large extent compulsory and is in advance of anything of the kind in the world.

Under the Act a Local Town Planning Board must be appointed in every urban and rural municipality, and a town planning controller has to be appointed for the whole province. No street can hereafter be laid out, nor any subdivision made unless the plans are approved by this Board. Within three years every Board must either prepare a town planning scheme or a set of town planning by-laws with the following minimum requirements:— (1) The distance between buildings to be not less than 60 ft. and up to 100 ft. on opposite sides of existing streets, both in respect of new buildings and reconstructed buildings, and to be not less than 80 ft. on new main thoroughfares, whatever the width of the street. (2) Land to be reserved for new main thoroughfares not less than 60 ft. in width, and provision made for allowing narrow streets of from 24 ft. to 40 ft. where not required for through traffic. (3) The number of dwellings to be limited on each acre, all windows of dwellings to have adequate light and air, separate areas to be prescribed for dwellings, factories, stores, etc.

Property is not to be deemed to be injuriously affected for purposes of compensation by reason of the following restrictions on its use, if the Commissioner of Public Works is satisfied that they are reasonable for the purpose of securing amenity:—(1) Prescribing space about buildings; (2) Limiting the number of buildings to the acre; (3) Limiting the height of buildings; (4) Prescribing the use or character of buildings, *i.e.,* whether the land shall be used for dwellings, factories, etc.

It is an essential part of the Act that there shall be co-operation between municipalities and owners and between adjacent municipalities. Ample safeguards are provided to prevent any person erecting buildings or sub-dividing land so as to contravene a proposed scheme or by-law, while either is being prepared. The Local Board has power to buy land up to 200 feet in depth on the frontages of new roads or reconstructed roads. The price of any land to be expropriated must be the market value and no extra allowance is to be made for compulsory purchase. The Act has been drawn up in consultation with the Commission of Conservation and immediate steps will be taken to put it into force in the province.

Although Nova Scotia has now the most advanced Act, New Brunswick is likely to give birth to the first statutory town planning scheme in Canada under its Act of 1912. The city of St. John has appointed a commission to prepare a scheme and steps are being taken to deal with an area of 10,000 acres.

* * *

"WHEN the east wind came I saw with proprietary alarm the point—shore on Lake Erie—wearing away. Everyone who came along told me how to save the point. For weeks they came. Heavy driftwood was placed in times of peace, so that the sand would be trapped in storm. No one failed me in advice, but the east wind made matchwood of all arrangements. . . . The high water would wash and weaken the base, and in the heaviness of the rains the bulk of earth above would fall—only to be carried out again by the waves. The base had to be saved if a natural slope was ever to be secured. Farther down the shore I noted one day that a row of boulders placed at right angles with the shore, had formed a small point, and that a clump of willows behind had retained it. This was a bit of advice that had not come so authoritatively in words. I followed the cue, and rolled up rocks now like an ancient Peruvian. It was a little jetty, that looked like a lot of labor to a city man, and it remained as it was for several days. One morning I came forth in lashing weather—and rubbed my eyes, for the jetty was not in sight. It was covered with a foot of sand, and the clay was dry at the base. A day's work with a team after that in low water, snaking the big boulders into line with a chain—a sixty-foot jetty by sundown, built on top of the baby spine I had poked together. No man ever spent a few dollars more profitably. Even these stones were covered in time, and there was over a yard of sand buttressing the base of the clay and thinning out on the slope of shore to the end of the stones. Later when building, I took a hundred yards of sand from the east side of the stone jetty, and it was all brought back by the next storm."—*W. L. Comfort.*

* * *

THE water-temple which stands in the Palace of Machinery at the Panama-Pacific Exposition was designed by E. B. Brown, architect. The fountain at the pinnacle of the water-temple pours a constantly flowing stream of water over the cement dome which runs along the eaves and then down through the eight supporting pillars of the temple to its base, from which point it is pumped back to the roof again. There are plate-glass inserts in each pillar, and the interior of each is lighted with concealed electric lights, showing a miniature Niagara between walls of cement. A semi-indirect electric light gives a restful and pleasing effect inside of the temple, which stands sixteen feet high, with its walls thoroughly waterproof with Ceresit waterproofing compound.

IT IS ESTIMATED that an expenditure of $4,000,000 will be required to put the Canadian Sault harbor into the shape that it is contemplated it should be eventually. The new harbor headline makes provision for a waterway at least 1,000 feet wide in Canadian water all the way from the foot of the ship canal to the eastern limit of the city. In dredging the waterway this width to a depth of 30 feet in that section, a great deal of work will have to be done, for the water in Canadian territory east of the Government dock is for the most part very shallow, and there is a lot of rock in the bed of the river. It must be added, however, that this is probably the most expensive section along the whole length of the "all-Canadian" waterway that has been under discussion. Any work that is to be done at the Sault will, of course, be spread over a number of years, and the expenditure will be comparatively small at any time.

* * *

THE bent wood furniture installed in the dining-room of the Board of Trade club rooms, in the new Royal Bank Building, Toronto, was furnished by J. & J. Kohn, of Toronto. The same furniture has been specified and installed recently in a large number of Canadian hotels, clubs, etc., among the more important of which are the Chateau Laurier and New Russell Hotel, Ottawa; Windsor Hotel and Montreal Club, Montreal; American Club, Ontario Club, and Central Y.M.C.A., Toronto; Fort Garry Hotel, Winnipeg; Prince Edward Hotel, Brandon; Chateau MacDonald, Edmonton; Vancouver Hotel, Vancouver; and Empress Hotel, Victoria. Other installations include the Cafeterias at Toronto, Child's Restaurants at Toronto and Montreal, and the Hudsons Bay Company's store at Calgary.

* * *

SUPERINTENDENT R. P. Miller of the Bureau of Buildings, New York City, prepared recently a list of the tall buildings on Manhattan Island in which there are only 1,156 structures of ten stories or over. Among these are 179 with ten stories, 181 with eleven, 191 with twelve, 389 with thirteen, 14 with forty-four and quickly reducing to one with fifty-five. Basements also are included in the list where the floor of the first story is above grade and where there is an entrance into the basement from the street.

* * *

A VERY interesting and instructive booklet has been issued by Samuel Cabot Inc., Boston, on the sound proofing of floors and partitions in schoolhouses. Many illustrations of buildings are shown wherein their "Deadening quilt" has been used together with testimonials.

THE question of affording absolute security to the patrons of the Royal Bank, shown in this number, in the safe deposit department and also for the protection of cash, securities, etc., belonging to the Bank, has been adequately provided for in the elaborate steel vaults. These vaults are lined throughout with heavy plates of drill proof chrome steel, built inside of re-inforced concrete walls 18 in. in thickness and consist of safe deposit vaults, cash and security vaults, book vaults and auxiliary silver safe deposit vault. The safe deposit vault, cash and security vaults have outside doors of solid steel which are 13½ inches in thickness, with inside doors 3½ inches, which are locked by an elaborate system of bolt work, each door having twenty-four round steel bolts 3 inches in diameter and secured by double combination locks and four movement time locks so arranged that they will work independently of the other, thus affording quadruple protection against lock-out. The doors are hung on steel crane hinges with ball and roller bearings so adjusted as to be easily swung with the pressure of one hand. The final operation of closing the door, however, is accomplished by a pressure mechanism of special design, which forces the door into the jamb with such force that the joint between the door and frame is absolutely air-tight and lock-proof. The work was installed by the York Safe and Lock Company.

* * *

THE Liquidator of the Dominion Marble Co., Limited, in liquidation, reports to have on hand a considerable stock of sawn, imported and domestic marble which he will be willing to dispose of to contractors, marble dealers or any person desiring the same at a considerable reduction under inventory values.

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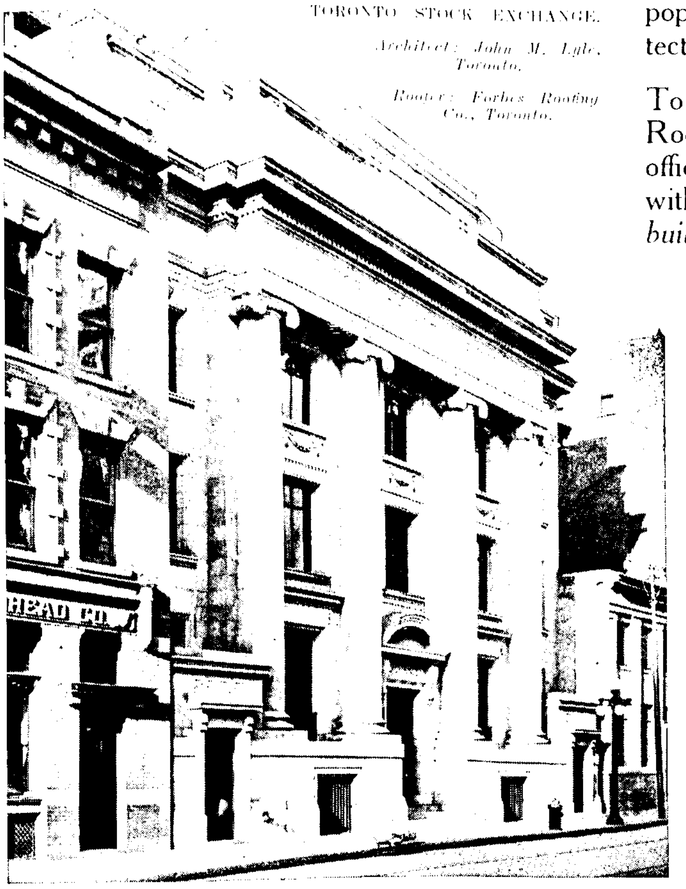

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Special Note

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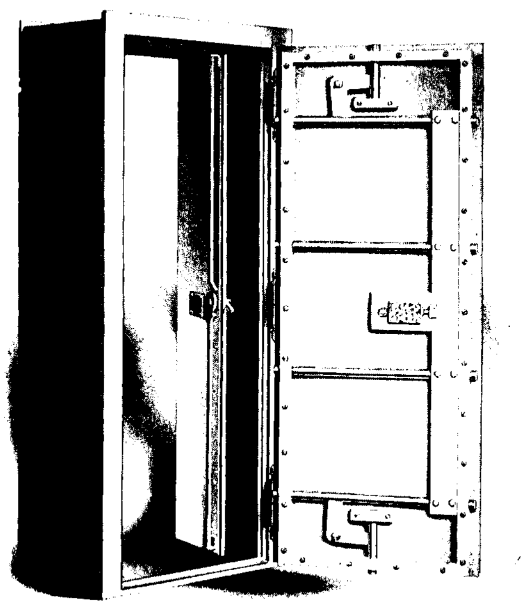

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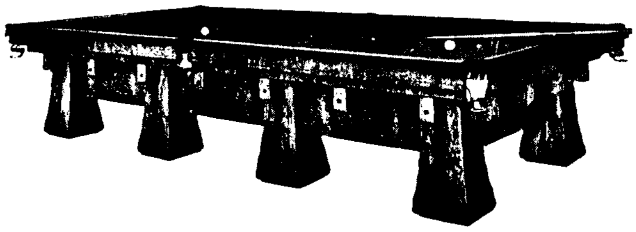

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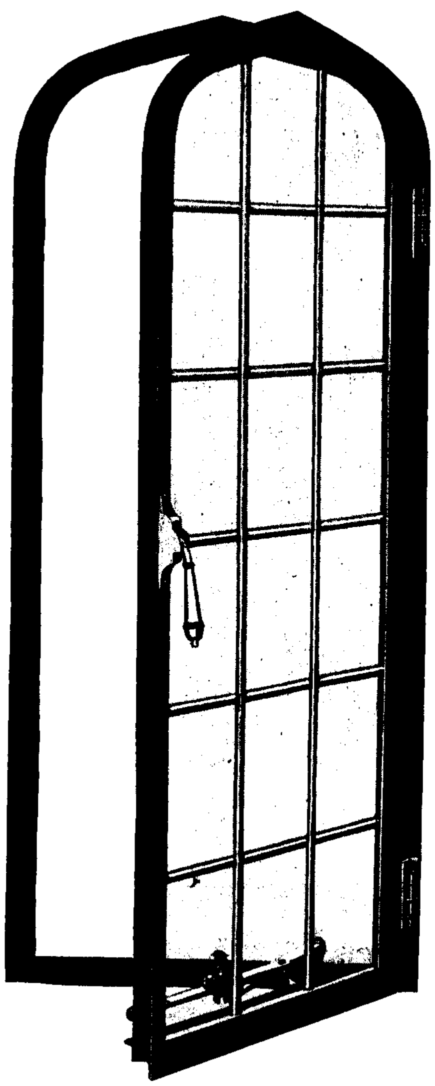

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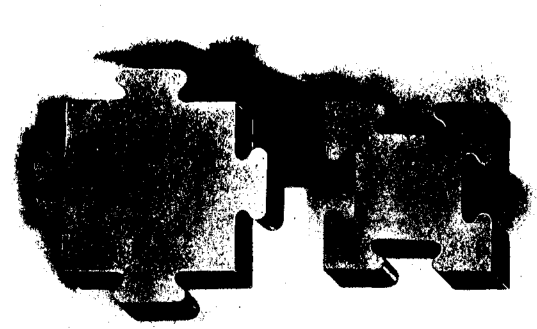

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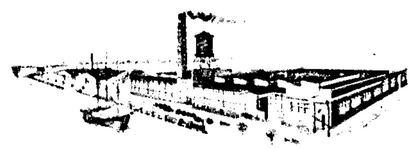

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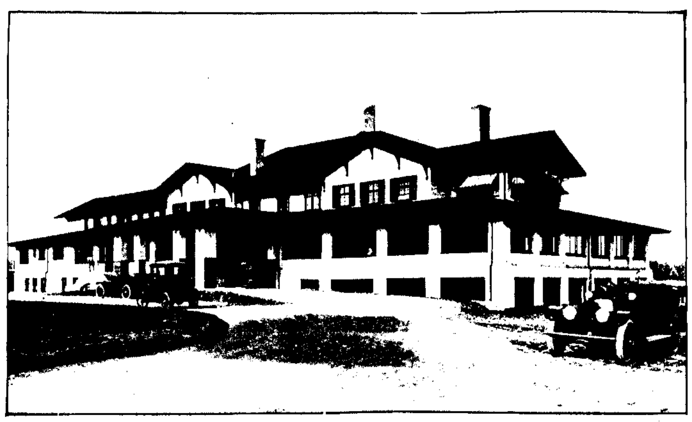

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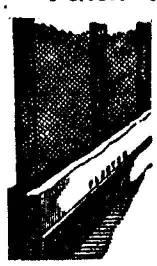

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