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ILLUSTRATIONS ON SHEETS.

Cottages on the Estate of Charles Francis Adams, from the Brickbuilder.
English Cottages—From The County Gentleman.
House on Manning Ave., Toronto. Messrs. Chadwick & Beckett, Architects.
House for Mr. I. C. Chambers, Winnipeg. F. R. Evans, Architect.

ADDITIONAL ILLUSTRATIONS IN ARCHITECTS' EDITION.

Front of St. Augustine's Church, Pittsburg. Messrs. Rutan & Russell, Architects.
Drawing by Mr. Wilson Eyre in the Eighteen Club Exhibition.

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A Plan for Toronto. At a meeting of the Canadian Institute on March 18th, Mr. J. P. Hynes read an interesting paper on the subject of civic improvements, with special reference to Toronto. Many lantern slides were shown, of improvements in other cities. Those in the United States come nearest to the case of Toronto, and especially in the cities of Cleveland and Buffalo, which like Toronto are situated on a lake and have their railroad approach along its shores. Thus the railway stations and the boat landings are in the same quarter, and it is both convenient and striking to combine them so as to make one grand "Entrance" to the city. In Cleveland they have arranged to group the principal public buildings at this spot, and Buffalo is going to do so too; making of the whole a distinct and ornamental "Civic Centre". This, which was the starting point of Mr. Hynes' lecture, was not received without some opposition, in the discussion which followed.

The truth is that there is some danger in plumping a city's principal buildings upon a site so close to a railroad; especially in combination with a park space, for which, even more than for fine buildings, smoke and cinders are contra-indicated. It was not, however, on this ground that the objection was raised, but on the more subtle but stronger ground of its crudity. The World's Fair undoubtedly started the idea of city planning, but it can hardly be taken as a model of how to proceed. Display is not the happiest end of beauty; and it is not unlikely that the generations to which the United States are working up will wish their ancestors had had a more engaging conception.

The task of city planning is something more difficult than this sort of Beaux Arts project. It is a process not of creation but of development. There are, it is true, features and needs which most American cities, in the north, have in common; and Mr. Hynes' plea for a civic centre in the neighborhood of the City Hall is justified on the ground of the stability it gives to property and the encouragement it holds out to development there in a permanent way. This centre, as far as locality is concerned, is almost established now in Toronto, and will be finally assured when the radial avenues are run, which have been already called for by the extension of the city to N. E. & N. W. But the tendency of public buildings in Toronto is upward, in the brighter part of the city; where is already a park that any city might be proud of. This and her other individualisms should be the basis of improvements for Toronto's plan. This is concrete application. The study of the plans of other cities is only general culture in the art.

Advertising Letters. We have a communication from a firm of architects who wish to ventilate a complaint as to the number of letters they receive from manufacturers and their agents, asking whether their goods are specified on certain work for which tenders have been called, or whether anything in their line is specified, &c., &c. Part of the complaint is that there is no self addressed envelope and no stamp, and the letters must be consigned to the waste-paper basket.

If our correspondent were to comment upon his own letter, he could hardly fail to see that this latter point is the key to the situation. These correspondents do not expect an answer. It is enough for their purpose if they have, by means of a letter imitating typewriting, succeeded in bringing these reminders of their goods, before his eye, on their way to the waste-paper basket. How far the method is wise it is hard for an ordinary man to say. It is at any rate wasteful. Nature, it is true, is the same. Many seeds are dispersed for one that takes root. But the extra output of nature has value as food, while the product of the waste-paper basket is food only for the furnace, and bad for that. In so far as the waste of an architect's time is involved, these advertisements, that gain attention under the guise of correspondence, are not only wasteful but are injurious to their own interests ; for the first property of advertising matter is to be attractive, but these are repellant.

A Builders' Organization. Some years ago a series of articles was published in this Journal advocating the formation of a Builders' Association for the Province of Ontario. Apparently the time was not ripe for such a movement and no action resulted. Recently, however, the Builders' Exchanges at London and Brantford have taken up this question, and are endeavoring to secure the formation of such an organization. At the Annual Banquet of the Toronto Builders' Exchange last month, the representatives from the London and Brantford Exchanges brought this subject prominently to the front, and on the following day the matter was further considered at an informal meeting of the Toronto Exchange. The opinion of the Builders' Exchanges throughout the the Province will be invited, and they will be asked to offer suggestions as to the basis on which a Provincial organization should be formed. The opinion prevails among members of the Toronto, London and Brantford Exchanges that if an organization can be properly constituted, work of much value to the building interests might be accomplished. This opinion is in a measure based on the good results which have already been attained by the local organizations. There are certain questions of a broad nature which these local organizations are not competent to deal with, and which it is felt might be effectively dealt with by a central association. Among these might be mentioned legislation affecting the interests of builders, insurance, the question of apprenticeship, a uniform agreement between employers and employees, etc.

The builders feel that they are surrounded on all sides by organizations with which they have intimate business relations, and it is time that they also should band themselves together for the consideration and furtherance of their interests. The Canadian Architect and Builder will be pleased to publish the views of any reader on this question.

Cement Blocks. There is no doubt that the cement block has a future. It has as a matter of fact a present. But the present is not altogether satisfactory, and there are difficulties about making it so. Yet it is in the improvement of the present that the chance for the future lies. There are two points in question—strength and appearance. As to the first, it is difficult to establish any guarantee but that of the character of the manufacturing firm ; and it is of the first interest for every manufacturer to establish a character for strength and durability in his blocks, and to see that nothing happens to give occasion for doubt in that respect. It is easy to spoil a block or a set of blocks, and there is money to be made (for a time) in making them carelessly. The wet process is the best for the block ; but requires a large number of moulds, if there is to be rapid production. The moist process is therefore introduced, in order to save moulds. There is no objection to this, apparently, if the blocks, when taken from the mould, are put in water, or damp sand or sawdust, to harden. In other words moulds may be saved but not labour. The tendency will naturally be to go as far as possible towards saving both. This process, as well as the materials used and the manner of mixing, will require, for constantly good results, not only liberality of mind but constant and careful supervision.

Defects of this kind, however, though hard to perceive in the block, are not really difficult to prevent, if there is the will to do it. It is the question of appearance which is of the first importance ; for it occupies the perception, to the exclusion of everything else, and is difficult to make satisfactory. If negative criticism will do any good, it is not hard to see that the failure lies in monotony. Both the colour and the unvarying size and shape of the blocks would be a hard matter to overcome in any case, but the makers add to these disadvantages by trying to give the blocks a face like natural stone. The accidental spalling of a rock face is selected—a surface which the most experienced stone cutter could not strike twice, exactly alike, in a hundred trials—and this is repeated, all round the house, in even courses, all the way up, until whatever life is possible to the material is lost in expressionless monotony.

Far preferable to this would be an abandonment of all effort to give appearance to the block. Let it have just true edges and a plain face. It is conceivable that there might be two heights of courses, running alternately. It facilitates work to have a sill course ; and this may be repeated where there are no sills. At any rate a sill course and a head course, different from the walling, would be a relief. And moulding (discretely) is suggested by the nature of the material.

The question of colour appears to be difficult but not impossible. Chemical admixtures are not good for compositions of cement, and some otherwise effective substances would be dangerous to use on this account. But there appears to be a mistaken idea—if one may judge from expressions in Mr. Sherer's paper, reprinted in this issue—that much colouring is necessary. "A strong, deep, cherry red," "moss or olive green with streaks of a livelier colour running through"—this is immoderate language to use about architectonic material. Architectural colours are slight. In stones (and concrete classes with stone) the colour, properly so called, is so slight as to be hard to name. Building stones have tone rather than colour. There are dark stones and light stones, each inclining but slightly to some colour. The best tones for building are light tones ; and cement has a light tone. Cement is unfortunately harsh in tone, but it ought not to take much colour to overcome this ; making it much as it was, but mellow. Slight variations in the blocks would be gain, if they were the result not of effort but of intelligent indifference. But who shall persuade the conscientious foreman that this is good work !

MARSH'S REINFORCED CONCRETE.*

The use of reinforced concrete at present has the disadvantage of want of exact knowledge. Those who use it become tied to some system and limited by its methods. This is not a state of affairs that can long remain. The whole world is at work finding out the possibilities of the new material, and a first hand knowledge of the principles involved in its construction is necessary for designers who wish to be up to the mark and happy in their work in following the progress of the times, no less than to the few original thinkers to whom a little knowledge is of no use, who must appropriate thoroughly before they can use at all.

For this reason the publication of Marsh's Reinforced Concrete is an event, since it gives a comprehensive account of what is known about the material and what has been done with it, up to the present time, and points out how to apply this knowledge.

The work is divided into seven parts of which five, concerned with facts and abundantly illustrated, are comparatively easy reading; the other two, devoted to theory, will require study.

Part I gives a general review of the subject, with a summary of the advantages and disadvantages of the material. The Advantages make a strong array. They are Fire-resisting qualities; Durability; Impermeability, which does away with cost of maintenance and also makes it a defence against vermin, borers, insects and even, it is said, microbes; Monolithic character, which makes structures composed of it resist vibration, shocks, unequal settlement etc.; Evenness of Temperature and Deadening of Sound in buildings; Ease and Rapidity of Erection; Notice of the Approach of Failure; Economy; and Appearance. The latter advantage, though the claim is justified by some of the structures shown in the illustrations of this volume—noticeably by the bridges, which, from the slight curva- of the arch, made possible by the material, are very graceful—can hardly be said to be established with certainty yet, or upon very sure lines; but in this unsolved future lies a stimulating interest in the material. It seems inevitable that a material compounded of plastic and flexible elements, which can each be brought into the exact position to meet the stresses to which they are subjected, will ultimately take form according to the lines of stress; for this reason departing in some way from the appearance of timber and masonry construction, in which, right lines being the condition of strength and stability, the lines of stress are taken care of by increasing the bulk of the member rather than by adapting its form.

The Disadvantages of reinforced concrete are two: First, the Precautions necessary in selecting and preparing the material, and in making economical but true and immovable falsework; and, secondly, Doubts as to Proper Method of Calculation.

The process of experiment upon the properties of the materials in combination is still going on, and we may expect more knowledge and better formulae; but the formulae at present in use are based on data deduced and hypotheses assumed from present knowledge, which is true as far as it goes; and there is nothing to prevent us from going ahead with these, and appropriating further enlightenment as it comes. Mr. Marsh's corrective for doubt in the matter is the fact that reinforced concrete construction is mainly in the hands of patentees of the different systems and that they "do not rely so much on their patent systems for bringing them business as upon the fact that they thoroughly understand the work and have in their employ men who have become thoroughly accustomed to use the care and forethought that is undoubtedly requisite." But that is England. We are not in such a happy position here. If the patentees have a local agent in the large cities, that is the most we can expect. It is on the whole safer to seek security in knowledge; in becoming ones self thoroughly accustomed to consideration of the care and forethought which are requisite.

Part II is long and interesting. Its nature will be understood if it is briefly stated that it is an account of the different "systems" employed. There are 44 of them; chiefly French and German or Austrian; but England, Holland, Switzerland and Italy are represented, and there are 8 in the United States. There is a full account of each with plentiful illustrations.

Part III treats of materials. A great point in favor of reinforced concrete is that the materials are used to the best advantage and therefore can be reduced to a minimum; but there is involved in this a necessity that the materials should be good. As there is a saving in quantity we can afford to pay more attention to quality; but attention is required and constant attention too. As it is important that the concrete should be of the same strength throughout, the materials used in making it must be of uniform quality. The matrix, which must always be cement, must also, Mr. Marsh says, be Portland cement and artificial; no other cement and no natural cement being strong enough or sufficiently certain in its behaviour. The specifications for cement and the methods of testing its essential qualities of Coolness, Fineness of Grinding, Specific Gravity, Constancy of Volume, Time of Setting, Chemical Composition, and Cohesive and Adhesive Strength, are considered in a series of sections in this part.

The aggregate receives attention chiefly in point of size and cleanness. The latter implies chemical cleanness as well as freedom from argillaceous or organic matter. Sand or gravel that has been in contact with acid or alkaline solutions, or the presence of sulphur in slag, are a danger, to both concrete and reinforcement, which requires probably more care in country work than in work in the cities. An instance is given of the loss of a large quantity of concrete, in consequence of the water, with which it was mixed, having been taken from a mountain stream into which some chemical refuse had been turned at some distance above the spot from which the water was taken. In the city the water is at least chemically pure and can be trusted to be always the same; and the aggregate comes usually from recognized sources that have been tested before and are not exposed to this kind of danger.

The size of the materials of the aggregate, their proportions and the methods of mixing, occupy the rest of this part, with a table of quantities as used by different authorities for different species of works. There is also a short section upon the reinforcing metal. The choice between wrought iron and mild steel is in favour of the latter except when welding is necessary, when wrought iron is safer than steel.

* REINFORCED CONCRETE by Charles F. Marsh; published by Archibald Constable and Co., 16 James St., Haymarket, London. Price 31s. 6d.

The tests given for application to each material suggest that steel may sometimes be more economical to use, because of its greater strength.

Part IV treats of Practical Construction :—the moulds, falsework, reinforcements, the advantages of moulding in place and in advance, and the method of constructing the different parts of a building and other structures to which the material can be applied. This part is copiously illustrated.

Parts V and VI are the theoretical backbone of the book. Part V, called Experimental Research and Deduced Data, gives an account, with diagrams, of experimental tests made of reinforced concrete structures and members. From observation of these experiments are deduced data for Part VI, on Calculations. This part after a preliminary section to establish the Necessary Hypotheses ; and a section devoted to the theory of Loads, Bending Moments, Shearing Forces, etc., as applicable to reinforced concrete ; goes at length into the question of Formulae, and the demonstration and establishment of Formulae for different stresses and reinforcements in different structural forms. A Proposed Method of Reinforcement and Calculation, which constitutes one section—a suggestion to reinforce pieces by hooping, to prevent the swelling of the concrete under compressive stresses, combining with it reinforcement on the tensile side to induce compressive stresses in the concrete—is one of the hints that changes in form may come ; for the most effective form for hooped reinforcement is not rectangular but round.

Part VII gives an account and illustrations of structures that have been erected in reinforced concrete. These are piles, warehouses, chimney stacks, lighthouses, churches, houses, shops, factories, covered reservoirs both sunk and elevated, silos, markets, theatres, railroad signal cabins and water tanks, stand pipes, aqueducts, water pipes, sewers, cement bins, bridges in great variety, quays, balustrades, sidewalks, vault light slabs, canal and river bank protections, railroad sleepers, troughing for electric cables, retaining walls, and a jetty on posts. We speak of these headings as plural, without knowing whether some cases are not solitary ; but the impression left be the chapter is of a vetriable age of concrete.

BOOKS.

A History of Architecture by Professor Bannister Fletcher and Bannister F. Fletcher. Published by B. T. Batsford. Agent for Canada, Thomas Henry, 53 McGill St., Toronto. Price $6.30, post paid.

This is the fifth edition of this History and it is visibly enlarged. The perface says that the greater part of the book has been re-written and that 700 new illustrations have been added.

The intention of the book is to apply scientific method to an account of the history of Architecture. Each style is treated in the same way. First the influences that brought the style into being are considered ; influences Geographical, Geological and Climatic which affect the structure ; influences Religious, Social and Political, which affect the character and condition of the builders ; and Historical influences which affect the course of affairs from without. Then the character of the architecture, so produced, is described ; that is to say its special quality is noted, and the general effect produced by the buildings as a whole. Next, examples are given of particular typical buildings ; and, finally, a comparative analysis, in which every style of architecture is regarded as the solution of certain fundamental problems viz. : Plan, Walls, Openings, Roofs, Columns, Mouldings and Ornament. Each building must have all or most of these parts and it is instructive to compare the solutions, by the different styles, of the problems these parts involve. In fact this is the true way to study the history of Architecture. The more extended the knowledge of how these problems have been solved in the past, the more just is likely to be the perception of how they should be solved in the present. It is by the study of all styles alike that the student acquires openness of mind to admit new ideas, and flexibility of mind to seize the point of view of other men ; acquires, in one work, culture. The secret process of such study is however a continual process of comparison, instinctive and often unperceived, and therefore, to the unaided student, slow and sometimes insufficient to attain the result. The business of the Architectural Schools is to direct attention in this way. For this reason the History under review is a good text book for the Architectural Schools and for the examinations of the Associations ; but more especially for the solitary student, who thus gets the advantage of tuition. The process of practical familiarity with any one style is a different process and less educative. It is a purely technical training which should come after and indeed must come after, or rather must have the general training come first, in order that there may be first a sure perception of the nature of design, without which the study of any one style is sure to degenerate into crude, unpractical and inartistic copyism.

It should be added, in order to give a full account of this book, that the chapter on each style concludes with a list of the books which treat of the style.

A Hand Book for Superintendents of Construction, Architects, Builders, and Building Inspectors; by H. G. Richey, Superintendent of Construction U. S. Public Buildings. Published by John Wiley & Sons, New York. $4.00.

This is a book of 742 pages, but printed on thin paper, bound in flexible Morocco, and convenient in shape for carrying in the pocket. It is a comprehensive work, intended both for study in the office and reference on the works. It has therefore a double character combining the sort of information usually met in text books with the sort usually found in handbooks. The operations of piling and foundations, stone and brick work, carpentry, plastering plumbing, &c., are described at length, with illustrations. To these are added a section on cement, reinforced concrete and terra cotta, fire-proof and slow burning construction, which is corcerned to a great extent with the products and systems of patentees. Wiring, heating, paper-hanging and other adjunctive trades are also described. In fact it is in body a treatise on building operations. But combined with each part are the tables, formulae and other information necessary to carry out the building operations which it describes. There is also a part concerned with drawing and laying out work, and combined with it, the various tables of mensuration and the problems in geometrical mensuration required for such work.

In the main a compilation, there is evidently new matter in the book as well as new arrangement.

OUR ILLUSTRATIONS.

COTTAGES.

As a contribution to the housing question we present a couple of pages of illustrations of labourers' cottages. In both the American and English examples the cottages are intended for agricultural labourers. But our housing of this sort is for the most part suburban in character; detached or semi-detached; and hints may be taken from these designs. The American example is most like home—all in-doors and more provision for comfort. But in the question of design Mr. Maurice B. Adams is stimulating. His one storey cottage is poetry. The pair for reinforced concrete depend to an unfortunate extent upon the M roof for their appearance. That must give place to a longitudinal ridge; but the double gable is not impossible combined with this, even when contiguous; and if, (with the sacrifice of a little room in the bedroom), the single projection is made into two, with gables subordinate to the main roof, the composition is improved rather than injured. The American example is most pleasing in plan. The

small view here presented shows that, in spite of its apparent simplicity, the design would be better if it were more truly simple. There is provision for a good sized family in each of these houses and the kitchen is certainly handsome; but it is questionable whether Mr. Adams division of the same space into two rooms is not preferable. If we recollect rightly it was much this arrangement that caused so much trouble in Miss Wilkins' story, "The Revolt of Mother." Since the old farmer would not build the new house he had promised, his wife, the good mother, took possession of the stable he had built instead; and her reason was that in the old house there was only one room to sit in, and how could their daughter keep company with any one if there was no room to receive him in? Home is the proper place for this proceeding and in this house, if the family holds its ground in the kitchen, there is nowhere for the young couple to spend the long winter evenings but the woodshed. Either of the English one storey plans are better off in this respect, and, curiously enough, in the American manner; for while the daughter occupies the living room her mother can retire to the scullery and work.

HOUSE ON MANNING AVENUE, TORONTO.—MESSRS. CHADWICK & BECKETT, ARCHITECTS.

This house occupies the north end of a 22 ft. wide corner lot, of which the south front is occupied by a shop. There were 49 feet available at the north of the lot for a house, with frontage on the side, or east, street, and light on the north line; light also, of course, within the lot, looking south to the shop. The house fills the lot, being 22 ft. from E. to W. (dining room and drawing room each 10' 0" wide by 14' 9" long), and occupies 34 ft. of the lot southwards, leaving 15 ft. for a yard. This is a true city house, of a type which is rare in Toronto, but ought to be usual now. It will be noticed that there is no exterior wood finish except the front door protection. The rafter feet just clear the wall and the gutter is the only cornice.

HOUSE FOR MR. G. H. CHAMBERS, WINNIPEG.—F. R. EVANS, ARCHITECT.

The narrow lot is the great trouble in planning the city house. The double-sided house with three rooms down-stairs, and the kitchen making a fourth without projection, is the house that everybody wants. If blocks were planned oblong with less internal depth we might be able to afford the other 10 or 15 feet in width that is necessary. The land inside, that is never used to any real purpose, must be represented in the value of the frontage, and we should be better off with less of it. This Winnipeg house plans well and builds well. Everything falls in place without torturing; and, even in looking at the plan, one has a sense of spaciousness.

FRONT OF ST. AUGUSTINE'S CHURCH, PITTSBURG.—MESSRS. RUTAN & RUSSELL, ARCHITECTS.

This photograph, from the Eighteen Club Exhibition in Toronto, last month, comprises enough of the gable to indicate the nature of the front and that it is carried out in a characteristic manner. Yet it does not seem so irreconcilably Italian as to be out of place in America, as the place of worship of a traditional church. The details are all old acquaintances but they appear to have been chosen with taste, so as not to shock us with a suggestion of the outré or exotic. The building is very much in our own manner; and there is this to be said of Italian Romanesque—that its breadth of wall suits brick, which is our ordinary building material, better than Gothic as we are too apt to have it; Gothic, that is to say, derived from stone and rejoicing in parts, rather than the modern English brick Gothic of broad surfaces of wall and window. It is perhaps not well to place too much confidence in a design of which one has not seen the whole, but the part before us is decidedly agreeable. The slight obtrusiveness in scale of the niche, both in general effect and in detail, seems to be no defect; but rather a virtue, giving life to the composition.

DRAWING BY MR. WILSON EYRE.

The colour of the original suggests, more than the reproduction, the advantage of brick, and particularly of a brick wall, in a plant room like this. It is the glass that it is difficult to be happy with in places of this kind, and also their strenuous floricultural qualities. The average man, who is not a flower fancier—and even if he is—wants just such a place as this; a place for himself rather than for plants; where, with a judicious choice of hardy plants that can stand variations of temperature, he can enjoy their beauty and freshness, with room to sit and stand and even to walk. There is evidently a stone basin, for filling watering-pots, at the end; which gives a central motive for the wall. The single jet fountain, falling in a basin in the floor, is always a lovely feature in a house; making a musical tinkle that does not interfere with conversation and is company for solitary thought.

ARCHITECTURAL ACOUSTICS.*

By G. R. Anderson, M. A.

Lecturer in Physics at the School of Practical Science, Toronto.

UNDER the general heading of Architectural Acoustics we shall have several related problems to solve, and it may be well at the outset to consider what these are. There will be,

1. The best form to give to an auditorium in order that the audience in all parts of the room may hear easily and without any confusion of sound or discrete echo. Here it may be pointed out that sound being reflected and refracted similarly to light, there may be formed regions of interference and foci representing concentration of the sound waves which will materially interfere with good hearing, if such points lie within the zone of the audience.

2. The arrangement of the heating, lighting and ventilation in such a way as not to interfere with the hearing in any part of the room.

3. The deadening of walls to prevent sound penetrating beyond the audience chamber. In this connection would also be included the location of pipes, ventilating shafts, etc.

4. The control of the acoustics of any audience room so that

(I.) The sound shall be sufficiently loud to be heard easily in any part of the room.

(II.) That the components of a complex tone maintain their proper relative intensities.

(III.) That the separate syllables be heard distinct from each other.

(IV.) In the case of music that there may be sufficient sustenance of tone to prevent the music from appearing dead or oppressed.

Apropos of this last condition it may be pointed out that in a hall destined for public speaking the reverberation should be as nearly as possible eliminated and that the most desirable duration may be different for different forms of music, so that a knowledge of the purpose for which the auditorium is mainly intended is necessary.

Sound being a form of energy, when once started will continue until it is either absorbed or transmitted by the furniture and boundary walls of the room. Scarcely any one can have failed to notice how a sound is prolonged in an empty hall or church, and how much more quickly it dies away in the presence of an audience. This continuance of sound after the source has ceased will be called reverberation, and is a measure of the duration of what may appropriately be called residual sound.

This paper will deal with the question of obtaining such data as may enable the architect to secure any required reverberation depending on the purpose for which the building is intended. The solution of the problem will then be to determine the absorbing power of the various materials used in construction, and of the audience, and then to so apportion them as to reach the desired result.

To measure the absorbing power of any room it will be sufficient to measure what is inversely proportional to it, viz., the rate of decay of the residual sound. For this purpose we require a sound of constant intensity and a device to measure with accuracy the reverberation after the source has ceased to speak.

The apparatus here exhibited consists as you see of an organ pipe of pitch C-517, mounted on a wind chest and operated electrically. This is in series with a specially designed torsion chronograph, so that the drum on which the records are made is held in its initial position so long as the pipe is sounding, but is released the instant the pipe stops. A second electric key serves to operate a pencil which makes a record on the moving drum at the instant that the operator decides the sound has become inaudible. Then, knowing the period of the drum, we can readily determine the exact duration of audibility of the residual sound.

The method of solution will be best understood by the study of concrete examples.

We may lay down the following preliminary propositions :

1. The duration of audibility of residual sound is practically the same in all parts of an audience room.

2. The duration of audibility is independent of the position of the source.

3. The efficiency of an absorbent in reducing the duration of audibility is ordinarily independent of its position.

These propositions which are readily verified by experiment are *a priori* evident when we consider that in a room of even fairly large dimensions the time taken by the sound to distribute itself is very small, the velocity of transmission being about 1,100 feet per second.

*A paper read at the Annual Meeting of the Ontario Association of Architects by Mr. G. R. Anderson, Lecturer in Physics at the School of Practical Science, Toronto.

If a room could be constructed whose walls were perfectly reflecting, the sound once started would continue indefinitely, and to measure the absorption of any material we would merely have to introduce a certain quantity of it and measure the duration of the residual sound, and so calculate the absorbing power directly. But such a room is not possible, and therefore we are driven to calculate the absorption of any material by a process of elimination.

We will consider the lecture room of the Fogg Museum at Cambridge, having a seating capacity of about 500, the volume being 2,740 cubic metres. In this room there were introduced by degrees a number of elastic felt cushions, the duration of the residual sound being measured from time to time, the results of which are indicated in the annexed table :

Area of Absorbent. Cushions.	Open Windows.	Duration of R. S.
0	0	5.61
5.2	4.2	5.33
11.	8.8	4.94
18.2	14.6	4.94
28.6	22.9	4.21
41.	32.8	3.94
54.	43.2	3.49
67.6	54.1	3.33
83.2	66.6	3.00
94.2	75.4	2.85
105.3	84.2	2.64
122.8	98.2	2.36
138.4	110.7	2.33
157.3	125.8	2.22

In order to render these results universally serviceable we must adopt some standard absorbent, and for this purpose an open window is at once the most easily available one and is practically absolute. A comparison of the absorption of the cusions with that of an equal area of open window gave as the coefficient of absorption of the cushions in question 8. If now we plot these results on a system of rectangular co-ordinates, we obtain this curve,

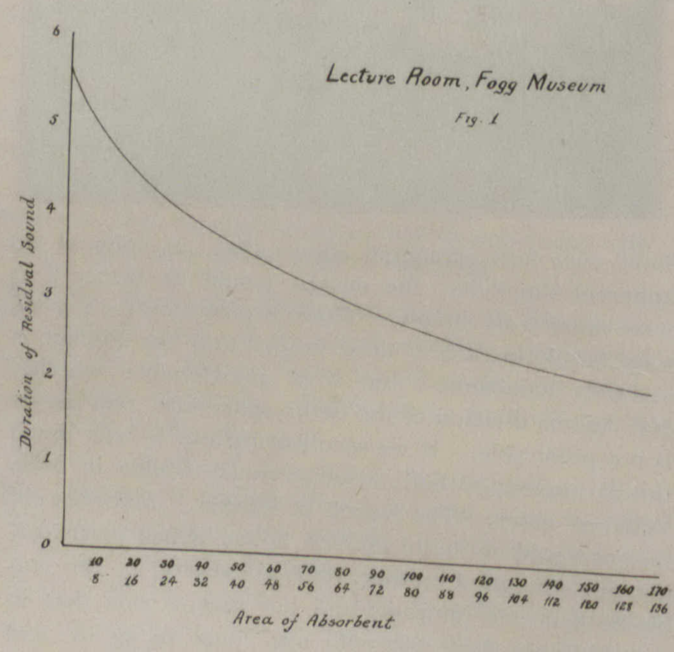


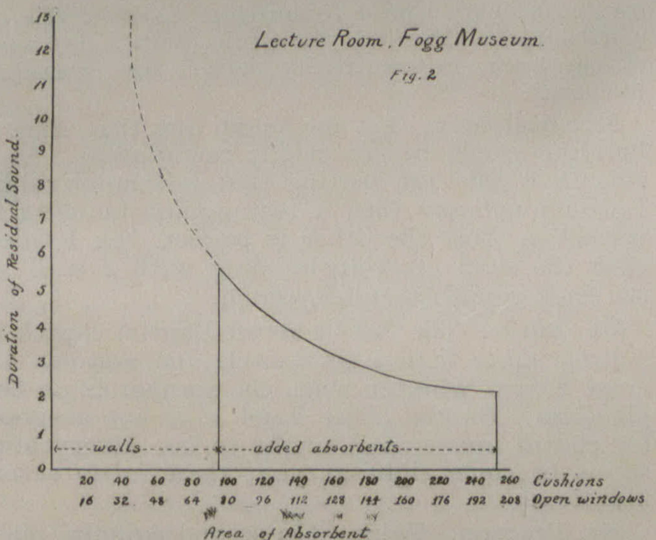
Fig. 1, which from the fact that it is evidently tangent to the horizontal axis suggests a rectangular hyperbola. To exhibit such a curve in full we shall have to shift the vertical axis to the left as shown in this second figure (Fig. 2) where the curve is symmetrical with regard to the axes. Here the full line represents the absorption due to the cushion or open windows while the dotted line is evidently that due to the walls of the room. The formula for this curve is $(a - x)\ t = k$ a const, a representing the fixed absorption of the walls, and x that of the added absorbents, either cushions or open windows.

Solving this equation from the given data we have a = (94 sq. metres of cushions (75 sq. " open window that is the total absorbing power of the walls, floor, ceiling and furniture of this room—75 sq. metres of open windows.

Having thus obtained the total absorbing power of a room, the next thing is to apportion that absorption among the various surfaces. For this purpose we shall require observations on as many rooms as there are different substances in order to secure enough independent equations to effect a complete solution. The following example of four small rooms will illustrate the method of solution :

Room	Hard pine	Glass	Brick & Cem't.	Total Absorp'n
	Area of Absorbents.			
1	127.	7	0	8.37
2	84.8	6	30	5.14
3	12.7	80	85	4.64
4	2.1	0	124	3.08
Coeffts. of Absorp'n.	.058	.024	.023	

To find the value of the constant K we may substitute in the equation (a+x) 1=K any of the values already given, e. g. (75+83.2) 3=K which gives K=474 for this particular set of experiments.



In order to get at the physical significance of this constant K we will consider it in connection with a number of different sets of observations.

Room	Volume=V	Absorp's=a	K	K/V
1	99	8.08	15.4	.155
2	1480	34.5	243	.164
3	1960	101	345	.176
4	2740	75	474	.170
			mean =	.166

Here K is approximately equal to .166 V. That K should be proportional to the volume of the room may be inferred from the following considerations : the absorption of the walls, etc., (a,) is proportional to their area, that is to the squares of the linear dimensions, and the duration of the residual sound (t,) is inversely proportional to the number of reflections of the sound, that is, it is directly proportional to the linear dimensions, and consequently K, which is proportional to the product of (a) and (t), is obviously proportional to the cubes of the linear dimensions, i.e., to the volume.

It is evident that K will also depend on the initial intensity of the sound, but the consideration of this point may well be omitted from this already long paper ; and furthermore, so long as the intensity is constant, its absolute value is not material to our results. In all these experiments the initial intensity was approximately 1,000,000 times that of minimum audibility.

We will now give some data derived from these experiments :

Substance.	Coeff't. of Absorp'n.
Hard pine sheathing	.058
Glass	.024
Brick set in cement	.023
Plaster on wood lath	.034
Plaster on wire lath	.033
Plaster on tile	.025
Ash settees, per seat	.007
Bent wood chairs	.008
Upholstered settees, per seat	.28
Upholstered chairs (hair & leather)	.30
Hair cushions, per seat	.21
Elastic felt cushions	.20
Oil paintings (including frames)	.28
House plants (per cub. metre)	.11
Carpet rugs	.20
Oriental rugs (heavy)	.29
Cheese cloth	.02
Cretonne	.15
Shelia curtains	.23
Linoleum	.12
Audience, per person	.44
Isolated man	.48
Isolated woman	.54

To illustrate the practical application of the foregoing principles we will consider the result arrived at in the construction of the Boston Symphony Hall.

Absorbents	Area in Sq. M.	Coeff'ts of Ab.	Tot. Ab.
Plaster on lath	1040	.034	35
Plaster on tile	1830	.025	46
Glass	22	.024	.5
Wood	625	.06	37.5
Audience	2570	.44	1135
Orchestra	80	.48	38
			1292

Volume = 18300 cub. metres.

$K = 18300 \times .164$

$= 30012$

$t = \frac{30012}{1292} = 2.32$ seconds.

The figure arrived at was decided upon from the consideration of two buildings, the old Boston Music Hall and the Leipzig Gewandhaus, the former having a seating capacity of 2,391, and a reverberation of 2.44 sec., and the latter a seating capacity of 1,517, anh a reverberation of 2.3 sec.

For the data used throughout this paper I am indebted to Professor Sabine, of Harvard University.

DISCUSSION.

Mr. Symons: Mr. President and Gentlemen,—In rising to propose a vote of thanks to the lecturer I should like to say that I think we are to be congratulated on having among us a gentleman who is able to bring before us so lucidly a subject of so much difficulty. I think I am safe in saying that this matter has never been brought before us at any previous meeting of our Convention and I suppose one of the reasons of that is that it is a difficult matter to treat. Certainly not because it is of little value. Professor Anderson in dealing with the subject from the standpoint of absorption of the walls has done us good service, inasmuch as that is a matter that we can more readily handle than the question of form. To construct a building having the proportions and form that have been found best for accoustics is a matter of difficulty. It is rarely that we can build in the shape best suited for that purpose, but we can all of us handle more or less readily the materials of which the walls are to be constructed. I was particularly struck with the Professor's opening remarks in which he spoke of the material covering these walls acting so effectively to absorb sound. I dare say we have all in our experience had illustrations of this fact more or less. Not very long ago I was dealing with the alteration of a room and immediately after the building was finished, while the walls were quite bare and the plastering just completed, I was dismayed at the effect of sound. The speaker had to occupy a position at the side of the room. The room was not very far from the proportions here and on the side opposite to the speaker the ceiling sloped down to about half the height of the room. The echo was dreadful. I wondered what would be the effect when people were in it. A few pictures were hung, and the chairs were brought in and other small articles of furniture, but more particularly the presence of the audience seemed to cure the difficulty. There has been very little trouble since the room has been occupied. The materials that were mentioned as having such good properties of absorption can be easily employed and, as we have had placed before us so clearly the way in which this can be done, this paper is of definite practical value to us. That the position in which these materials can be placed does not materially affect the improvement is a point the knowledge of which may save us much misdirected effort. A building that has been looked upon as perhaps one of the most perfect auditoriums in the world is that of the Mormon Temple in Salt Lake City. I have seen outlines of the form of that room which I think is of very great size; some 250 by 150 feet. It is I think almost a perfect oval. I don't know of course anything about the material of which the walls are formed but I presume they are of some material fairly absorbent. But, whatever may be the truth as to the best form of chamber, we may seldom have the opportunity of devoting our efforts entirely to its attainment. We have all, however, within our reach the means by which we can overcome imperfections, and for the knowledge of what these are and how to apply them we are very much indebted to Professor Anderson. I have much pleasure in moving a vote of thanks to Mr. Anderson for his valuable paper. (Applause.)

The President: Are there not forms of rooms in which it would be utterly impossible to reduce the echo sufficiently to make it a good speaking room?

Mr. Anderson: Of course there are some forms of rooms that are quite unsuitable for public speaking. There is no question but that a room that focuses the sound at some particular point is going to prove detrimental to the hearing. That room could not be made perfect but it could be very much improved. If we take the room and succeed in absorbing the sound we shall certainly reduce it. There are rooms that from their form would not be capable of being brought into a perfect condition, but we can always improve a room which has decidedly bad reverberation. Improvement is all that we can hope for in a room that has been already constructed and where principles have been obviously violated. But the question of form is a very important one; perhaps quite as important as the question of material. It is a question that I have entirely avoided in this paper. I had not time to consider both of them. All I can say now is that a room that is bad cannot be made entirely good, but it can be improved.

Mr. Pearson: The room used as an example is for orchestral music; the time there is 2.32 seconds. For speaking what should be the time?

Mr. Anderson: As low as possible. There is no object in having any decided reverberation for a speaker. That means that a room suitable for an orchestra is not suitable for a speaker. I might say in this connection that data have been determined for piano music, by making a number of tests in the new Conservatory of Music. The figure arrived at was 1.08 seconds. That was arrived at by tests conducted there with a similar apparatus to this. The judges were the President of the Conservatory and several members of the faculty. Nothing was said about the apparatus; they simply decided when it was right and when it was not. Curtains were draped around the room until a certain stage was reached. One of the faculty played a number of airs on the piano and they decided whether there was too much, or not sufficient, reverberation. The rooms were tested one after the other and a figure of 1.08 was arrived at. That is only about half for orchestral music. For speaking the reverberation should be very slight. A hall that has a reverberation of more than one-half a second is unsuitable for the best effects in speaking.

Mr. Pearson: What would you consider the best form of room for speaking and for orchestral purposes?

Mr. Anderson: I do not think there is any form better than the rectangular for either purpose.

Mr. Burke: Mr. President,—In connection with the form of room I remember my late Principal, Mr. Langley, stating that it is practically impossible to make an octagonal room suitable for speaking. He had built a little chapel on Albert Street of octagonal form and it was never good for speaking in. I also remember a church in Montreal, built on the octagon plan, which was never satisfactory. They put in wires, curtains, and galleries and never could make it thoroughly satisfactory. I have always understood that the form of the Greek theatre is considered the best for speaking; that is a semi-circular building with a straight wall at the back, such as the hall that Professor Anderson spoke about. In my own experience I have found that a semi-circle or a little more than half the circle, with a flat wall at the back, is practically perfect for speaking purposes.

Mr. Anderson: Let me point out that such a building would be practically rectangular. As a rule it is only the seating that is semi-circular. I would not say that a rectangular building is perfect or that the other is perfect, but I think that the semi circular building with a wall at the back would be equally good.

Mr. Burke: The Jarvis street Baptist church is a little more than a semi-circle and you can almost hear a whisper when the speaker is on the platform. On the other hand it is not as good for choral music as it ought to be. Everything seems to come right at you; there is no reverberation.

Mr. Pearson: Taking the second column, plaster on lath, are those figures constant?

Mr. Anderson: Approximately. There would be small variations depending on the thickness of the plaster and its kind and so on. But those quantities are fairly constant. Hard oak would differ slightly from pine but not very greatly. Those differences are comparatively small and in any case it would simply lie with the architect to obtain such data as he could of various forms of material used and keep them for reference.

MISSION FURNITURE.

Art in house furuishings never fares so hard in this country as when it tries to assume the virtue of honesty and avoid the appearance of deceit. Everybody whose memory runs back a third of a century will recall the dreadful shamming which overwhelmed the "Eastlake" movement, and a glimpse at the catalogues of "mission" things uow to be found at every turn—the catalogue—brings to mind the old horrors when sham wedgepins and tenon ends were glued on almost any place for decorative purposes. Eastlake things went the way of all the world, not so much because they were ugly, or because they came to be made by people without anything genuine in their natures—such people as wave the flag and make a loud noise on state occasions and call their efforts patriotism—but because change of fashion ruled theu out. Now one might well respect the founders of the missions, who with crude tools and at plenty of cost of hard labor, made lumbering furniture that brought some degree of comfort to a simple, honest, hard life. If their chairs had legs two or three times too large, it is still easy to expect the maker for doing a thing that he probably regretted at the time. The piece of musquite that he must use, could only be reduced to a proper size with his crude tools by an amount of labor which he could not spare from his other duties, so he cut it to his lengths and used it as it was, any notion of a vain display of profusion and indifference to cost of materials being farthest from his thoughts. He then framed and joined the work as well as the limitations of his tools, his skill and time permitted, and while he rested, thanked God for what he had done and what he had taught his followers to do. One might take honest pleasure in having a bit of furnishing that came from such sturdy hands, but when it comes to most of the latter-day stuff that is advertised as Spanish Mission furniture, stuff that is ground out by modern machinery and put together without intelligence, stuff in which structural skill is conspicuously absent, and silly profusion of material and sham constructive details most prominent, we submit that the degree of simplicity that with indifferent success it retains, ought not to save it. Yet, despite the fact that most of this stuff is lacking in all the qualities of quaintness and sturdiness that distingnished the originals, it will probably have its vogue until fashion decrees its undoing.—Western Architect.

THE COLORING OF CONCRETE.*

Having been requested to make a few remarks on the coloring of concrete, I will endeavor to give you my experience in that line. Representing the pioneer block manufacturing company of the Northwest, we have made many experiments in coloring artificial stone.

First, I will state to you that we found the ground colored natural stone and mineral iron oxide were the most desirable and practical, from the fact that they in no way weaken or damage the setting qualities of our stone, but, on the contrary, they add very materially to the strength of the finished product. We tested many different coloring compounds, some with fair results, but all those containing acids or greases (among these are graphites and lamp blacks) are found to be detrimental.

We tested some very fine samples of ground crushed stone from Europe and from different sections of the States, always with the same result. They are too weak in actual coloring matter to bring about the desired shades, and always with the same complaint, "too expensive." Expensive at least in the manner we always use coloring, as we color our entire stone.

Very early in our manufacturing experience, we dropped the facing plan and adopted the plan of coloring the entire stone. Beginners are led to believe, as we were, that the facing of stone is desirable. In theory it is all right; in practice we found it undesirable, and were not satisfied with the results financially. That many beautiful results may be obtained is true, both in the facing and coloring of stone, but that the facing of blocks is not practical, and that they are not merchantable, on account of the cost of manufacture, is also a fact, and we have found that the best results are obtained by keeping as close to the manufacture of your primary product as possible. We may at times find customers that will pay the additional price, but they are the exception and not the rule.

To illustrate this, we will mention that we were recently asked to figure on a very elaborate design for an office building for one of our large manufacturing concerns, but when we made our estimate and named the price, the owners simply shook their heads. That one of our competitors made this building is a fact, and that it is a handsome building is true. However, the contractor recently asked me to condole with him on the results financially. The only satisfaction I could give him, was the old reply, "I told you so."

In making tests either with coloring concrete blocks, or concrete of any character, it is our motive to make our product at a minimum cost, and market it at a fair profit in competition with other non-combustible materials.

The colored stone that we are most frequently called upon to imitate in Wisconsin is what is known as "Portage Entry Red stone." This is a Northern Michigan product, and we are at a loss to know why they term it "red" stone, for, in fact, it is a very light shade of pink, and the most singular condition is that if we were to produce an artificial stone as light in color, the public would exclaim at once, "Why, how pale it it. It must have faded considerably." Our only test is to place the natural product by the side of the manufactured, and allow our customers to see the difference. Then they say, "Why, I did not imagine it was so light."

We have found it necessary to color our artificial stone several shades darker (when first made) than the natural product. We are frequently asked, "Will not this color fade?" That the stone grows lighter as the cement sets is true, and it will continue to grow lighter until it has attained a thorough initial set and has become dry. This setting and drying process (as all of you know) is governed largely by the temperature and time of year, and the exposure to which the manufactured product is subject. All of you who are contractors and builders, know that when you desire a deeper or darker shade of mortar coloring, you are obliged to make your wet mixture many shades darker than when it is finished and the action of the lime has taken place.

We are also frequently asked what proportion of coloring matter we use per stone. This is rather hard to answer, from the fact that different block manufacturers make many different sizes of stone, and that the material used in different localities varies so much in character. We also find that different cements change the coloring more or less. However, this is not perceptible to any great degree.

In the manufacture of red stone with such sand and cement as we are in the habit of using, to obtain a strong, deep, cherry red after final setting, we find it necessary to use from 5 to 7 pounds of the pure mineral oxide per cubic foot of concrete. In this mixture we use clean silica sand containing no loam or clay of any character and very little organic matter. We also found that the thorough mixing of the color with the cement, before adding sand, was very necessary.

We discovered that to get good results it was absolutely imperative to have our sand thoroughly dry, and that we were obliged to mix sand, cement and color together thoroughly, much more so than in making the ordinary concrete block. We learned this early in our contracting career, when at times we found it necessary to use lamp black in producing dark mortar color. We were at a loss many times to find some liquid mixture with which the lamp black would thoroughly assimilate. At times we used vinegar, at others stale beer (and incidentally will say that this very seldom grows stale in Milwaukee). By simply taking very fine dry sand and mixing the lamp black with it thoroughly, we found no trouble in getting an even, dark color for our mortar.

We have been for some time endeavoring to get a green stone for an architect and customer, but as yet have not been satisfied with the results. We did make a green stone, the body of the block being of a moss or olive shade, with streaks of livelier green color running through, but we have been somewhat afraid to recommend this stone to the architect, as we have not fully satisfied ourselves as to the action of this ultra-green on the cement. Our first trial was some six months ago, and we are watching the product of this trial very carefully; as yet it shows no signs of disintegration, and we are now subjecting it to the strong climatic changes, to see what effect the weather will have upon it.

We also found that to get an even and artistic product, it is essential to have our materials as nearly in the same condition as possible, as regards moisture and mixing, all these little details causing additional expense over the original product we made.

We are frequently asked, "Have you experimented with hydrated lime, stucco or other fine materials, in making colored concrete?" Yes, we have experimented with all of these, and, in addition, have used other fine filling materiais, such as Warrenite ground flint clay, also ground silica. I found that hydrated lime and gypsum quickened the setting qualities of the material, provided enough water was used and added from time to time, to keep the concrete from burning or falling apart, as the lime or stucco absorbs the moisture more readily than the cement, and robs it of the moisture it must have. I also found that if I succeeded in keeping it moist enough, after a period of six months to a year, a condition almost akin to decomposition set in, and the mass would crumble and fall apart. However, the latter conditions did not occur with the ground Warrenite or fine silica, but we did find that it was necessary to add about 2 more parts cement to get desired results with the extremely fine material.

You ask, "Why use such fine material?" We found that in producing a beautiful colored artificial stone, it was necessary to have a very dense product, especially when your customer gives the stone a close and crictical inspection. . .

*From a paper read at the Initial Convention of the National Cement Users Association, held at Indianapolis, by Mr. J. P. Sherer of Milwaukee.

ADDRESS ON REINFORCED CONCRETE.

By C. A. Turner, M. Am. Soc.C. E. Minneapolis,

The industry and enterprise of the American Portland cement manufacture has now placed at the disposal of the enterprising engineer or builder, a thoroughly reliable material when properly handled which bids fair to replace timber and structural steel in buildings and short span bridges. . .

In treating the subject from the popular standpoint, the writer would first say a few words as to the relia- of the construction as compared with steel or timber. Ignorant abuse will render dangerous the best material which the engineer uses,—for example, some months ago the writer was called on to inspect some coupler pockets forged out of 1 ¼x4 inch bars made by a Pittsburg company. They were worthless, the writer was told, and going to the pile and selecting four, they were placed on the ground and struck a few sharp blows with a sledge, a single blow fractured 10 square inches of metal in two cases. In normal condition this area would carry 600,000 pounds in tension. Taking the shank to a steam-hammer, the center was bent flat on itself without fracture, proving that the smith had burned the steel in forging, until it was worthless at the bend.

Similar inexcusable ignorance in working concrete will likewise result in inferior work, but by no means such an extent as that instanced in the case of the steel.

The mistake that is made by many in fabricating reinforced concrete is the endeavor to get strength with a cheap concrete. A common proportion is 1 cement, 3 sand, 5 stone—a mixture much too poor to secure the best results, or the greatest strength for a minimum cost. A mixture of 1 cement to 2 sand and 2 broken stone of size from a pea to that which will pass a three-quarter inch screen is to be preferred. The stone should be screened, if limestone, otherwise the dust such as that of trap rock or granite may be used in lieu of sand. By making this mixture wet enough to flow slowly and require no tamping whatever, the question of poor workmanship when the material is mixed by machine in exact proportions is entirely climinated; any laborer you may employ who can dump the car and level off the cement will do as good work as can be done.

Such concrete three months old should give a value in compression of 2,500 pounds per inch, or more, without reinforcement. In the form of a column, if constrained laterally, Considère has shown that this crushing strength can be increased five-fold, or more, dependent on the reinforcement.

The principle of this reinforcement is this : If we take a light sheet metal cylinder and fill the same with sand, the cylinder will support a load on the sand much greater than it would empty, since the metal is in tension and the filling with the lateral restraint carries the load.

Now were the metal shell square, evidently the sides of the shell would bulge sidewise under the internal pressure—similarly any attempt to hoop a reinforced column with a square hoop is an amusing absurdity, the slightest lateral bending removing the necessary restraint.

At first thought it might seem that a continuous cylindrical shell would be the best means of reinforcement, but the vertical metal being more rigid than the concrete, would be strained to its limit before being brought into action in its capacity of lateral reinforcement ; hence the undesirability of attempting to make the vertical reinforcement used continuous, *i. e.*, without some concrete between ends where this principle is to be employed, or making the reinforcement in form of a spiral coil as recommended by Considère.

The criticism that may be urged against some of these forms of reinforcement appears to the writer to lie in the failure to make a good connection to the beams. For that reason the reinforcement advocated by him is in the form of a grill of vertical rods banded at intervals by a strong riveted hoops with one of the rods bent outward into each beam, connected to and supported by the column, and the whole wrapped or hooped with netting.

As in this country the use of concrete construction is in its earlier stages, it is not surprising perhaps, that many of its advocates are imitating the methods of framing required for construction in entirely different materials, rather than forms and proportions peculiarly adapted to reinforced concrete. . .

In the structural line we have attempts to reinforce structural steel with concrete, to put in beams as thick as required for the old fashioned wood framing, attempts to reinforce in one direction only, forgetting that in a monolithic mass of the size with which we are dealing, temperature stresses must be provided for in the reinforcement of the work so as to make it stand without cracking.

In designing reinforcement of beams, advantage should be taken of the principle of continuity, since with the constant section we have to provide only for 2-3 the moment of a simple beam and we have but one-fifth of the deflection, for the beam fixed at both ends that we would have for a simple beam.

This system of design calls for the major section of the metal for flange reinforcement over the support and furnishes ample provision for shear.

In constructing work in this line it is well to bear in mind that centering is a considerable item and that each additional beam is an extra expense. While we may not discard beams for heavy work for light loads, such as two to four hundred pounds per square foot, we may make a simple slab from column to column spacing 16 to 18 running main lines of reinforcement from column to column directly and transversely with lighter fabric between these lines, all buried in a slab of uniform thickness.

A few words regarding the interesting peculiarities of reinforced concrete. We will shortly illustrate a panel which under 82 tons load showed absolutely no deflection whatever. Now the materials with which we deal in engineering work are elastic, why then such deportment of these beams? In setting up, the concrete shrinks and the rods reinforcing the bottom of the beam are actually in compression, also the top of the beam in tension due to internal stress. Until this condition is counterbalanced we could then expect no elastic deformation. This feature of the deportment of reinforced concrete is worthy of serious consideration by those who contemplate using shapes of irregular form as reinforcing members.

In crushing concrete usually shears at an angle approximately forty-five degrees to the direction of pressure, hence plain reinforcement, either parallel or at right angles to the line of pressure has a marked influence on its strength.

To return to the more popular phases of the question of reinforced concrete: Can it be figured with accuracy? And do we know enough about it to use it with safety? The answer is emphatically in the affirmative. The engineer can figure the strength with the same degree of precision certainly, that he can timber construction while if the tensile value of the concrete is disregarded as is the case in good practice, the error is invariably on the side of safety.

How does reinforced concrete compare in cost with older styles of construction? For heavy building we can compete with wood when the working load is 500 pounds per square foot or more.

For lighter loads we can compete at a good profit with any of the older forms of fireproof construction, saving the owner the cost of the entire steel skeleton.

For loads greater than 800 pounds per square foot it is cheaper than timber if both are made of equal strength.

As regards its fireproof properties there is nothing in use which equals it.

At the Paris Exposition the Hennebique Company erected a cement concrete building in which to test both the strength of the floors and their resistance to fire when loaded. The first floor was loaded to three thousand pounds per square yard. The upper floor to two thousand pounds. The deflection was barely 1-25 of an inch. A big fire of cord wood and oil was started on lower floors and kept at full intensity far an hour, and although the heat developed was 1,800 degrees F., yet the temperature on the floor above the fire only increased about four degrees, showing that merchandise would not have been injured in such a position. At the end of an hour the deflection of the heated ceiling had increased to one-half inch. Then the whole building was drenched with water, and two hours later the load was removed whereupon a rise of one-half inch took place showing no permanent deflection or injury to the construction.

The construction of reinforced concrete is supposed by many to be slow business while as a matter of fact in no system of construction can the materials be as promptly obtained or the work more rapidly pushed. The cement and rods can be obtained, if necessary, at a weeks notice and the rough timber for forms is a stock proposition. A single half yard mixer and suitable crew can readily erect a with floor of 16,000 square feet area including columns and beams in a week's time with fair weather.

To the contractor who has vainly tried in our cold climate in winter to conglomerate 16 parts of frozen sand and gravel with one part of cement—plus ice water, and produce smooth concrete work, the idea of putting in satisfactory reinforced concrete in winter seems an impossibility. He is respectfully referred to the paper of W. A. Rogers, read before the Western Society of Engineers, who concludes from the tests that exposing freshly mixed Portland cement to a freezing temperature seems to effect its rate of hardening making it slower, but eventually the concrete will be just as good as if it had not been exposed to the cold. A conclusion in accord with the writer's experience.

The question is frequently asked—will reinforced concrete stand the test of time? Buildings built by Hennebique have been in use for twenty years and are claimed to be stronger today than when first built.

GAS AS A FUEL FOR HOT-AIR HEATING.*

By R. S. Thompson.

For cleanliness, convenience of management and economy of labor, gas is the ideal fuel. I believe the day is not far distant when the householder would no more think of filling his cellar with coal in order to supply his house with heat than he would of putting a slaughter house in his cellar in order to supply his family with meat.

So obvious are the advantages of gas as fuel that on the introduction of natural gas, most people in the gas regions who had hot-air furnaces made haste to have the grates taken out and gas-burners put in. They had their cellars cleaned up and their coal-bins taken away.

In a large proportion of cases, after a trial for a single season, they made equal haste in having the gas-burners taken out, the grates put back and their coal-bins fitted up again.

So generally unsatisfactory was the result of the attempt to use natural gas in hot-air furnaces, that it became a generally accepted idea throughout the gas regions that gas was adapted only for use in stoves and was entirely unsuited to hot-air furnaces.

And yet there is no scientific reason why gas cannot be as successfully used in hot-air furnaces as in any other form of heating apparatus.

The difficulty arose from lack of proper consideration of the conditions requisite in using a new fuel. Furnace men were putting new wine into old bottles. The result was that the old bottles (furnaces) were spoiled and the new wine (natural gas) was wasted.

There is a wide difference between a gas fire and a coal fire, each developing the same number of heat units per minute.

With coal, there is a bulk of intensely heated carbon throwing off radiant heat in great quantity; consequently the fire-box and combustion-chamber of the furnace become intensely heated by that radiant heat and a comparatively small amount of this highly heated surface will heat a large amount of air.

There is comparatively little radiation of heat from the pure blue flame produced by the perfect combustion of natural gas. The heat produced is principally contained in the gaseous products of combustion. Owing to the dilution of these products with the nitrogen from the air and with the excess air usually admitted, this temperature is not very high. One of the principal products of the combustion of gas is water in the form of steam, and this contains in latent form a large amount of heat.

In the combustion of one thousand cubic feet of natural gas there will be produced from eighty to one hundred pounds of water in the form of steam. This steam will continue from eighty to one hundred thousand B.T.U.* as latent heat which cannot be utilized until the steam is condensed into water by lowering its temperature below 212 degrees.

The attempt to heat a building with steam, allowing the live steam to escape uncondensed into a chimney, would be no more extravagant or unscientific than the attempt to heat with gas while allowing the live steam produced by the combustion of the gas to escape uncondensed into the chimney.

In order to use gas successfully and economically in hot-air heating, the following points are necessary:

1. A burner which will secure combustion of all the gas which passes through it and will not permit the production of carbon monoxide, or, as it is commonly called "carbonic oxide gas."

2. A sufficient amount of surface exposed to the products of combustion on one side and to air at a temperature very considerably below 212 degrees on the other, and so arranged that the products of combustion will be reduced to a temperature below 212 degrees before leaving the furnace.

3. A sufficient quantity of air passing through the furnace to take the heat from the products of combustion without itself becoming sufficiently heated to impair its power in extracting heat.

4. Provision for getting rid of the water of condensation.

We will consider these points in order.

There has been much unscientific talk on this subject. The heat is in the gas, not in the burner. If a burner secures the combustion of all the gas which passes through it without the production of carbon monoxide, it has done all that can be done. Talk about burners which burn large quantities of air is all nonsense. A cubic foot of gas in complete combustion combines with a fixed quantity of oxygen. This quantity can be neither increased nor decreased. If the quantity of air supplied is insufficient, part of the gas will be unburned. If the air is supplied in excess of requirement, the excess of air will not be used. If more air is mixed with the gas than required, combustion will be imperfect and part of the gas will be unburned.

A perfect gas flame is a clear blue and perfectly transparent. A white or yellow flame, or a milky-blue flame indicates imperfect combustion. Sometimes a gas flame seems blue, but by holding an object on the other side it will be found it is not transparent. This indicates imperfect combustion.

If the flame "blows" or "lifts" away from the burner it shows too much air and consequently imperfect combustion.

If the fire "streaks up" in long, ragged flames, there is imperfect combustion.

If any portion of the burned gas mixes with the fresh gas, it poisons the latter and there is imperfect combustion, for a small amount of carbon dioxide mixed with gas renders the whole mixture incombustible.

The best gas fire is obtained by a large number of small jets so arranged that each jet will be fed with pure air and that the burned gas from one jet cannot

*Paper read beforr the American Society of Heating and Ventilating Engineers.

*British thermal unit.

become mixed with the fresh gas issuing from another.

A gas fire should have a supply of air in addition to that which is supplied through the mixer. It is impossible to supply enough air through the mixer to secure complete combustion, and one of the most common errors in setting gas burners is the attempt to exclude all other air.

On the other hand if an excess of air is supplied it will unduly reduce the temperature of the products of combustion.

It is a mistake to attempt to "hold the heat back," by tightly closing the damper in the smoke-pipe. When this is too tightly closed the poisonous products of combustion are retained too long in the furnace and poison the fresh gas issuing from the burner. The way to avoid loss of heat to the chimney is to take the heat out of the products of combustion and then let them escape freely. When the heat has been extracted, the sooner they are carried away the better. By actual test, with careful measurement of the heat units utilized in the air, I have found that more heat units were utilized with a free outlet to the chimney than with the damper tightly closed. In the latter case the smoke-pipe was cooler, but the total number of heat units developed per thousand feet of gas was less, showing that much of the gas was unburned.

Considerable scientific knowledge, skill and common sense are required to properly adjust a burner and mixer so as to secure the proper mixture of gas and air and the proper pressure in the burner. A three-quarter inch mixer will, in some burners, carry in more air than an inch and a half mixer in others. No rule can be given. I have secured a perfect fire with a three-quarter inch mixer, using one hundred feet of gas an hour, and I have had other cases where not more than fifty feet of gas an hour could be burned with an inch and a quarter mixer. A burner adjusted for one locality may not work properly in another as the composition of the gas and the pressure in the mains differ. The supply pipes should be of liberal dimensions, especially if long, as the friction in the pipes will reduce the pressure, and a low pressure at the mixer means an imperfect mixture of gas and air, and, in consequence, imperfect combustion.

THE SURFACE

It is impossible to give any hard and fast rule in regard to the amount of heating surface required, as there is much difference in the efficiency of surfaces, and so much depends on the quantity and temperature of the air carried over these surfaces. The problem is to extract the heat from the products of combustion, and no amount of surface will do this unless that surface is exposed to a constant current of air at a temperature considerably below 212 degrees. In general I have found that, with a liberal air supply, there should be about one square foot of surface for each cubic foot of gas burned per hour.

AIR SUPPLY

This is not so difficult to estimate. Natural gas is a product of uncertain chemical composition, and this statement is even more true in regard to most artificial gas, but a good quality of natural gas should contain about one thousand B.T.U. to the cubic foot. This would heat about five hundred and fifty cubic feet of air one hundred degrees. It would therefore appear that the amount of air passed over the heated surfaces should be from three hundred to five hundred cubic feet for each cubic foot of gas consumed. The greater the amount of air and the lower its temperature when passing over the heated surfaces the more complete will be the exhaustion of the heat.

This raises an interesting question as to what disposition should be made of this air after it is delivered to the room which I will consider later.

DISPOSING OF WATER OF CONDENSATION.

This is one of the most difficult problems in connection with the use of gas as fuel. A thousand cubic feet of gas weighs about thirty-seven pounds, and if of high quality contains from nine to eleven pounds of hydrogen, but as each pound of hydrogen in the gas, combines during combustion with eight pounds of oxygen from the air there is a production of nine pounds of water for each pound of hydrogen contained in the gas, and a thousand cubic feet of good gas will produce from eighty to one hundred pounds of water when burned. To allow this water to escape in the form of steam at a high temperature, involves, as already shown, a great waste of heat. To utilize this heat by cooling the products of combustion to the point where the steam will be condensed, involves the problem of disposing of the water of condensation.

By proper construction of the burner and regulation of the air supplied to the fire, a large portion of this water can be mechanically carried off through the chimney in the form of mist which is suspended in the air after the latent heat has been removed, but some of it will, under some conditions, form into drops, run down the inside of the chimney and drop from the furnace.

Therefore every chimney used for a gas fire should be perfectly straight and lined with tile, and provided with an opening at the bottom for the escape of the water.

In several cases I have provided for a gas furnace a special chimney made of gas pipe from three to six inches in diameter, according to the size of the furnace, with an inch and a quarter pipe at the bottom connected with a drain.

The furnace itself should be provided with some small openings to drain off the water, though, of course, the arrangement of these will depend on the construction of the furnace. I have been called to "sick furnaces" where the trouble was that the lower flues had become completely filled with water. I was called to one case where the furnace was connected with the chimney by means of a smoke-pipe thirty-five feet long. This pipe near the chimney was close to a window. I found the trouble was due to a careless janitor who had left this window open and the pipe at this joint had become completely closed with ice.

Most natural gas contains sulphur, and this when burned in connection with hydrogen produces sulphuric acid. The water of condensation is, therefore, usually quite corrosive. It will eat the mortar out of chimneys, hence the necessity for lining them with tile. It will corrode iron, so the smoke-pipe should be of heavy iron and coated inside and out with some acid-resisting paint. It should be kept in mind that the products of combustion of natural gas are not corrosive while hot. Corrosion begins only when these are sufficiently cooled to cause condensation of the steam. The more perfect the operation of your furnace, the more trouble you will have with condensation. Complete absence of trouble from this source is usually an indication that the furnace is ineffective.

I referred to the problem of disposing of the large amount of air which, in using gas, is required to extract properly the heat from the products of combustion. With a furnace burning one hundred cubic feet of gas per hour this would require from thirty to fifty thousand cubic feet of air per hour. The large amount is preferable.

But a family of six persons would require for the most perfect ventilation but ten thousand eight hundred cubic feet of fresh air per hour, so if all this air that is poured into the house is allowed to escape at a temperature of 70 degrees through the windows or drawn off by a ventilating stack, there will be an enormous waste of heat.

To my mind, there is but one proper solution of this problem. Return to the furnace all the air supplied in excess of the amount required for thorough ventilation.

This would require additional expense in the installation of the system. But any system of hot-air heating is defective which does not provide means for the exhaust of the waste air as well as means for the supply of warm air. A perfect system of hot-air heating should include double piping, that is to say, one set of pipes for the supply and another set of pipes for the exhaust.

MONTREAL NOTES.

THE APPROACHING BUILDING SEASON.

A great many building schemes are announced as in contemplation for the coming season. Whether Montreal is going to get what she most wants is open to question, but at this season of the year there is no doubt what is most urgently needed. The talk is all of the high rents which rise higher and ever higher. One can hardly cast a glance on a daily paper without lighting on some reference to the subject. There are probably few cities of the same size in which are so few houses which look like homes, while whole streets of recently erected dwellings for people of moderate means, proclaim unmistakeably, from every galvanized battlement and turret, that the first object of their existence is to extract coin from their tenants under false pretences. No doubt the demand is being met to some extent; it is difficult to judge how far, as the largest supply comes from the multitude of small individual speculations.

Amongst other bitter cries on the subject, one has taken the form of a petition from the Trades and Labor Council to endeavour to induce the Quebec Legislature to pass a law compelling the rents charged for houses to be based on the assessed value of property—a proposition which might take its place admirably in a scheme of things nearer to ideal justice than is likely to be found in the Province of Quebec for some time yet. Meanwhile there can be no manner of doubt, that the high rate of rents is having a most pernicious effect on the planning of the humbler sort of dwelling. Knowing well that people must be housed, and that in existing conditions, they may be compelled to pay whatever may be asked for whatever accommodation is offered them, speculators are putting up the flimsiest apologies for shelters with so many rooms crowded upon a given area that bedrooms and W. Cs. are often enough arranged where neither light or ventilation can reasonably be expected to percolate to them.

Amongst the larger housing schemes, the Montreal Land & Improvement Company are about to erect fifty dwellings mostly for workingmen on the lots between the Angus Workshops and Sherbrooke street. A large apartment house, to be known as the "New Sherbrooke," is to be built adjoining the present "Sherbrooke" flats in Sherbrooke street. It is to contain nine large and forty-one small suites of rooms with a general dining room. It is to be a five storey building of concrete fire-proof construction. Messrs. McVicar and Heriot are the architects.

In the same locality the Bishop Street Apartment House, designed by Messrs. Saxe & Archibald, is now nearing completion. At Raymond one proprietor is having nearly 60 dwellings in single and double houses completed for the 1st of May.

At the sitting of the House of Commons on the 16th of Feb., the estimates for public buildings in the Province of Quebec, were under consideration and funds were voted for several purposes. Important changes are to be made in the Post Office arrangements: $25,000 are to be spent on alterations to the Central office. The interior is to gain floor space by bringing the main wall forward to the street line. A site on the south side of St. Catherine street, close to the Renouf Building, was purchased some time ago, on which to build an uptown Post Office. A distributing station is to be placed on a site extending from the G.T.R. Square to Cathedral street adjoining the St. James' Hotel. This station will be connected with the central and with the uptown office by pneumatic tubes. A sum of $50,000 has been voted for the work. A similar sum has been voted for additions and repairs to the Inland Revenue Office. New additions are to be placed upon the small open square in front of the present building. Another building for which the Government has voted $20,000, is a barrack for the Permanent Corps. A site in Lafontaine Park may be requisitioned, but the civic authorities are endeavouring to provide a site elsewhere.

Last year most of the important building of the city was done

(Continued on Page 47)

—THE—

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PERSONAL.

Messrs. Chadwick & Beckett of Toronto have taken into their partnership, Mr. Howard Bovell, jr., who has recently returned to Toronto after spending between two and three years in office experience in Chicago.

Messrs. Lawrence Munro and William R. Mead, architects, of Hamilton, have entered into partnership. They have opened an office at No. 10 Main street east, and will be pleased to receive manufacturers catalogues and samples.

To Restore Faded Marbles.—The lost colours of marbles may often be quite restored by washing with the strongest soap lees combined with quick-lime, about the consistency of good milk. This composition should be laid on the surface for a day and night. Finally remove it with soap and water, and the marble should be found as beautiful as ever.

in the eastern part of St. James St.; and while the number of estate transfers, recently effected in the same street somewhat farther west, may foreshadow more building in that locality, people are expectant of more important improvements in the uptown district, more especially in St. Catherine street west. The City Building Inspector has recently drafted a by-law to regulate buildings in this street. This by-law very properly calls for substantial, durable materials in the construction of new buildings. It forbids the erection or adaptation of buildings for stable or factory purposes and contains the rather curious requirement that new buildings must be at least three stories high, and thirty-eight feet in height from the sidewalk to the roof. It is to be supposed that a demand so arbitrary would not in every case be arbitrarily enforced.

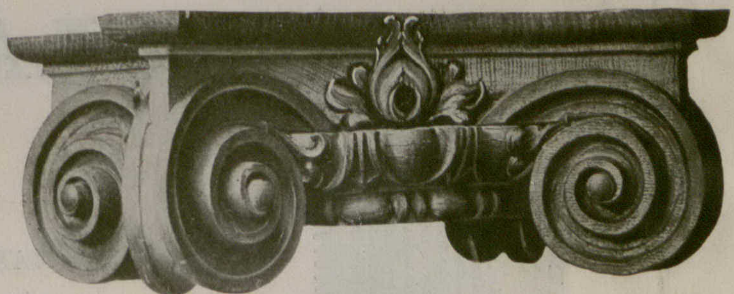
In the block between St. Timothy St. and St. Andrew St. on the north, Mr. N. G. Valiquette, who now owns nearly the entire block, is to erect a five storey factory, which will however face St. Andrew street. Messrs. Henry Morgan & Co. have, in a similar manner purchased almost the whole of the large block bounded by St. Catherine st., Berthelet st., Union avenue and Aylmer st., and intend to provide themselves with factory accommodation thereon. This scheme may take some time to develope, in order to allow certain of the existing leases to expire.

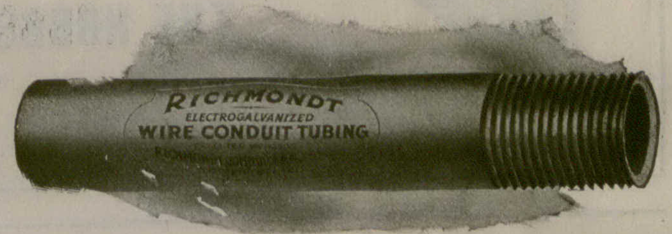
Farther west in St. Catherine St., on the south side between University St. and McGill College avenue, is the site for the uptown Post Office spoken of above. On the same side, some doors west of Real street. Messrs. Lindsay, the Piano dealers, are to put up a seven storey building. At the north-east corner of St. Catherine St. and Stanley St., Molson's Bank are to erect a branch. This is the corner at present occupied by Mr. Frank Norman's Stanley Hall, which will be built anew at 108-110 Stanley Street, at a cost of upwards of $30,000, with balconies on three sides to seat 800 persons.

Not far from here, at the north-west corner of Peel St. and Burnside Place, the Bank of Montreal have announced their intention of establishing another branch. The same Bank has already a branch at the corner of Mansfield St. and St. Catherine St., and intend to place still another on the south-west corner of Sherbrook and St. Lawrence Streets. The Bank of Hochelaga is adapting a building at the corner of St. Denis St. and Mt. Royal avenue, to the purposes of a branch. But, as in Montreal banks and their branches seem to breed like rabbits in a warren, it is useless to begin to try to enumerate even the latest additions to the family—they come so quickly.

In addition to a very fair share of commonplace substantial work, which promises to take shape in stone and lime in the near future, there seems to be a dim vision that haunts the mind of the Montrealers. This is of a magnificent hotel not at present located in any particular spot, but hovering most frequently about the block between Dominion Square and St. Catherine st. This phantom hotel, inspired we know not whence, seems to be a subject in which the imagination of the dwellers in these parts loves to revel. It is to cost fabulous sums of money of course, it is to be a place of next to heavenly splendour and excellence of management, and it is to be erected some day.

CONCORDIA SALUS.





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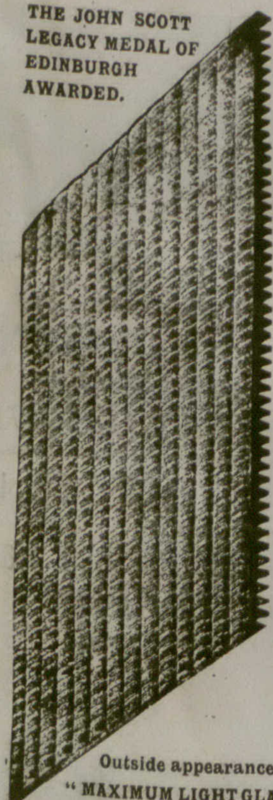

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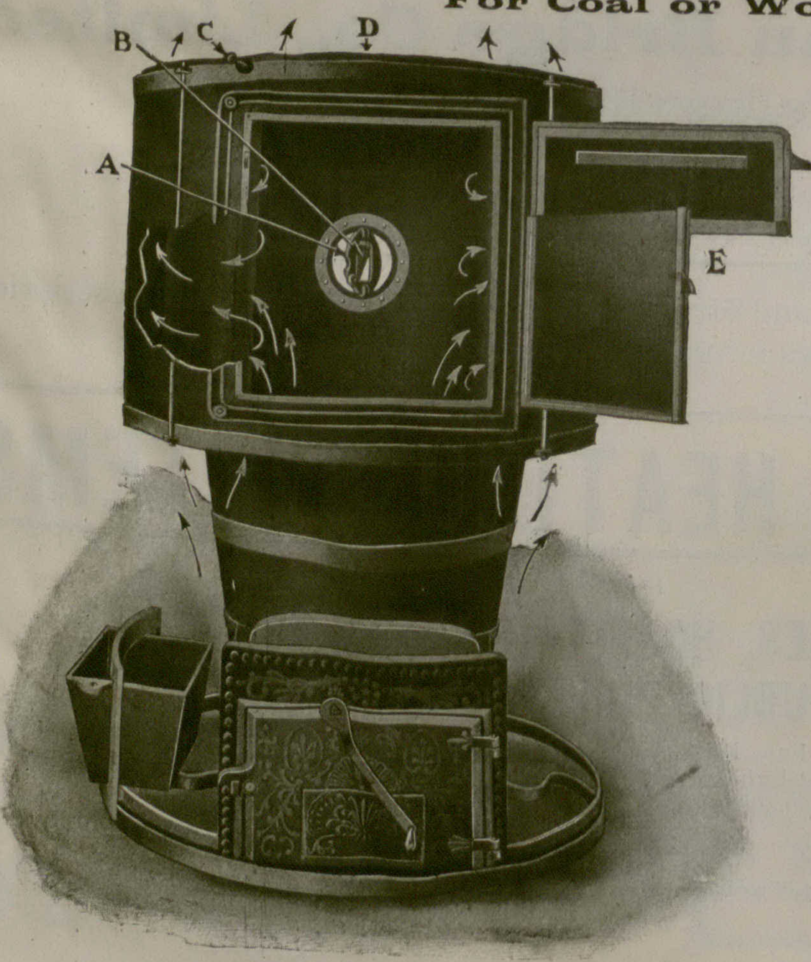

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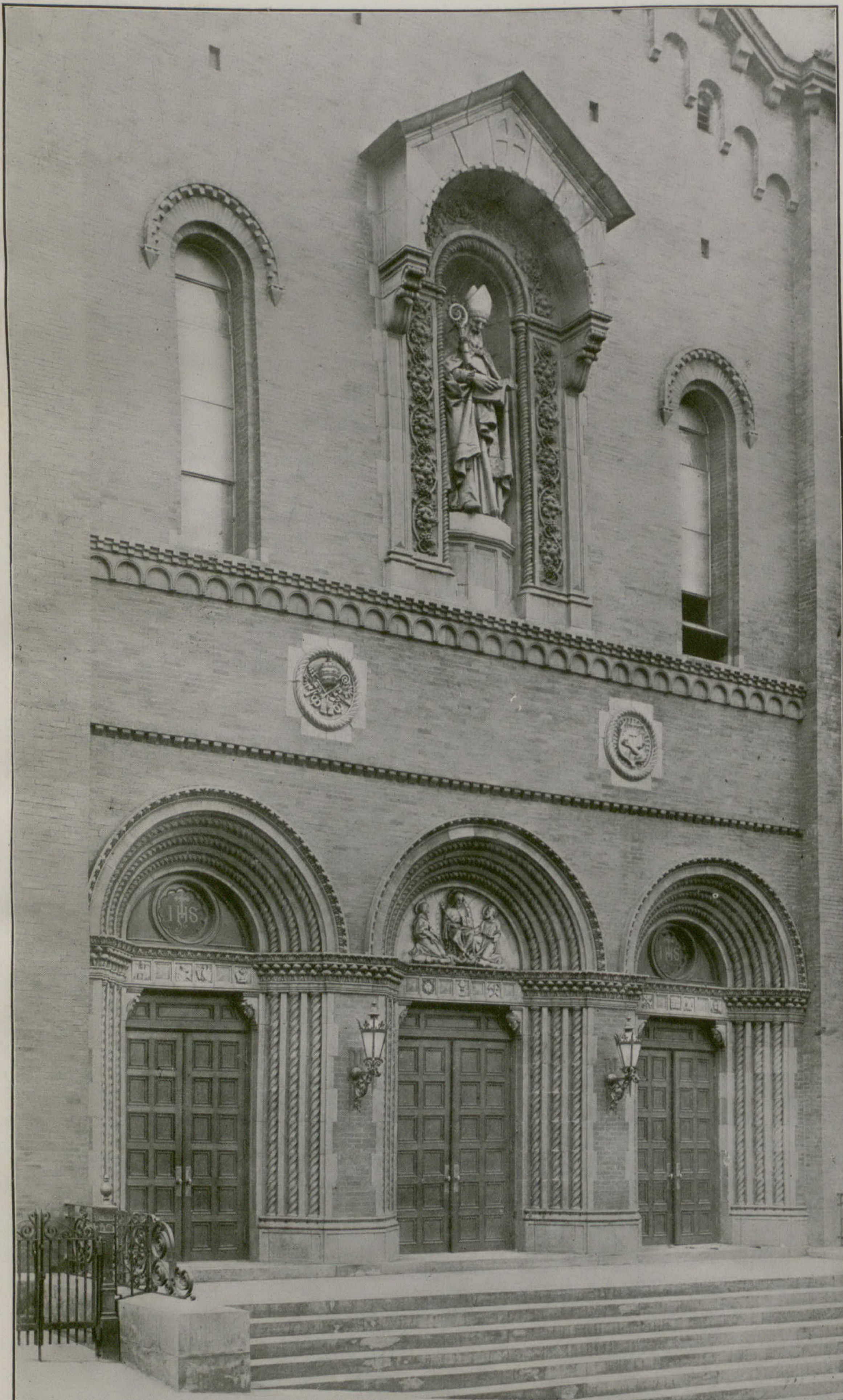

FRONT OF ST. AUGUSTINE'S CHURCH, PITTSBURGH.

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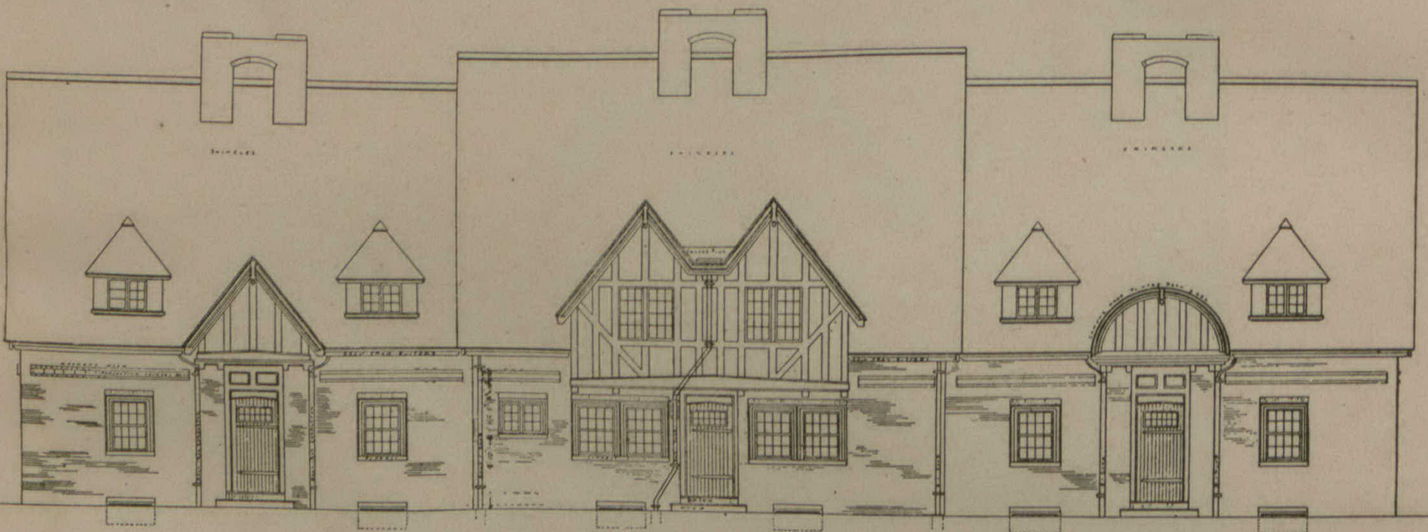
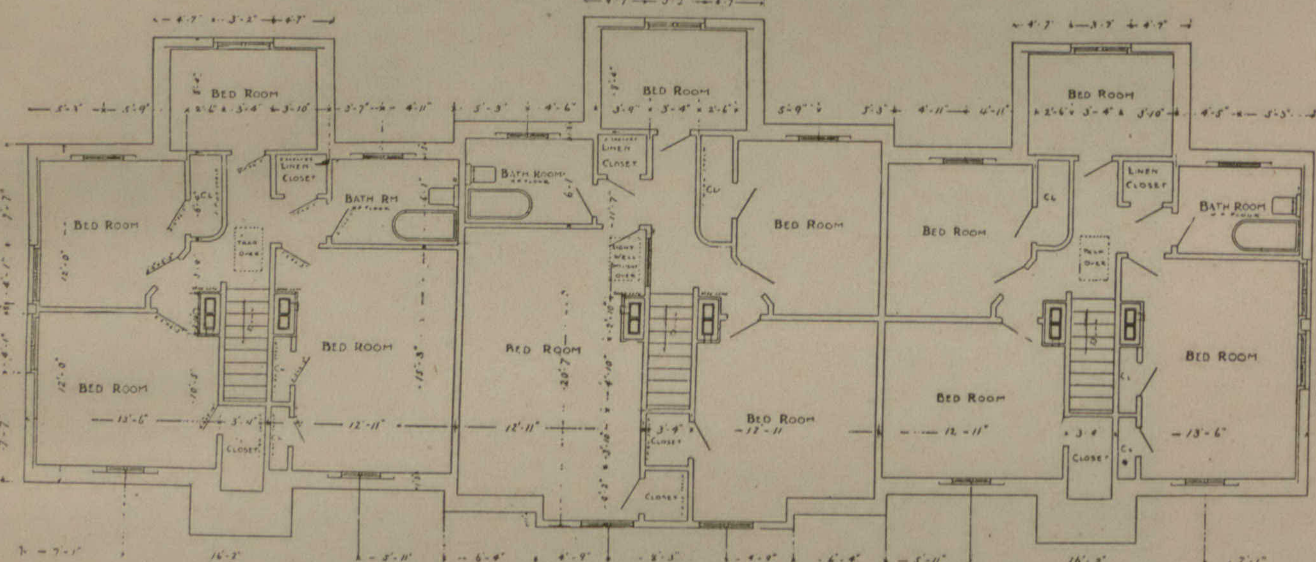
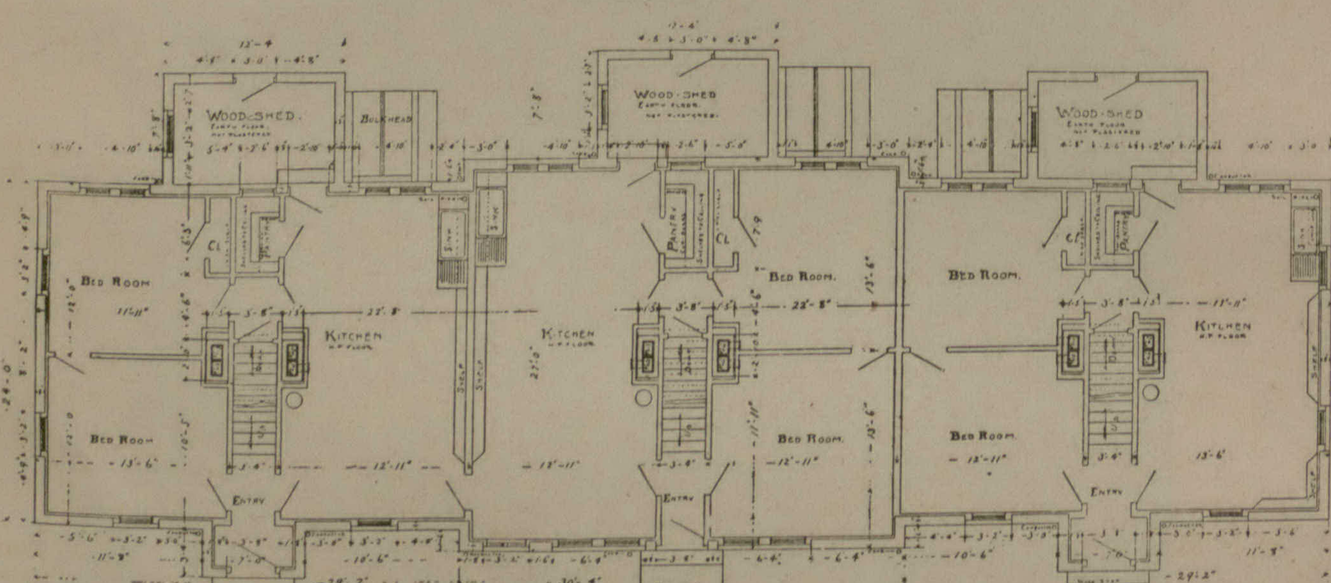


FRONT ELEVATION.



SECOND FLOOR PLAN.



FIRST FLOOR PLAN.

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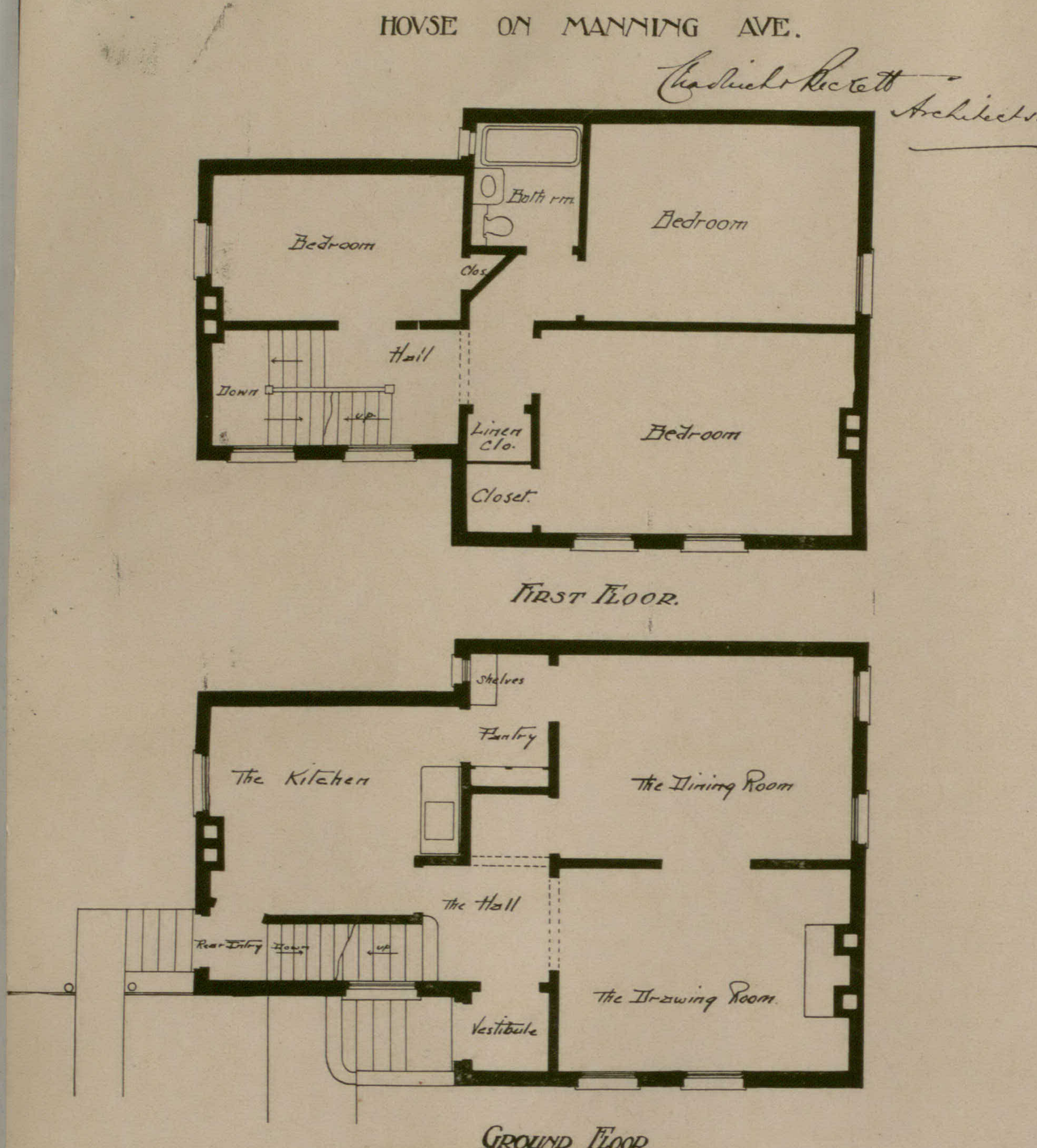

House on Manning Ave., Toronto.

Messrs. Chadwick & Beckett, Architects.

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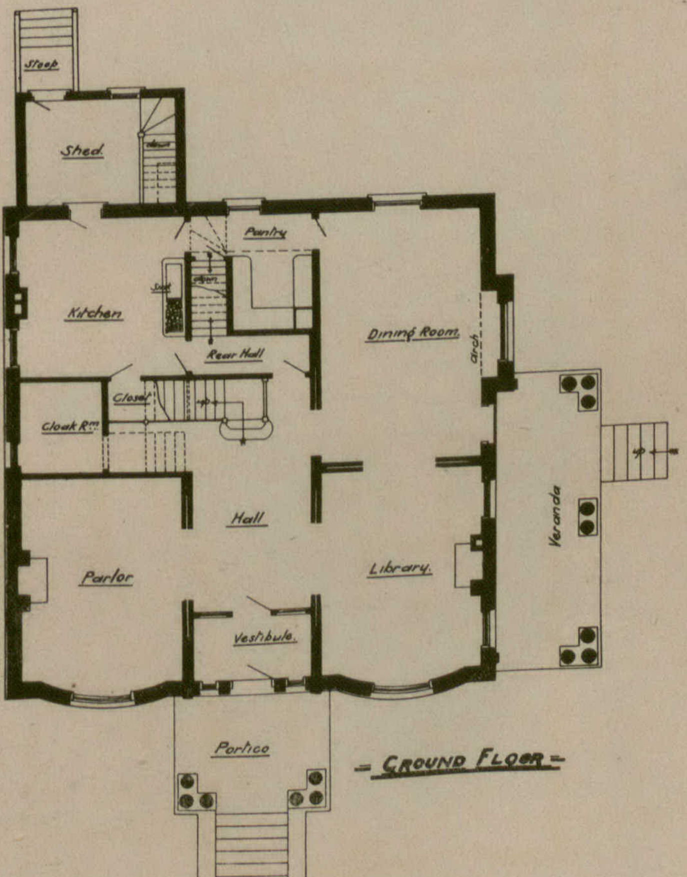
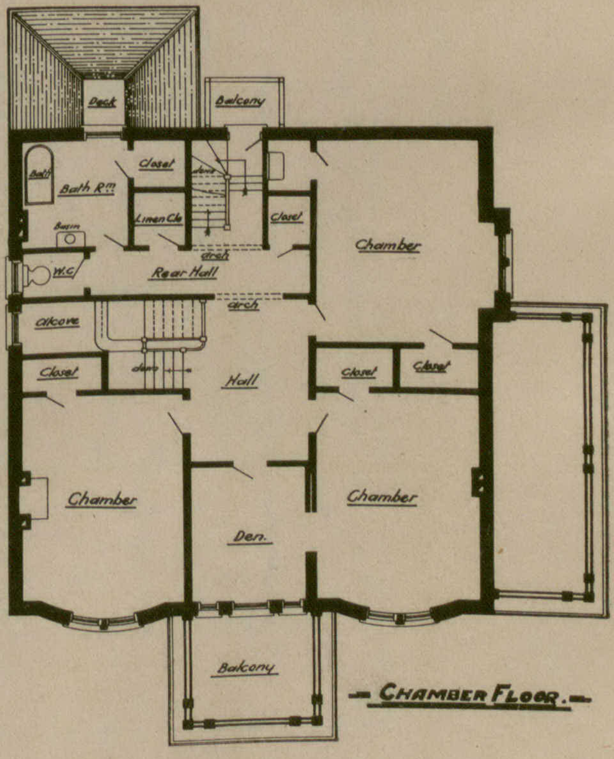


– GROUND FLOOR –



– CHAMBER FLOOR –

HOUSE FOR I. H. CHAMBERS, ESQ., WINNIPEG.

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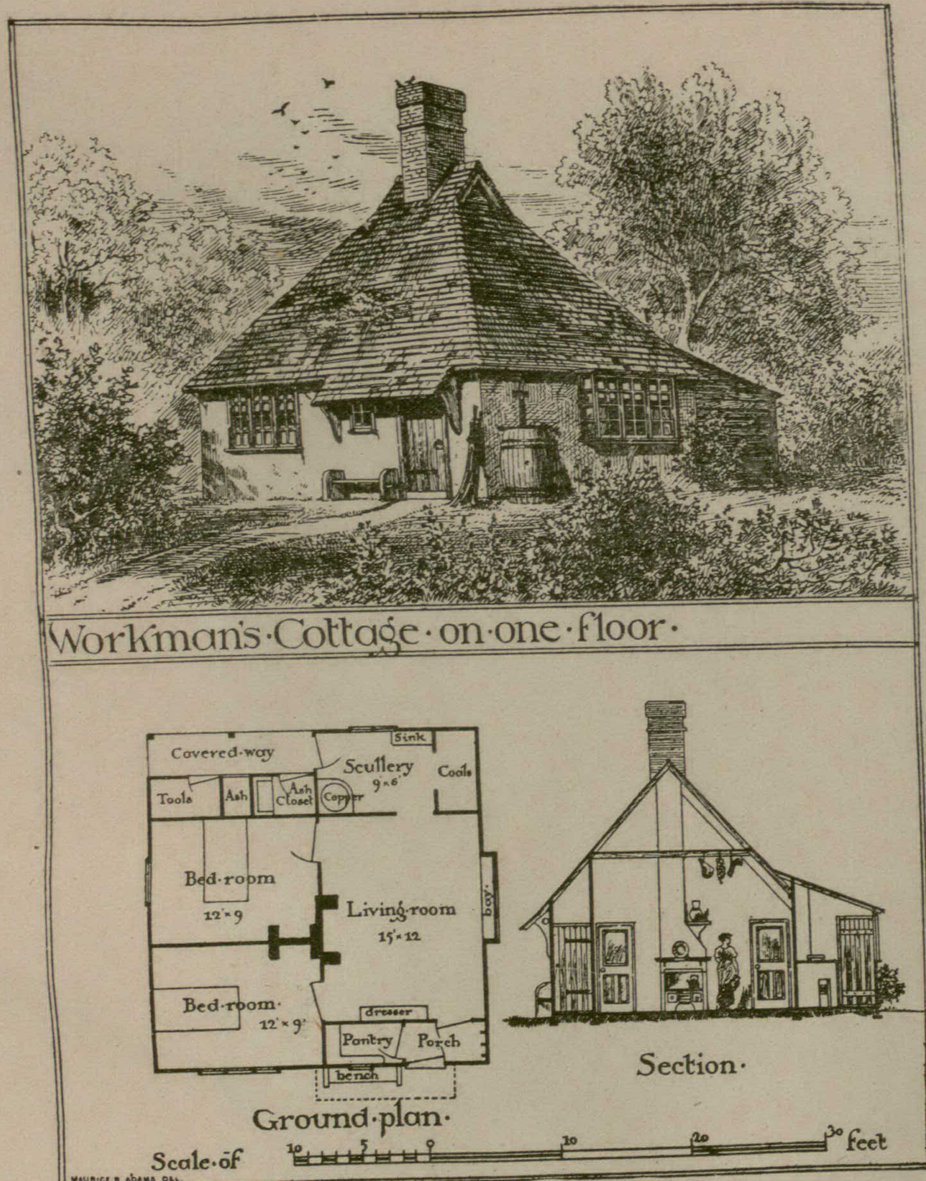

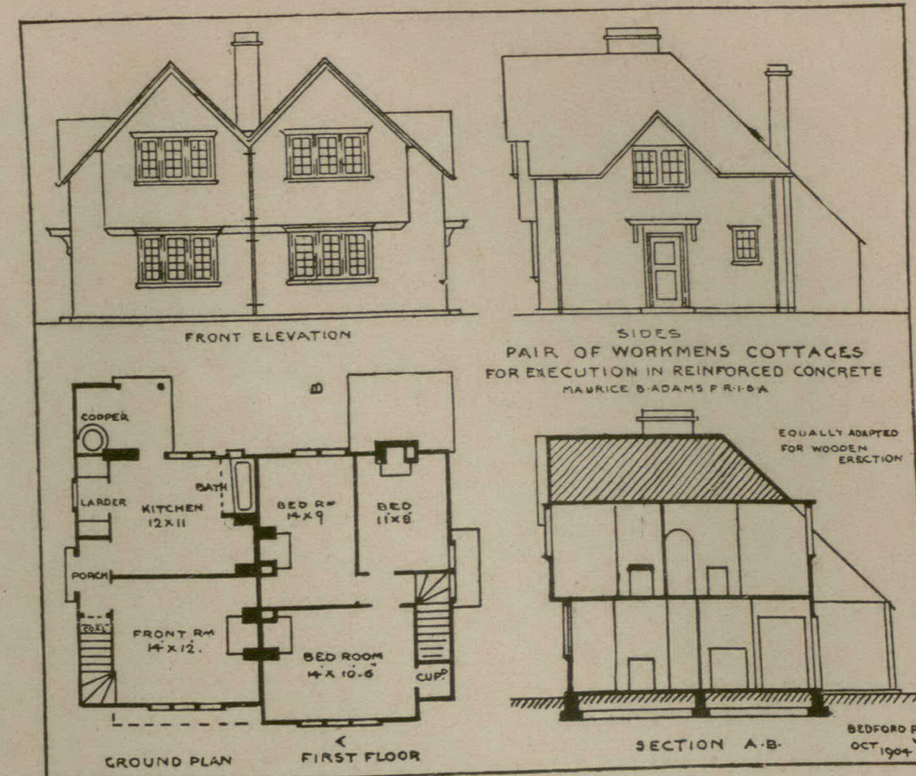

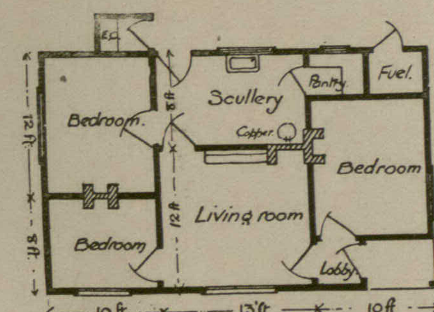

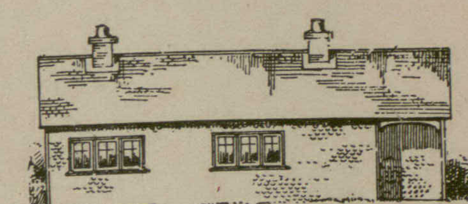

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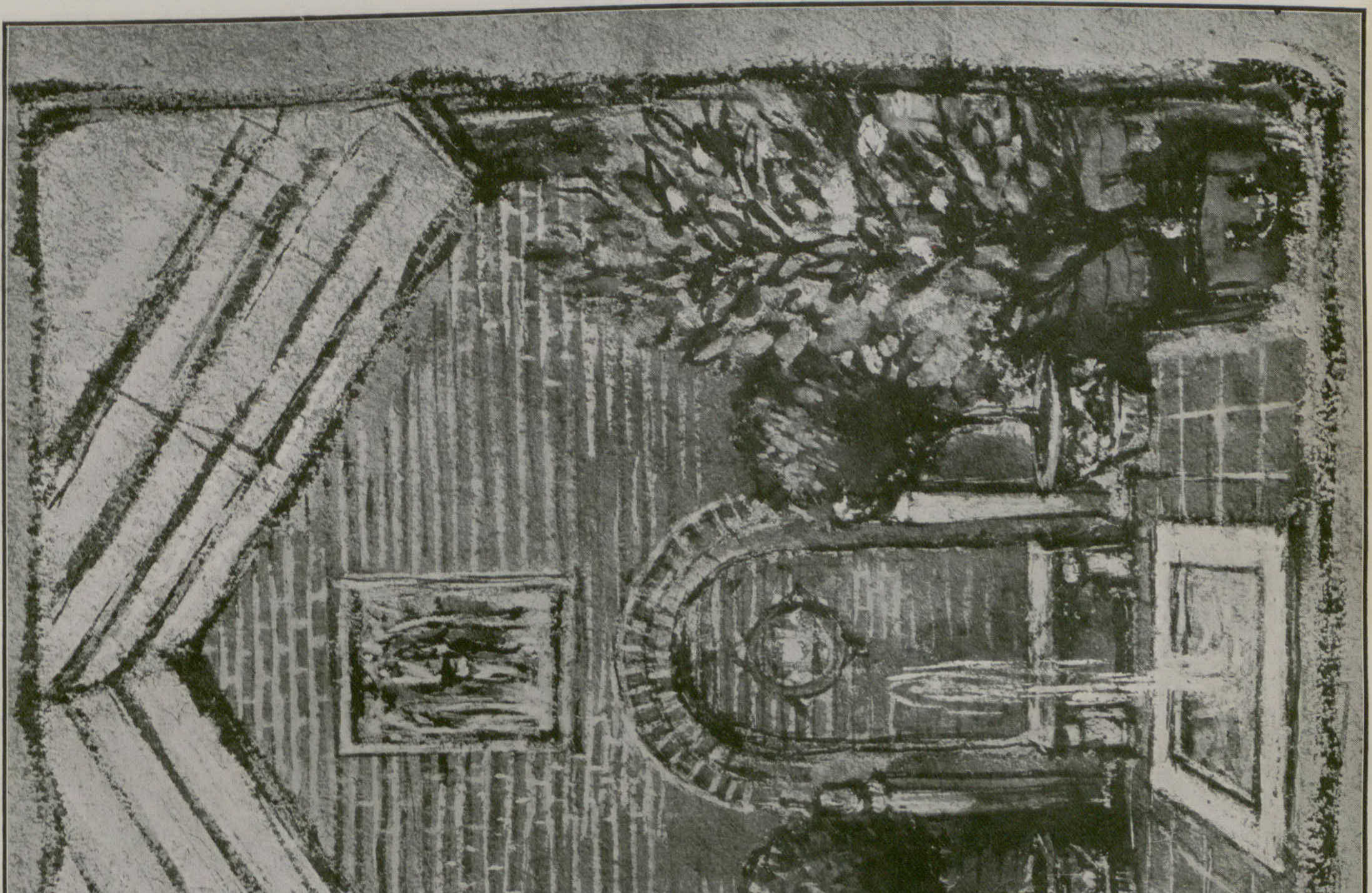
MARCH, 1905



DRAWING BY MR. WILSON EYRE, IN THE EIGHTEEN CLUB EXHIBITION, TORONTO.

SUPPLEMENT TO
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