CANADIAN ARCHITECT & BUILDER

Fine & Industrial Arts: Decoration Furnishing: Construction Sanitation: Engineering

Vol. XIII.—No 10. OCTOBER, 1900 PRICE 20 CENTS $2.00 PER YEAR.

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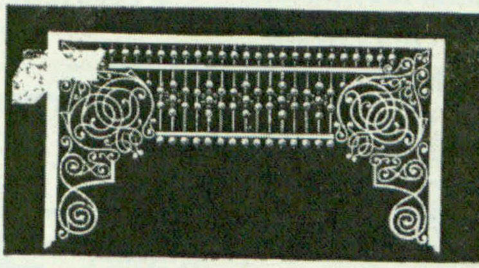

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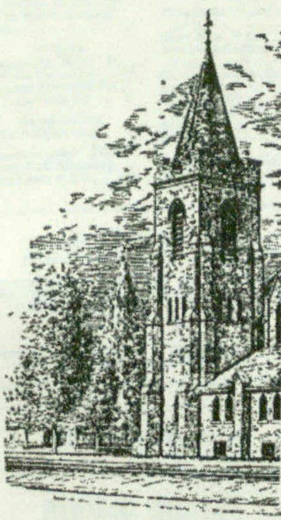

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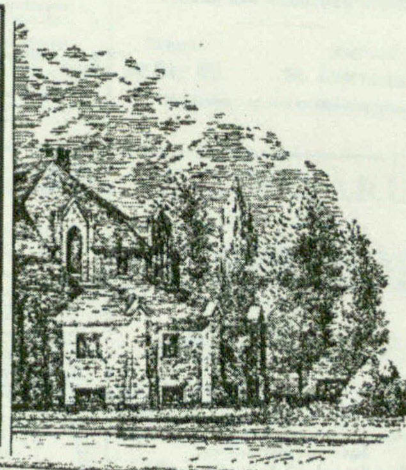

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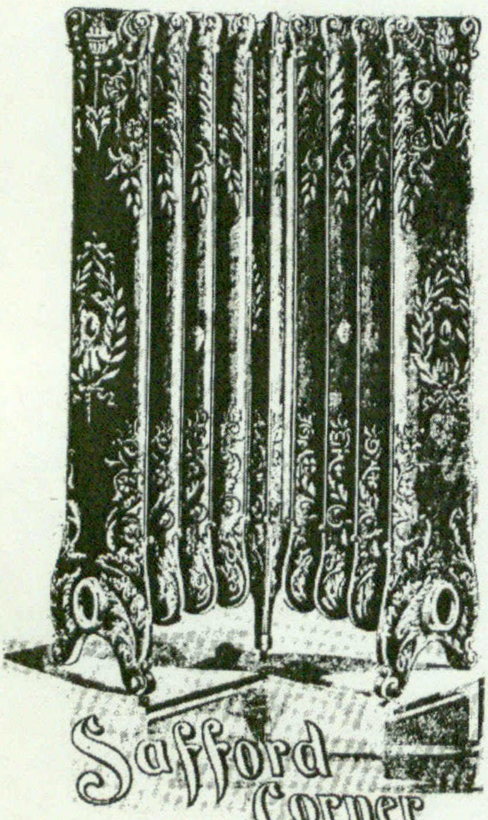

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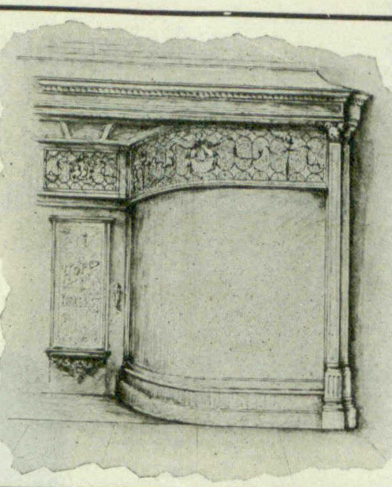

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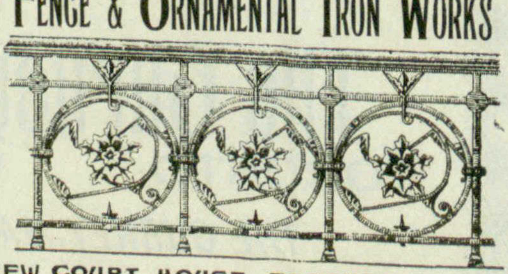

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EDITOR'S ANNOUNCEMENTS.

Contributions of value to the persons in whose interest this journal is published are cordially invited. Subscribers are also requested to forward newspaper clippings or written items of interest from their respective localities.

Subscribers who may change their address should give prompt notice of same. In doing so, give both old and new address. Notify the publishers of any irregularity in delivery.

Tower Fire Escapes For Schools. THE Board of Education of Philadelphia recently resolved by a unanimous vote that all new school buildings shall be provided with stone, brick or iron tower fire escapes. Tower escapes are adjudged to be in every way superior to the old style outside fire escape, and can be used in connection with the fire drill.

Building In Toronto. There has been no falling off in volume of building operations in Toronto, in comparison with 1899, notwithstanding the increased cost of materials, although no doubt the rise in prices of the tatter was the means of retarding many enterprises which otherwise might have gone forward. At the close of the half year the value of permits granted was greater than for the like period of 1899. The population of the city has considerably increased during the year. Vacant houses have in consequence filled up rapidly, and there is now a great scarcity of houses at a moderate rental. Rents of houses of this class have advanced about twenty-five per cent. It would appear that an era of house building must shortly begin. Let us hope that the opportunity thus offered for improvement in design and construction will not be lost, even upon the speculative builder. The fact should be borne in mind by every person who puts up a building that it is possible at little or no extra cost above that of the most commonplace structure to use materials in a manner that shall secure a pleasing result, and not violate the canons of good taste. How many ugly buildings do we see in which the best and most costly materials have been employed, but without knowledge or skill? What a constant waste there is of money and material in this manner. Not only so, but our streets are made to exhibit architectural monstrosities which constantly offend the perception of educated beholders, and prove stumbling blocks in the path of progress of those whose artistic faculties are in process of cultivation.

Burning Damaged Cement. MR. R. W. EGERTON, Executive Engineer of the Northwestern Railway, describes the results of reburning cement which had been damaged by floods during the progress of the Khojak Tunnel. To this purpose a furnace was employed which had been used for heating trough sleepers before reshaping them, the fuel used being dust coal. The damaged cement, which in most cases was found to be set solid to the centre, was taken out of the barrels, broken into pieces which would pass through a 3" ring, placed in the furnace, and the firing kept up day and night. After burning and cooling the cement was ground in a steam mortar mill and screened in a revolving screen of 1600 mesh. The material so treated was found to heat when slaked it used fresh, but this tendency disappeared after air slaking 15 or 20 days. The results of tests showed the material to have an average strength of nearly 200 lbs. after a period of slightly more than 2 months, or about one-third of the original strength. The re-burning was done at a sufficiently low cost to make the expenditure profitable, and the re-burned cement mixed with three parts of sands to one of cement, gave excellent results.

Roof Coverings. SHINGLED roofs have recently come into favor for dwellings in Toronto. While less durable, they are said to be cooler in summer and warmer in winter than slate. A shingle roof is also less liable to injury from wind and settlement of the building. Perhaps its most important recommendation, however, in the eyes of the architect is the possibilities it offers for color effects. The monotony of black slate roofs has long been a cause of dissatisfaction with architects. Many of the new shingle roofs are stained, while others have been left to the softening influences of the weather. In the majority of instances where a stain has been employed, the entire roof is made uniform in tone—usually some shade of green. Now and then the attempt has been made to use a variety of shades, but as a rule the effect has not been satisfactory, the gradations of tone not being sufficiently gradual. Some architects have successfully adopted the method of mixing their own shingle stains. By this plan they claim to have been able to secure any desired color, as well as any number of tones of a particular color, being thereby enabled to obtain satisfactory graduated effects. This method is also preferred on the ground of cheapness.

The Financial Aspect of Rapid Building. MR. Gilbert Cass, in an article in the New York Record and Guide, supplies data showing the wonderful rapidity with which modern tall buildings are constructed in that city. As an example, he takes the Broadway Chambers, a structure 50x95 feet and 18 stories high, which was contracted for on March 1st, 1899, and completed on May 1st of the present year. The site had to be cleared of old buildings, neighboring buildings and streets supported, foundations put in and materials prepared and assembled. Mr. Cass shows that the great value of the land upon which these structures are erected renders such rapid construction necessary. Assuming, he says, that the value of the land upon which the building is to be erected is placed at $1,500,000, the interest thereon at 4 per cent. is $60,000. If two years are consumed in construction of the new building, it will have cost in interest $120,000, to say nothing of the loss of rental of the old building." Therefore, owners naturally hesitate about putting up structures of this character unless the work can be completed within a year. The writer referred to states that in order to accomplish such rapid construction, drawings must be prepared considerably in advance, and the contracts should be let at least two months before the work is to be begun. This gives the contractor the required opportunity to get the structural steel and other material under way in the shops.

Legislation Affecting Workmen and Contractors. IMPORTANT legislation has recently been enacted by the Dominion Parliament affecting the rights of workmen and contractors engaged on public contracts. In July last the House of Commons adopted the following Resolution: "That it be Resolved, That all government contracts should contain such conditions as will prevent abuses which may arise from the sub-letting of such contracts, and that every effort should be made to secure the payment of such wages as are generally accepted as current in each trade for competent workmen in the district where the work is carried out, and that this House cordially concurs in such policy, and deem it the duty of the government to take immediate steps to give effect thereto. It is hereby declared that the work to which the foregoing policy shall apply includes not only work undertaken by the government itself, but also all works aided by grant of Dominion public funds. That it is not expedient to mix with this proposal the salaries of those employed in the public departments of the government." In pursuance of this resolution a number of new conditions have been embodied in government contracts since that date, the principal points of which are, that a contractor shall not assign or sublet his contract; that all workmen employed upon government contracts shall be residents of Canada, unless Canadian labor is not available, or unless there should be special circumstances which would render it contrary to public interest to enforce the condition. Workmen must be paid in accordance with the Fair Wages Schedule prepared by the government, the hours of labor and the rate of wages to be such as generally obtain in the locality in which the work is to be done; the contractor must furnish to the Minister of Labor a statement showing names of workmen, rate of wages, amounts paid and unpaid for work done, this statement to be attested by a statutory declaration; a similar statement is to be furnished with regard to the materials purchased for use on the contract; the Minister of Labor is given the right to reserve and pay over to the workman or the persons supplying materials out of the moneys due the contractor, any unpaid amounts which may be due them, no portion of the work is to be done by piece-work.

An officer has been appointed to collect data from various parts of the Dominion relating to the existing scale of wages in each locality and the rate of wages to be paid on each individual contract is specified by this official. The fixing by the government of the rate of wages to be paid workmen should be of some advantage to contractors, and will at least tend to equalize to a greater degree than heretofore bids for public works. Another effect of the measure will be the employment by contractors for works of this character of only the most rapid and skilled class of workmen. Whether or not this will result in raising the standard of workmanship will depend to some extent upon the amount of employment afforded by government works.

In connection with the newly established Department of Labor there will be published an official journal called the Labor Gazette in which will be printed statistics, copies of legislation, reports of legal cases affecting the interests and rights of workmen, etc. Several correspondents have been appointed to report to the department the rates of wages and labor conditions in various centres of population. The first number of this publication contains a complete list up to the end of August of all contracts let by the Department of Public Works since the adoption of the Fair Wages Schedule. In connection with this list the schedule of wages to be paid by the contractors on these contracts is also given; such information should be of value to the contractor as well as to the workman.

In addition to the legislation above referred to there has been put on the Statute Books a Conciliatory Act which provides for the appointment of a conciliator by application of either of the parties to a dispute, the appointment of an arbitrator on application of both of the parties, and under certain conditions a commissioner or commissioners to hold an enquiry under oath where, for the better settlement of the disputes, such course is deemed desirable. This Act, which is based on similar legislation previously in force in Great Britain, Australia and elsewhere, provides the machinery whereby disputes between employer and workmen may be adjusted, and is designed to reduce the number of strikes. It is, however, a purely voluntary measure, inasmuch as the Dominion Parliament has not the power to pass a compulsory measure. This power, affecting civil rights, resides in the Provincial Legislatures.

Uniform Contract. THERE appears to be need for the adoption by Canadian architects and builders of a standard form of contract. Enquiry shows that there are at present in use many different forms—as many perhaps as a dozen in the city of Toronto alone—while various forms are also in use in the other cities and towns of the Dominion. Many architects, especially the younger members of the profession, seem to prefer to use special forms of their own. The desire to maintain friendly relations with the architects and the keenness of competition, has induced contractors to sign contracts, the terms of which they did not always regard as being entirely just and satisfactory. Some 15 years ago a form of contract was agreed upon between the architects and builders of Toronto which was found to be equitable and was generally used for many years. Gradually, however, by reason of changing circumstances new forms were introduced, and the number has steadily increased. The time seems to have come when an effort should be made to draft a standard form of contract which should conserve the rights of all parties concerned, and which would be likely to come into general use throughout the Dominion.

HOT WATER VS. STEAM HEATING.

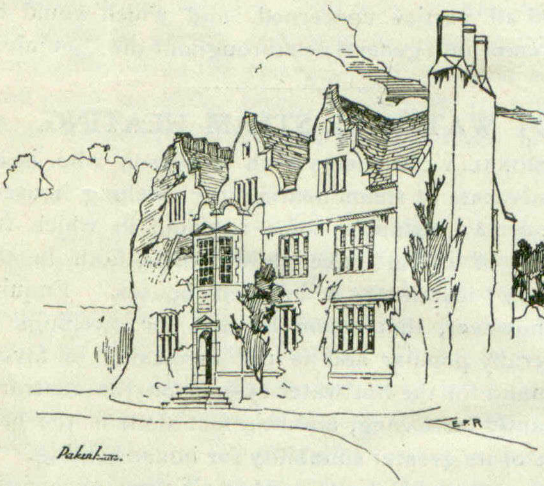
OCCASIONALLY one meets with a person who is an ardent advocate of steam heating for dwelling houses, and one or two instances come to mind in which the advocates of steam have shown their faith in the system by installing it in their houses. Enquiry shows, however, that steam heating for dwellings is not generally popular and is not increasing in favor. The demand for the hot water system on the contrary, is constantly increasing, and this fact alone is the best evidence of its greater suitability for house heating.

Fifteen years ago steam and hot air were exclusively used for heating houses where furnaces were employed. One of the largest manufacturers of hot water apparatus sought to at that period introduce the hot water system into the eastern States and met with great difficulties. The steam-fitters who had become familiar with the installation of steam heating apparatus knew nothing about hot water plant, and apparently did not wish to take the trouble to learn. At first none of them could be induced to put in a hot water system, but the manufacturers were determined that the system should be introduced, and upon obtaining an order, sent their own men to put in the apparatus. In this way the steam-fitters were gradually forced to give attention to the new method and undertake the work of installation.

To-day the great majority of houses of the better class are heated by hot water, and no steam-fitter is presumed to understand his business who cannot install a hot water system. There are many advantages connected with the hot water system as compared with steam heating. It is, in the first place, more economical, much less fuel being required than where steam is used. The regulation can be adjusted to suit climatic conditions, while with steam the same degree of heat is maintained at all times. With hot water the heat is retained by the water for some time after the fire has been extinguished. With steam the radiators cease to give out heat immediately that the temperature in the boiler falls below 212 degrees, and in starting up the system this temperature must be reached before any heat is available, while with hot water when the temperature reaches 35 or 40 degrees, radiation of heat commences. There is also with hot water heating the advantage of greater humidity of air as compared with either steam or hot air. The value of this greater moisture in the air to the health of the occupants of dwellings need scarcely be dwelt upon.

While steam heating is not well adapted for dwellings, it is undoubtedly superior to hot water or any other method for public buildings where some of the rooms may at times be vacant. Hot water would be liable to freeze in the pipes in such rooms. It is also, as stated by Mr. Robert King in the paper published in the last number of this journal, best adapted for large greenhouses, as the heat can be forced more rapidly through long stretches of pipe, while with the spraying apparatus, which is a necessity in all large greenhouses, the required humidity in the air can easily be supplied.

Plain English and plain type, well put together, have made more fortunes than all things else combined.—Press and Printer.



BY THE WAY.

THE management of the celebrated Carnegie Public Library at Pittsburg, Pa., the design ot which was selected by competition a few years ago, propose to remove the building to another site 4,000 feet distant, with the object of preserving its appearance from injury from changes which are now taking place around it. The building is 150 x 400 feet in size, having a skeleton of steel cased with stone. Its estimated weight is 58,000 pounds. Means must be found of transporting it across a ravine 200 feet wide and 100 feet deep.

× × ×

THE somewhat surprising statement is made that it is the intention of the Pennsylvania Railway Company to supersede the iron bridge across the Susquehanna river at Rockville, near Harrisburg, by one of masonry. The structure about to be removed consists of twenty-three spans of about 160 feet each. The masonry bridge will have forty-eight spans of 70 feet each, and including piers and approaches the total length will be 3,820 feet, or nearly three-quarters of a mile. Masonry is considered to have advantages over steel in endurance and economy of repairs.

× × ×

IN Montreal and several of the the smaller cities and towns organizations of public spirited citizens have been formed to promote and protect the interests of the residents and property owners. These organizations will make suggestions with regard to the manner of carrying out public improvements, and exert an influence in behalf of the selection of a proper class of men to compose the municipal council. The latest town to join this movement is North Toronto, and I observe that in the fore front of the movement is Mr. W. R. Gregg, the Registrar of the Ontario Association of Architects.

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THE relative merits of the various methods of heating were under discussion, when a well-known Toronto steam fitter told how he once lost an important contract. He had submitted a tender for installing a steam heating plant in a court house in a certain town in Ontario, and in common with other bidders, was asked to attend a meeting of the council for the purpose of fully explaining his system. At the conclusion of his remarks, the representative of a firm of manufacturers of hot air apparatus got up and addressed the assembled councillors, the majority of whom were farmers, somewhat as follows: "Gentlemen,—you all know what happens when a steam thresher explodes or gets in too close contact with the barn. How would you like to sit here knowing that beneath you was a steam boiler liable to explode at any moment?" In vain the steam fitter explained that no damage could occur from a boiler operating with but five pounds pressure—the hot air man's ruse succeeded, and he was given the contract. The apparatus which he installed has since been replaced by steam.

× × ×

THE locality in which the town of Midland, Ont., is situated abounds in springs of water. So strong is the flow from these springs, that by placing a small water wheel in his cellar the proprietor of one of the hotels forces the water into an elevated tank, from which it is drawn as required through pipes and taps. The device has been in successful operation for a number of years. It is proposed to construct next year a water works system which will be supplied from springs situated about a mile distant from the town. Midland is said to be very prosperous, there being at present under construction about 275 dwellings, ranging in cost as high as $15,000.

THE OCTAGON.

THE American Institute of Architects opened rooms last year as headquarters in Octagon House, Eighteenth street and New York avenue, Washington, D. C. The secretary, Mr. Glen Brown, here preserves all literature which is received in exchange for the Institute's Proceedings and in other ways, and classifies it in the most careful manner. The Institute now receives publications from more than forty-three foreign societies, forty American societies and institutions, and fifty-nine publications on architecture and allied subjects.

A card catalogue is kept, and a quarterly bulletin is issued by the Institute, in which is given an index of all publications received and another index of the literature contained in them classified under subject headings, as, for instance, acoustics, banks, biographical, brickwork, cement, colonial, construction, French school, etc. This bulletin is sent to the Ontario Association of Architects, and will be kept in the new rooms, 96 King street west, Toronto, and will be found valuable for reference.

Mr. S. Okamato, an architect from Tokio, Japan, lately called at the Octagon, and left a gift of one hundred sets of drawings of tea houses made with a brush with as true and neatly drawn lines as if done by a pen. These drawings are folded on a plan so that when the sides, partitions, &c., are raised a paper model is formed showing both exterior and interior of the house. Mr. Okamato says that the Society of Japanese Architects has sixty full members who are educated in the modern sense, and over 700 sub-members forming a distinct class, and including anyone connected with buildings, contractors, uneducated architects, superintendents and foremen.

W. R. GREGG, Registrar O.A.A.

A resolution recently passed by the Dominion Trades Council recites the fact that a great cause of disease is insanitary plumbing, and favors application to the various governments for legislation to compel all municipalities using water works and sewerage systems to appoint a permanent plumbing inspector. There are yet a number of cities in Canada which have no plumbing inspector. These should be compelled to appoint one. In the case of towns the expense would be too great, unless there could be combined with the position other duties.

LEGAL.

Mr. J. W. Siddall, architect of the St. Lawrence market improvements, Toronto, has entered an action for slander against alderman Sheppard, a member of the Board of Control of the City Council claiming $10,000 damages.

BROWN VS. EAGER.—Judgment by the Court of Appeal at Toronto on appeal by defendant Eager from judgment of Falconbridge, J., in favor of plantiff in action to recover from defendant Fillion $2,158.44 (and interest) alleged to have been advanced to him by plaintiffs in connection with a con tract dated July 23, 1896, for the construction by Fillion of four dams on the river Otonabee, between Nassau and Lakefield, as part of the construction work of the Trent canal extension. The plaintiffs were the original contractors with the Government, and they alleged that defendant Eager was a partner in the contract with Filion by reason of subsequent agreement between Filion and him after Filion had failed to keep his contract, and so liable, and, if not a partner, that the money was advanced by plaintiff to Filion at Eager's request and for his use. The trial judge held that defendants were not partners, but that defendant Eager had made himself liable by his conduct, particularly by his letter of December 7, 1897, requesting plaintiffs to pay for provisions and supplies for Filion's camp and his telegrams of December 17, 1897, requesting them to advance the amount necessary to carry on the work and to pay back wages, if necessary. Held, that defendant Eager was liable to plaintiffs for such moneys as they, on the authority of his letter and telegram, may have properly advanced or paid to or for Filion in respect of the contract, but whether the moneys claimed in this action are payments and advances properly chargeable to Eager under such a letter and telegram must be dealt with by the Master upon the reference directed. Appeal dismissed with costs.

A CASE UNDER THE WORKMEN'S COMPENSATION FOR INJURIES ACT.—The following particulars are given in vol. 31, page 521, of the Ontario Law Reports for the current year, relating to a workman, who, while employed by contractors in the erection of a building, sustained injuries by falling a distance of 30 feet to the ground through the giving way of part of the scaffolding on which he was working. He claimed damages for negligence in the construction of the scaffolding. The scaffold on which he was standing consisted of a single plank, 16 feet long, one end of which rested on a trestle, and the other on a stay formed of a plank nailed to two upright posts forming part of the main building. The stay, as originally fastened to the posts, was perfectly secure, as the plank forming the stay was 2 inches thick and rested on its edge on a cleat securely fastened to the posts by spikes ; the stay itself being also securely fastened to the posts by large spikes. The whole evidence showed that the stay, while in that condition, was capable of sustaining a great weight. The general superintendent of the contractors' works was explicit in giving directions to the workmen, from time to time, that the stays should be put up and secured as these stays were. The day before the accident, the stay in question was removed by two of the workmen, for their own convenience, while working a windlass, and raised about a foot above the cleats and nailed to the posts. This rendered the stay dangerous, because it was fastened at one end with two or three nails, and at the other end (upon which the plank forming the scaffold was placed) by only one nail. On the day of the accident the plaintiff (the carpenter) and a fellow workman, were directed by the foreman on this work to cut off the ends of two beams at the top of the third story, and the plank referred to was thrown across from the trestle to the stay, a distance of 12 feet. The carpenter and his companion mounted this plank, which was over an open hatchway, when the stay gave way, and the carpenter fell down through the hatchway and so received the injuries for which the action was brought. In answer to written questions put to them by the judge, the jury found :—(1) that the defendant (the contractors' foreman) did not direct the two workmen to remove the stay ; (2) that replacing the stay caused it to be defective ; (3) that the defect was not discovered through the neglect of the contractors' foreman; (4) that the foreman placed the plank across between the two beams to form the scaffold ; (5) that the foreman, through his own negligence, was not aware that the stay was defective. The jury assessed the damages at $500. The trial judge reserved judgment on these answers, and subsequently dismissed the action with costs. He held that the jury having found that the foreman did not direct the two workmen to remove the stay, there was no evidence to support the finding of the jury that the defect was not discovered through the negligence of the foreman. The foreman, he said, had no reason to suppose that any charge had been made in the stay. On returning with their answers the jury were asked by the judge what was the negligence imputed to the foreman. They replied : 'The plank would be higher at one end than the other, and he could easily see facing that.' As to this the court makes the following comments : 'The foreman having a right to assume that the stay had not been tampered with by the workmen, and that it was in the condition of security in which it was placed under his directions, and when it was in the same condition up to 3 o'clock the previous day, there was nothing in the mere difference in the height of the two ends of the plank to indicate that there had been a change. The difference caused no comment on the part of the plaintiff who was present and saw the plank placed in position, and who mounted on it to commence work. If it could be held that there was negligence on the part of the foreman upon the facts disclosed here, it would cast a responsibility on employers never contemplated by the Act.' (1900), Ontario Reports, vol. 31, page 521.

STANDING DRAWING BOARD.

The following description of a standing drawing board is contributed to the American Machinist by Mr. Baxter Alakson. He says that he is well pleased with it. The board is 6 ft. by 4 ft., and when standing at an angle of 30 degrees from a vertical plane the lower edge is 24 inches from the floor. The straightedge is carried by two drums. These drums are keyed 5-16 in. shaft running the full length of the board. At midway of the shaft is another drum of the same diameter, which is wrapped in the opposite direction, and to which is attached the counterweight which balances the straigtedge. The carrier cords are of braided linen, are simply laced to the straightedge. Each of the little holes shown at the ends of the straigtedge has in it a brass bushing, rounded at the ends, to make the cord run through easily. At each end of the straightedge is a cleat 3⅛ in. thick, lapping the ends of the board, to prevent any side movement.

METHOD OF DIFFUSING LIGHT.

As an experiment in trying to obtain a uniformly distributed light throughout the rooms of the new engineering building of the University of Wiscousin, the auditorium and drawing rooms will be lighted by electricity with the lamps so placed as to be invisible to persons in the rooms. They will be arranged around the sides of the rooms with opaque reflectors to project the light evenly over dead white ceilings. These ceilings will reflect the light throughout the rooms, thus furnishing a reflected light of uniform intensity everywhere in the rooms. Prof. J. B. Johnson, Dean of the College of Engineering, of the University of Wisconsin, says it is not known that this method of illumination is now in use anywhere in America, but the professors in the electrical department of the College of Engineering affirm that it can be readily done.

ON the morning of September 25th, the Works of the Caledonian Portland Cement Co. at Marlbank, Ont., were destroyed by fire, with the exception of the kiln house. Spontaneous combustion of coal gas is given as the cause. The fire appliances are said to have been very inadequate. The loss is placed at $60,000. The capacity of the works was 500 barrels per day. The Managing Director, Mr. F. G. B. Allan of Deseronto, states that the works will be immediately rebuilt, and in a more substantial manner.

THE new Immigrant Station on Ellis Island, New York Harbor, has stone roofs, each serving as a balcony floor, designed by Messrs. Boring and Tilton, architects. These are of thick slate slabs, supported on steel beams, according to the Engineering Record. The slabs were selected sound and uniform in color, 1½ inches thick, and dressed smooth on both sides. On each beam galvanized iron double gutters are fixed along each side of top flange, to catch any leakage at the joints, which are filled with slater's cement. The slabs are clamped to the top flanges of the beams by steel clips, having bolts set with plaster of Paris in holes drilled in the slate. These metal clips are 1½ in. by 3/16 in., and are 18 in. apart. The roof is pitched to the front edge, where it drains into a copper gutter on wrought iron brackets, with one side flashed up over the blocks which raise the slabs from top of the beams to clear the joint gutters.

STANDARD SPECIFICATIONS FOR STEEL AND IRON.*

SPECIFICATIONS FOR STEEL FOR BRIDGES AND SHIPS.

1. Steel shall be made by the open-hearth process.

2. Each of the three classes of structural steel for bridges and ships shall conform to the following limits in chemical composition:

	Steel made by the Acid Process. per cent.	Steel made by the Acid Process. per cent.
Phosphorus shall not exceed....	0.08	0.06
Sulphur shall not exceed........	0.06	0.06

3. There shall be three classes of structural steel for bridges and ships, namely, rivet steel, soft steel and medium steel, which shall conform to the following physical qualities:

4. Tensile tests:

Tensile strength, pounds per square inch 50,000 to 60,000 rivet steel, 52,000 to 62,000 soft steel, 60,000 to 70,000 medium steel.

Yield point in pounds square inch shall not be less than 30,000 rivet steel, 32,000 soft steel, 35,000 medium steel.

Elongation in per cent. 8 inches shall not be less than 26 rivet steel, 25 soft steel, 22 medium steel.

5. For material less than 5-16 inch and more than ¾ inch in thickness, the following modifications shall be made in the requirements for elongation:

(a) For each increase of ⅛ inch in thickness above ¾ inch, a deduction of 1 per cent. shall be made from the specified elongation.

(b) For each decrease of 1-16 inch in thickness below 5-16 inch, a deduction of 2½ per cent. shall be made from the specified elongation.

(c) For pins made from any of the three classes of steel the required elongation shall be 5 per cent. less than that specified in paragraph 4, as determined on a test specimen the centre of which shall be 1 inch from the surface.

6. Eye bars shall be of medium steel. Full size tests shall show 12½ per cent. elongation in 15 feet of the body of the eye-bar, and the tensile strength shall not be less than 55,000 lbs. per square inch. Eye-bars shall be required to break in the body, but should an eye-bar break in the head, and show 12½ per cent. elongation in 15 feet and the tensile strength specified, it shall not be cause for rejection, provided that not more than one-third of the total number of eye-bars tested break in the head.

7. The three classes of structural steel for bridges and ships shall conform to the following bending tests, and for this purpose the test specimen shall be 1½ inch wide, if possible, and for all material ¾ inch or less in thickness the test specimen shall be of the same thickness as that of the finished material from which it is cut, but for material more than ¾ inch thick the bending test specimen may be ½ inch thick.

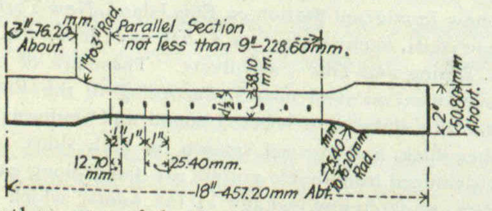
Rivet rounds shall be tested of full size as rolled.

(d) Rivet steel shall bend cold 180 degs. flat on itself without fracture on the outside of the bent portion.

(e) Soft steel shall bend cold 180 degs. flat on itself without fracture on the outside of the bent portion.

(f) Medium steel shall bend cold 180 degs. around a diameter equal to the thickness of the specimen tested, without fracture on the outside of the bent portion.

8. The standard test specimen of 8 inch gauged length shall be used to determine the physical properties specified in paragraphs Nos. 4 and 5. The standard shape of the best specimen for sheared plates shall be as shown by the following sketch:



For other material the test specimen may be the same as for sheared plates, or it may be planed or turned parallel throughout its entire length and in all cases where possible, two opposite sides of the test specimens shall be the rolled surfaces. Rivet rounds and small rolled bars shall be tested of full size as rolled.

(9) On the tensile test specimen shall be taken from the finished material of each smelt, but in case this develops flaws or breaks outside of the middle third of its gauged length, it may be discarded and another test specimen substituted therefor.

10. One test specimen for bending shall be taken from the finished material of each melt as it comes from the rolls, and for material ¾ inch and less in thickness this specimen shall have the natural rolled surface on two opposite sides. The bending test specimen shall be 1½ inch wide if possible, and for material more than ¾ inch thick the bending test specimen may be ½ inch thick.

(g) The bending test may be made by pressure or by blows.

11. Material which is to be used without annealing or further treatment shall be tested for tensile strength in the condition in which it comes from the rolls. For material which is to be annealed or otherwise treated before use, a full-size section of tensile test specimen length shall be similarly treated before cutting the tensile test specimen therefrom.

12. For the purpose of this specification, the yield point shall be determined by the careful observation of the drop of the beam or halt in the gauge of the testing machine.

13. In order to determine if the material conforms to the chemical limitations prescribed in paragraph No. 2 herein, analysis shall be made of drillings taken from a small test ingot.

14. The variation in cross section or weight of more than 2½ per cent. from that specified will be sufficient cause for rejection, except in the case of sheared plates, which will be covered by the following permissible variations:

(h) Plates 12½ lbs. per square foot or heavier, when ordered to weight, shall not average more than 2½ per cent. variation above or 2½ per cent. below the theoretical weight.

(i) Plates under 12½ lbs. per square foot, when ordered to weight, shall not average a greater variation than the following:

Up to 75 inches wide, 2½ per cent. above or 2½ per cent below the theoretical weight; 75 inches and over, 5 per cent. above or 5 per cent. below the theoretical weight.

(j) For all plates ordered to gauge there will be permitted an average excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in the following table:

TABLE OF ALLOWANCES FOR OVERWEIGHT FOR RECTANGULAR PLATES WHEN ORDERED TO GAUGE. THE WEIGHT OF ONE CUBIC INCH OF ROLLED STEEL IS ASSUMED TO BE 0.2833 LBS PLATES ¼ INCH AND OVER IN THICKNESS.

Thickness of Plate. Inch.	Width of Plate. Up to 75 Inches. Per cent.	75 to 100 Inches. Per cent.	Over 100 Inches. Per cent
¼	10	14	18
5/16	8	12	16
⅜	7	10	13
7/16	6	8	10
½	5	7	9
9/16	4½	6½	8½
⅝	4	6	8
Over ⅝	3½	5	6½

PLATES UNDER ¼ INCH IN THICKNESS.

Thickness of Plate. Inch.	Width of Plate. Up to 50 inches. Per cent.	50 inches and Above. Per cent.
⅛ up to 5/32	10	15
5/32 up to 3/16	8½	12½
3/16 up to ¼	7	10

15. Finished material must be free from injurious seams, flaws or cracks, and have a workmanlike finish.

16. Every finished piece of steel shall be stamped with the melt number, and steel for pins shall have the melt number stamped on the ends. Rivets and lacing steel, and small pieces for pin-plates and stiffeners, may be shipped in bundles, securely wired together, with the melt number on a metal tag attached.

17. The inspector representing the purchaser shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications.

* Recommended by a Special Committee of the American Institute Civil Engineers.

All tests and inspections shall be made at the place of manufacture prior to shipment.

SPECIFICATIONS FOR STRUCTURAL STEEL FOR BUILDINGS.

The only marked deviations from the specifications for bridge and ship steel are in the following clauses and in permission to use Bessemer as well as open-hearth steel:

2 Each of the two classes of structural steel for buildings shall not contain more than 0.10 per cent. of phosphorus.

3 There shall be two classes of structural steel for buildings, namely, rivet steel and medium steel, which shall conform to the following physical qualities :

4. Tensile tests.

	Rivet Steel.	Medium Steel.
Tensile strength, pounds per square inch . . .	50,000 to 60,000	60,000 to 70,000
Yield point, in pounds per sq. in. shall not be less than .	30,000	35,000
Elongation, per cent. in 8 ins. shall not be less than .	26	22

SPECIFICATIONS FOR WROUGHT-IRON.

1. Wrought-iron shall be made by the puddling process or rolled from fagots or piles made up from No. 1 wrought-iron scrap, alone or with muck bar added, it being understood that test iron Class B and stay-bolt iron contain no scrap.

2. The minimum physical qualities required in the four classes of wrought-iron shall be as follows :—

	Refined Iron.	Test Iron Class A.	Test Iron Class B.	Stay-Bolt Iron.
Tensile strength, lbs. per sq. in. . .	48,000	48,000	50,000	46,000
Yield point, lbs. per sq. in. . . .	25,000	25,000	25,000	25,000
Elongation, per cent. in 8 ins. . .	15	20	25	28

3. In sections weighing less than 0·654 lb. per lineal foot the percentage of elongation required in the four classes specified in paragraph No. 2 shall be 11·25 per cent., 15·00 per cent, 18·75 per cent., and 21·00 per cent. respectively.

4. The four classes of iron when nicked and tested as described in paragraph No. 9 shall show the following fracture :—

(a) Refined iron, a generally fibrous fracture, free from coarse crystalline spots. Not over 15 per cent. of the fractured surface shall be granular.

(b) Test iron class A, a generally fibrous fracture, free from coarse crystalline spots. Not over 10 per cent. of the fractured surface shall be granular.

(c) Test iron class B, a long, clean, silky fibre, free from slag or dirt or any coarse, crystalline spots. A few fine crystalline spots may be tolerated provided they do not in the aggregate exceed 10 per cent. of the sectional area of the bar.

(d) Stay-bolt iron, a long, clean, silky fibre, free from slag or dirt, and wholly fibrous, being practically free from crystalline spots.

5. The four classes of iron when tested as described in paragraph No. 10 shall conform to the following bending tests :—

(e) Refined iron shall bend cold 180 degs. around a diameter equal to twice the thickness of the tested specimen, without fracture on outside of the bent portion.

(f) Test iron class A, shall bend cold 180 degs. around a diameter equal to the thickness of the tested specimen, without fracture on outside of the bent portion.

(g) Test iron class B, shall bend cold 180 degs. flat on itself without fracture on outside of the bent portion.

(h) Stay-bolt iron, a piece of stay-bolt iron about 24 inches long shall bend in the middle through 180 degs. flat on itself, and then bend in the middle through 180 degs. flat on itself in a plane at a right angle to the former direction, without a fracture on outside of the bent portions. Another specimen with a thread cut over the entire length shall stand this double bending without showing deep cracks in the threads.

6. The four classes of iron, when tested as described in paragraph No. 11, shall conform to the following hot-bending tests :—

(i) Refined iron shall bend sharply to a right angle, without showing cracks or flaws.

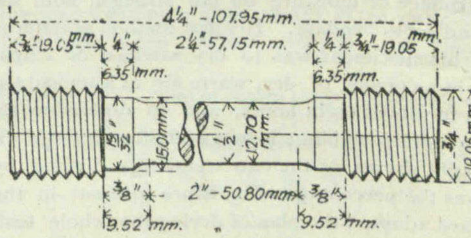
(j) Test iron class A, shall bend through 180 degs. flat on itself, without showing cracks or flaws.

(k) Test iron class B, shall bend through 180 degs. flat on itself, without showing cracks or flaws. A similar specimen heated to a yellow heat and suddenly quenched in water between 80 degs. and 90 degs. F. shall bend without hammering on the bend, 180 degs. flat on itself without showing cracks or flaws. A similar specimen heated to a bright red heat shall be split at the end and each part bent back through an angle of 180 degs. It will also be punched and expanded by drifts until a round hole is formed whose diameter is not less than nine-tenths of the diameter of the rod or width of the bar. Any extension of the original split or indications of fracture, cracks or flaws developed by the above tests will be sufficient cause for the rejection of the lot represented by that rod or bar.

(l) Stay-bolt iron shall bend through 180 degs. flat on itself, without showing cracks or flaws. A similar specimen heated to a yellow heat and suddenly quenched in water between 80 and 90 degs. F. shall bend, without hammering on the bend, 180 degs. flat on itself, without showing cracks or flaws.

7. Stay-bolt iron shall permit of the cutting of a clean, sharp thread, and be rolled true to gauges desired so as not to jamb in the threading dies.

8. Whenever possible, iron shall be tested in full size as rolled to determine the physical qualities specified in paragraphs Nos. 2 and 3, the elongation being measured on an 8-inch gauged length. In flats and shapes too large to test as rolled, the standard test specimen 1½ inch wide and 8 inches gauged length. In large rounds the standard test specimen of 2 inches gauged length shall be used ; the centre of this specimen shall be half-way between the centre and outside of the round.



9. Nicking tests shall be made on specimens cut from the iron as rolled. The specimen shall be slightly and evenly nicked on one side, and bent back at this point through an angle of 180 deg. by a succession of light blows. Tested iron class B and stay-bolt iron may be nicked approximately 20 per cent. of its thickness.

10. Cold bending tests shall be made on specimens cut from the bar as rolled. The specimen shall be bent through an angle of 180 deg. by pressure or by a succession of light blows.

11. Hot bending tests shall be made on specimens cut from the bar as rolled. The specimens, heated to a bright red heat, shall be bent through an angle of 180 deg. by pressure or by a succession of light blows, and without hammering directly on the bend.

If desired a similar bar of any of the four classes of iron shall be worked and welded in the ordinary manner without showing signs of red shortness.

12. The yield point specified in paragraph No. 2 shall be determined by the careful observation of the drop of the beam or halt in the gauge of the testing machine.

13. All wrought iron must be practically straight, smooth, free from cinder spots or injurious flaws, buckles, blisters or cracks. As the thickness of bars approaches the maximum that the rolls will produce the same perfection of finish will not be required as in thinner ones.

In flat and square bars 1-32 inch variation either way from the size ordered will be allowed.

In round iron 0·01 inch variation either way from the size ordered will be allowed, except in stay-bolt iron, which shall be at least 0·01 inch, and not more than 0·025 inch below normal size, to insure freedom from jambing in the threading dies.

INSPECTION.

14. This clause, for inspection, is the same as for bridge steel.

THE STRENGTH OF TIMBER, AND HOW TO TEST IT.

I PROPOSE to discuss in this paper the determination of the chief mechanical properties of timber. I shall deal with the methods best adapted for obtaining their numerical values, and also the actual results obtained in the most modern experiments.

You will find scattered through the older text books, the proceedings of various societies, and in other works an immense mass of experimental results of mechanical tests of various kinds of timbers, including all the timbers used in constructional work. Unfortunately, many of these figures are not very reliable, and if used in any calculations require to be used with the utmost circumspection and caution. There are three reasons for this statement:—

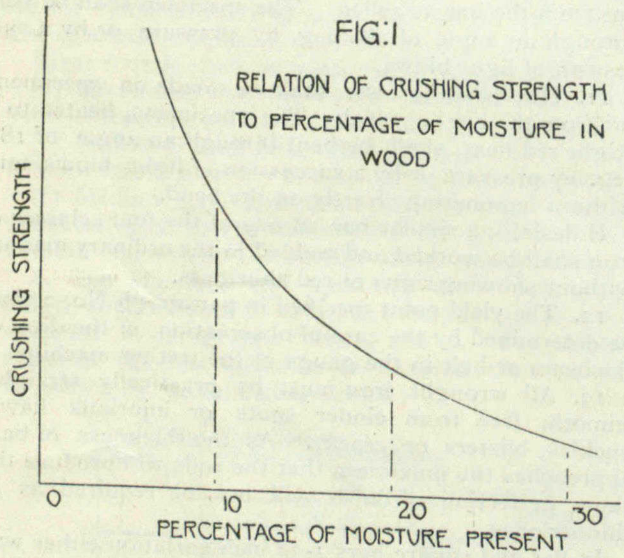
(a) The tests were in almost every case carried out on specimens of very small sizes, and often it is quite clear that the specimens were selected with great care, so as to insure straightness of fibres and freedom from all knots and other blemishes; they were thus by no means fairly representative of the average quality of the particular timber experimented on.

(b) From the unfortunately very loose way in which various timbers are named on the market, it is sometimes impossible to know now what the timber was which was tested.

(c) In no case, as far as I know, were any observations made to determine the amount of moisture in the timber at the time of the test, in most cases not even the time of seasoning was given, nor time of felling, &c. Now as will be seen shortly the moisture condition is a vital factor in determining the mechanical properties of timber.

The first tests in which careful observations were made both as to moisture condition, and previous history of the timber were those made by the late Professor Bauschinger at Munich in 1883 and 1887, the results being published in "Mitthilungen aus dem Mechanisch-Technischen Laboratorium der K. Technischen Hochschule in Munchen," 1883 and 1887. He investigated very fully the influence of moisture on the strength both as regards crushing and cross bending. His first method of determining the dryness of his specimens was to dry sawdust or chips from his specimens in a current of dry, warm air at a temperature of 214 deg. Fahr. for about eight hours, and to determine the loss of weight by careful weighings before and after drying. The difference of weight shown by the two weighings divided by the dry weight gives the percentage of moisture present in the sample. He afterward adopted the plan of drying the whole tested specimen at the above temperature in an oven from two to four days, determining the loss as before by weighings. He eventually selected 15 per cent. as a standard of moisture to which all results should be reduced. (Timber in a dry, well-warmed house has probably about 10 per cent. of moisture.)

The law expressing the relation of strength to moisture present in the specimen was readily determined by making tests on sev-



eral specimens cut from the same stick of timber, the specimens being of different degrees of dryness. Plotting the strengths to a base of moisture percentage gave a curve of the form shown in fig. 1.

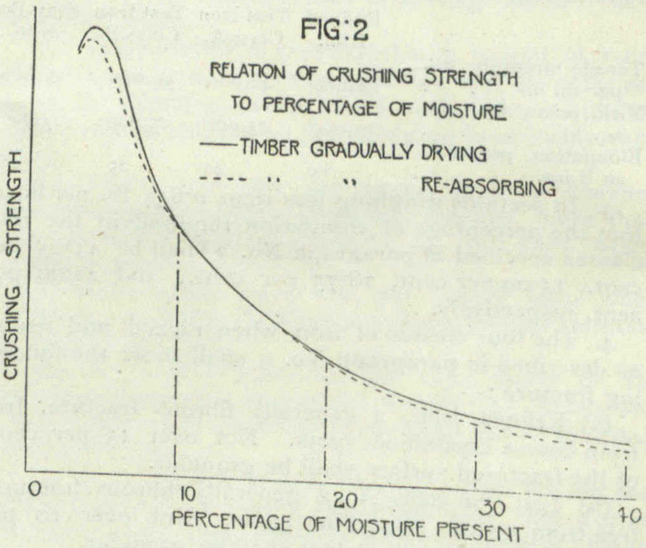
The equation to this curve gives the law expressing how the strength increased with increase of dryness. Making use of this law, the result at different moisture conditions can be reduced to the standard dryness of 15 per cent. for that particular class of wood.

The next great series of tests were made on behalf of the Forest Department of the Board of Agriculture of the United States from 1891-1895. The experiments were made as to the mechanical tests by Professor Johnson, while all timbers were examined carefully as to their cellular structure, at Washington. Over 300 trees were cut down and experimented with, embracing ten different kinds of pine or needle leaf (soft woods) and five different kinds of broad leaf trees (hard woods) all United States timber trees.

Very careful observations were made as to the condition of the soil and climate where they were grown, the age and size of trees, and conditions of growth, time of felling, &c.

As in Bauschinger's tests, to whom entirely belongs the credit of establishing a rational system of timber testing, very careful determinations were made of the moisture conditions of the tested bars. For this purpose, they adopted the plan of cutting a thin disc across the whole of the section of the stick as close to the fracture point as possible. These were at once weighed and again weighed after drying for a sufficiently long period in a current of warm, dry air, temperature 220 deg. Fah. As in Bauschinger's experiments, it was again found that the moisture condition was a vital one in determining the mechanical properties.

Johnson's crushing tests of similar material with different de-



grees of dryness, as shown by fig. 2, seems to show that the greatest strength is reached not when the wood is absolutely dry, but with some 3 per cent. or 4 per cent. of moisture. It is somewhat difficult to ascertain this with perfect accuracy as absolutely dry wood re-absorbs moisture so rapidly from the air; it is how ever not a point of practical importance as such dryness condition as 3 per cent. is never found in actual practice.

Another point, however, of much greater practical importance brought out by these tests was that re-absorbed moisture has the same effect in weakening the timber as the original sap. This is shown by the two curves in fig. 2, one belng a series of tests of material undergoing a steady increase of dryness, the other of material with its moisture being steadily increased by absorption. This, of course, is of importance in such cases as timber in use underground in damp situations where no means are taken to prevent the absorption of the water. He found as a general rule that the strength with 12 per cent. moisture was, with all species, 75 per cent. greater than when "green."

The form of these curves for variation of strength with variation of moisture indicates clearly enough that increase of moisture beyond a certain amount has little effect, the reason being that we are then merely filling the cells themselves with water; and similarly, when drying, the curve begins rapidly to steepen when the walls themselves begin to dry; this occurs in the case of pines at about 33 per cent. moisture.

Another question investigated in these tests which we may deal with here was whether or not "bleeding" or tapping for turpentine, the "pitch pine" had any harmful effect upon its mechanical properties. (It has been freely stated that it did, as well as on its durability.) The experiments showed, as a result of over 1,300 separate tests, no such result; the mechanical properties were apparently not in any way injured. An investigation was also made as to effect of rapid seasoning, and here, again, no injurious effects

From a lecture delivered by Professor Hudson Beare at Carpenters' Hall, London, and reprinted from The Herald.

were produced by this process as usually carried out with currents of hot air.

We will now deal in succession with the different kinds of tests made to determine the mechanical properties of timber, giving a few typical results in each case.

TENSION EXPERIMENTS.

Tension experiments are very difficult to carry out owing to the fact that the specimens so frequently give way by shear, drawing out the part held in the shackles.

The form of specimen usually adopted is shown in fig. 3, with the dimensions.

The results of different experiments vary very much, partly from the above cause, and partly because the specimens being of necessity small, the great influences of original differences in quality

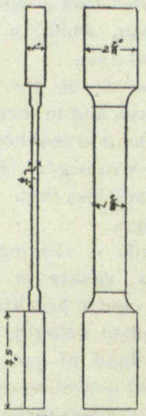


FIG.3

are more important. The tenacity, however, appears to be relatively very great, especially when one considers the porous nature of timber.

Professor Lanza, who failed to get satisfactory results with his big tension tests, says, " tie bars in construction will always give way in some other manner than by direct tearing, for instance, by tearing out the fastenings by shearing and splitting the timber. "

Again, in the long series of tests of American timber made by Professor Johnson for the United States Government they decided to abandon tension experiments because "it was thought timber would never fail in pure tension in practice. "

Bauschinger found that the elastic limit in tension practically coincided with the breaking point ; while, apparently, the influence of time of felling soon disappeared. The figures given below are taken from Bauschinger's first paper, and show the great difference of strength in tension between the living sap wood and the dead heart wood. The figures are the mean of eight tests for the sap wood and four tests for the heart wood in each case, and they show also the influence of time of feelling, which, however, as stated before, appears to disappear after a long seasoning :—

COMPARISON OF STRENGTH OF HEART WOOD AND SAP WOOD IN TENSION, AND OF SUMMER AND WINTER FELLING.

Tenacity in lbs. per sq. inch.

	Summer felled.		Winter felled.	
	Sap Wood.	Heart Wood.	Sap Wood.	Heart Wood.
Red Pine	14,940	3,270	10,660	4,120
Spruce..	13,790	4,413	17,620	4,905

COMPRESSION.

Fortunately it is much easier to carry out crushing tests, easier to make our specimens, and easier to get concordant results. Enormous numbers of tests have been made at various times ; but I will only deal with the more modern ones, in which the condition of the timber as to moisture, &c.—to which I have already drawn attention—has been noted.

Bauschinger concluded that when the average quality of a timber was under determination—as, for example, when investigating the effect of time of felling—then pressure tests were the best. He advises cutting a disc from each end and from the centre of the log, then dividing each of these into four sections, and from each of these cutting a square prism of length about one and a half times its side. These should be crushed, if possible, at a standard dryness of 15 per cent., and their density determined by weighing and measuring.

Bauschinger found for pine woods that the strengths of short columns when plotted to a base of densities gives a straight line that is the crushing strength is a function of the density.

The figures below are Bauschinger's results for the crushing strength per square inch reduced to 10 per cent. dryness for the same quality of timber as the tension figures just given:—

SUMMER FELLED.

Red Pine......5,310 lbs. per square inch.
Spruce........4,770 " " " "

WINTER FELLED.

Red Pine......7,167 lbs. per square inch.
Spruce........5,600 " " " "

In Lanza's tests a large number of poats 7 in. and 10 in. diameter, mostly 12 feet long, were crushed ; all gave way by pure compression. A summary of the results obtained are given below :—

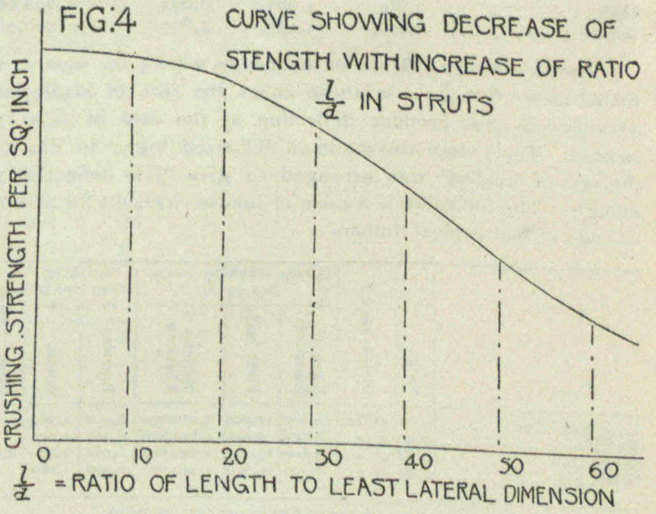
	Max.	Min.	Mean.	
Yellow Pine..............	4,720	3,920	4,370	lbs. sq. in.
Old and seasoned white oak	5,197	3,965	4,480	" " "

Another big series was made on the Watertown machine in the United States of America on struts of considerable length. These show markedly the same condition of affairs as with long struts of iron and steel—namely, an enormous reduction of strength with increase of ratio of least diameter to length. These Watertown tests were apparently on green timbers, but the data is not known.

In several cases three pieces were bolted and keyed together to act as one, but in no case did they show a greater strength per square inch (they were all 15 ft. long) than single pieces, though they ought, according to the ordinary formula for the strength of columns, as they had their least dimension increased—in fact, they buckled out in the same plane as the single one.

Fig. 4 shows the relation of crushing strength to length of column, or rather to ratio $\frac{l}{d}$ for yellow pine.

Johnson in his compression tests, cut off pieces 8 in. long from 4-in square sticks, the ends of the long sticks which had been tested as beams. He noted that after the shearing in of one end, which is the way the timber strut usually gives way, its strength is only 80 per cent. of the original strength. He also concludes



from his experiments that this is the easiest and most valuable of all tests. He advises a factor of safety of 8 for dry, and 5 for green timber when used in compression.

All the crushing I have been discussing so far is that applied endwise and with the grain. Now, it frequently happens in practice that a piece of vertical timber stands upon a horizontal piece, thus transmitting a load to it ; it becomes, therefore, very important to determine the crushing strength across tqe grain. Not many experiments have been made. Tredgold found that 1,000 lbs, was sufficient to indent Memel fir distinctly, and 1,400 lbs. English oak.

It is, of course, rather a matter of judgment to decide what is the crushing load, i. e., what indentation we must take as the limit; some authorities give $\frac{1}{20}$ in. Johnson takes 3 per cent. compression as a working limit, or ⅜ in. in a foot-thick bar, and 15 per cent. as destructive = 1¾ in. in a 12-in.-thick bar. He experimented with specimens 2 in. and 4 in. thick, and found a value in the case of pines on an average of 1,400 lbs. per square inch as against 7,000 lb. with the grain, or only $\frac{1}{5}$. With American oaks the figures were respectively 2,300 lbs. per square inch, and 7,500 lbs. per square inch, or about ⅓.

These figures prove the extreme importance of paying attention to this point in designing any structure or temporary timber erection.

CROSS BENDING.

This is a very favorite form of test, partly because very large pieces with big spans can be readily tested without requiring very big loads; in fact, it is a test which can be readily carried out on a job with but little trouble or expense. Two knife edges or supports, a cradle to carry weights, and some pig or other lumps of iron for weights, are all that are needed, while a stretched cord and a 2-foot rule readily enable the strains or deflections to be measured. I will again describe only a few of the more modern experiments.

Bauschinger made a large number of tests on beams 7½ in. by 7½ in. by 98 in. span. The table gives some of his figures for the quality of timber for which the previous figures have been given :—

	Modulus of Elasticity, lbs. sq. in.	Limits of Elasticity. lbs. sq. in.	Breaking Stress, lbs. sq. in.	Density.	Moisture. per cent.
Red Pine.					
Summer..	1,535,000	2,867	6,720	0·50	23
Winter...	1,465,000	3,136	6,405	0·55	33
Spruce.					
Summer..	1,563,000	3,247	5,957	0·45	29
Winter...	1,670,000	3,719	6,406	0·45	27

Lanza's tests in general support Bauschinger's conclusions. His beams were 2 in. to 6 in. thick, 2 in. to 12 in. deep, span, 4 ft. to 20 ft.

It is, perhaps, well to point out here that the calculated stresses in the outer fibres deduced from the ordinary formula for beams is only the real stress in the case where the load does not exceed the elastic limit; beyond that the formulæ does not hold. The figures we obtain, therefore, for the stress from the observed value of the load in the centre at rupture, are not stresses but mere numbers, useful, however, as comparative figures. Lanza's results are given in the table below :—

CROSS BREAKING STRESS PER SQUARE INCH IN LBS.

Material.	Max.	Min.	Mean.	Mean Modulus of Elasticity.
Spruce...........	8,756	2,994	4,883	1,330,000
Yellow Pine......	11,360	3,962	7,289	1,744,000
Oak..............	7,660	4,985	6,074	1,292,000
White Pine.......	7,250	3,437	4,807	1,080,000

JOHNSON'S TESTS.—Most of his beams were 4 in. square, and tested on a 6 ft. span; in these cases the rate of loading was arranged so as to produce deflection at the rate of ⅛-in. per minute. Tests were also made on full-sized logs; in this case the rate of loading was arranged to give ¼-in deflection per minute. The following is a table of Johnson's results for all kinds of tests of four typical timbers :—

	Sp. gr.	Weight per c.f.	Cross breaking stress per sq. in: Limit of Elasticity.	Cross breaking stress per sq. in: Final load.	Cross breaking stress per sq. in: Modulus of Elasticity.	Crushing stress per sq. in. in lbs.: Endwise	Crushing stress per sq. in. in lbs.: Across.	Shear stress in lbs. per sq. in.
Long Leaf Pine.........	0.61	38 lbs.	10,000	12,600	2,070,000	8,0 0	1,260	835
Red Pine..............	0.50	31 "	7,700	9,100	1,620,000	6,700	1,200	800
White Oak.............	0.80	50 "	9,600	13,100	2,090,000	8,500	2,200	1,000
White Elm.............	0.54	34 "	7,300	1[illegible],300	1,540,000	6,300	1,200	800

All the figures are reduced to 12 per cent. moisture.

To give you an idea of the variation in such tests, in red pine, with 100 tests the highest crushing strength was 8,200 lbs. per square inch; lowest, 4,300 pounds; 54 per cent. were within 10 per cent. of mean, and 96 per cent. within 25 per cent. In cross-breaking the highest figure was 12,900 lbs., lowest 3,100 lbs.; 28 per cent. came within 10 per cent., and 60 per cent. within 25 per cent. In these tests only absolutely bad stuff was rejected in testing; no attempt was made to pick specimens.

Johnson has shown by cutting up his large sticks into smaller ones that under conditions of moisture of the same character little sticks have the same strength as big ones. Only the temptation to pick out specially good small samples is usually too great to allow such tests to be fair averages.

One general result of Bauschinger's tests, verified also by Johnson, was that the strength is much affected by the ratio of summer (solid) to spring (open) growth in each annual ring, or in other words, that the specific gravity is the determining factor. He also showed that there was a definite relation between the modulus of elasticity (determined from bending tests) and the values obtained for crushing and bending strengths—it varied directly with them. Johnson similarly found that for all timbers dealt with in his experiments (except in the case of oak, which from its complex cellular structure seems an exception) the strength rises steadily with density, i.e., with increase of specific gravity.

SHEAR.

In many beam tests, the beams actually give way by shear along the neutral axis. In Lanza's tests eleven beams gave way like this, the shear stress per square inch at the neutral plane being :—Spruce, 191 lbs. per square inch; yellow pine, 248 lbs. per square inch, which was also about the shear stress in this plane in the case of those which actually tore fairly across, so apparently they may in the case of soft woods give way in either fashion.

Direct shear tests are not numerous. The Watertown results were higher than above, namely, for yellow pine, 286 to 415 lbs. per square inch; and for spruce, 253 to 374 lbs. per square inch. Johnson's results for the shear were somewhat higher. These are accounted for by the fact that a special shear test fixes the shear at a particular section, while in the beam it selects the weakest plane near neutral axis.

I must now say a few words on the influence of time on the ultimate strength. I always find in bending tests and crushing tests that when a certain load is reached the material will go on steadily yielding, i.e., the strain goes on increasing, and no doubt rupture would occur at loads less than the final one, if only we left the load on long enough.

Professor Thurston made a striking series of tests on this question; nine bars 1 in. square in section carried on 40-in. supports were tested, the centre breaking load (on a similar bar on same span) rapidly applied being 375 lbs., and the deflection 1·8 in. On three bars a load of 350 lbs. was hung from the centre of the beam and left continuously on; on another three the load was 300 lbs., and on the last three the load was 250 lbs. All nine of the bars eventually broke in half under these loads.

The three with 350 lbs. all broke in less than forty-three hours, deflection 2.3 in.

The three with 300 lbs. all broke in from eighty to 719 hours, deflection 3·0 in.

The three with 250 pounds all broke in from 6,000 to 11,000 hours (=250 to 460 days), deflection 2·5 in.

Hence 60 per cent. of the final load produced rupture when kept on long enough.

In conclusion, I would say that in most cases where much timber is to be used, it is better and safer to make fresh tests of the actual stuff to be used rather than to rely upon old figures.

If cross bending tests of measurements are made of the deflections for gradually increasing loads, and if the results are plotted in the ordinary way as stress-strain curves, then the curves show that the timber has no true elastic limit, but that up to a certain load the relation between load and deflection is pretty constant. It is probable that if this load is not exceeded rupture would not occur, no matter how long the load was left upon the beam.

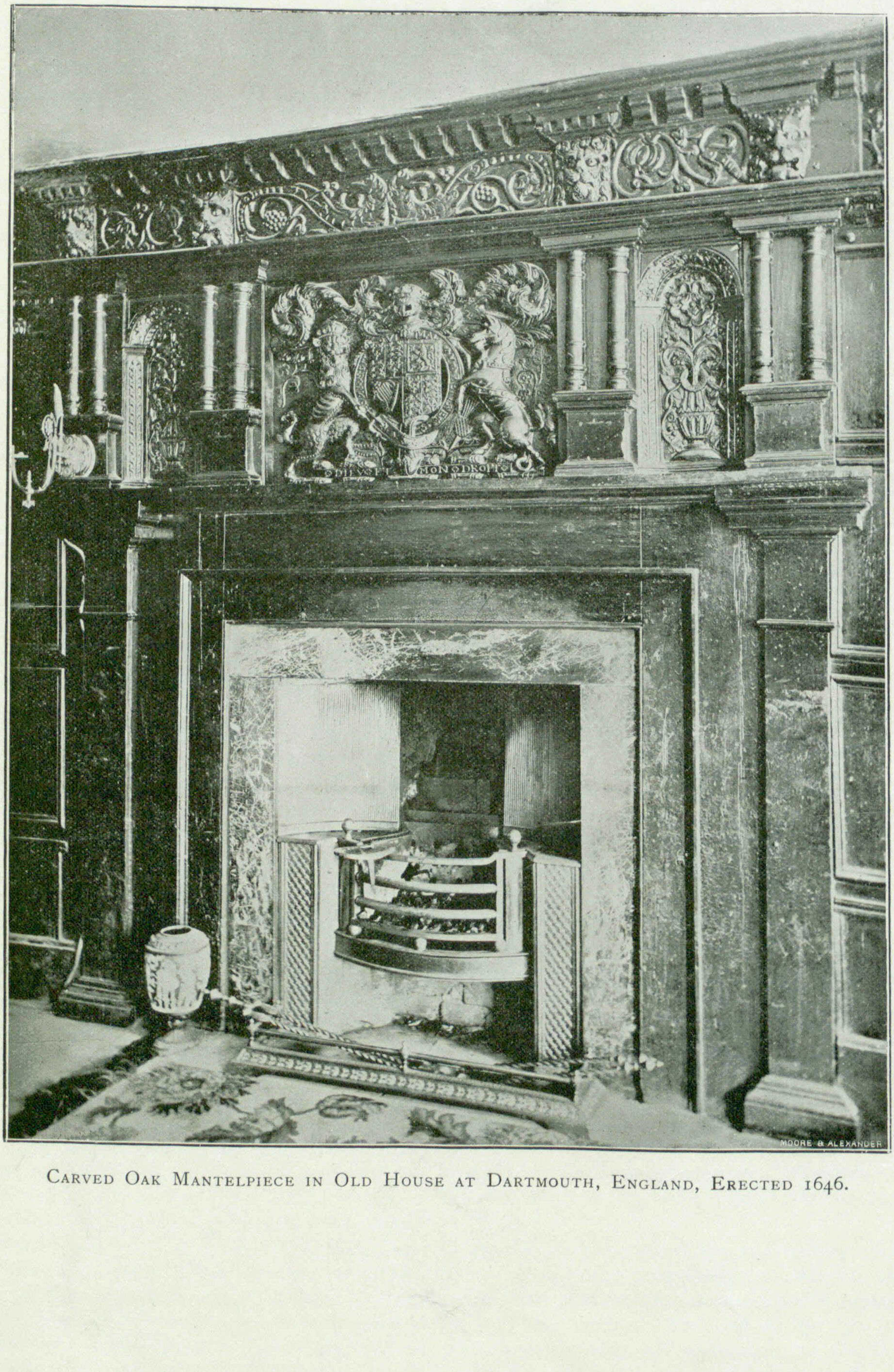
PERSONAL.

Mr. James Scott Webster, contractor, of Galt, was married on September 27th to Miss Annie Johnston, of that town.

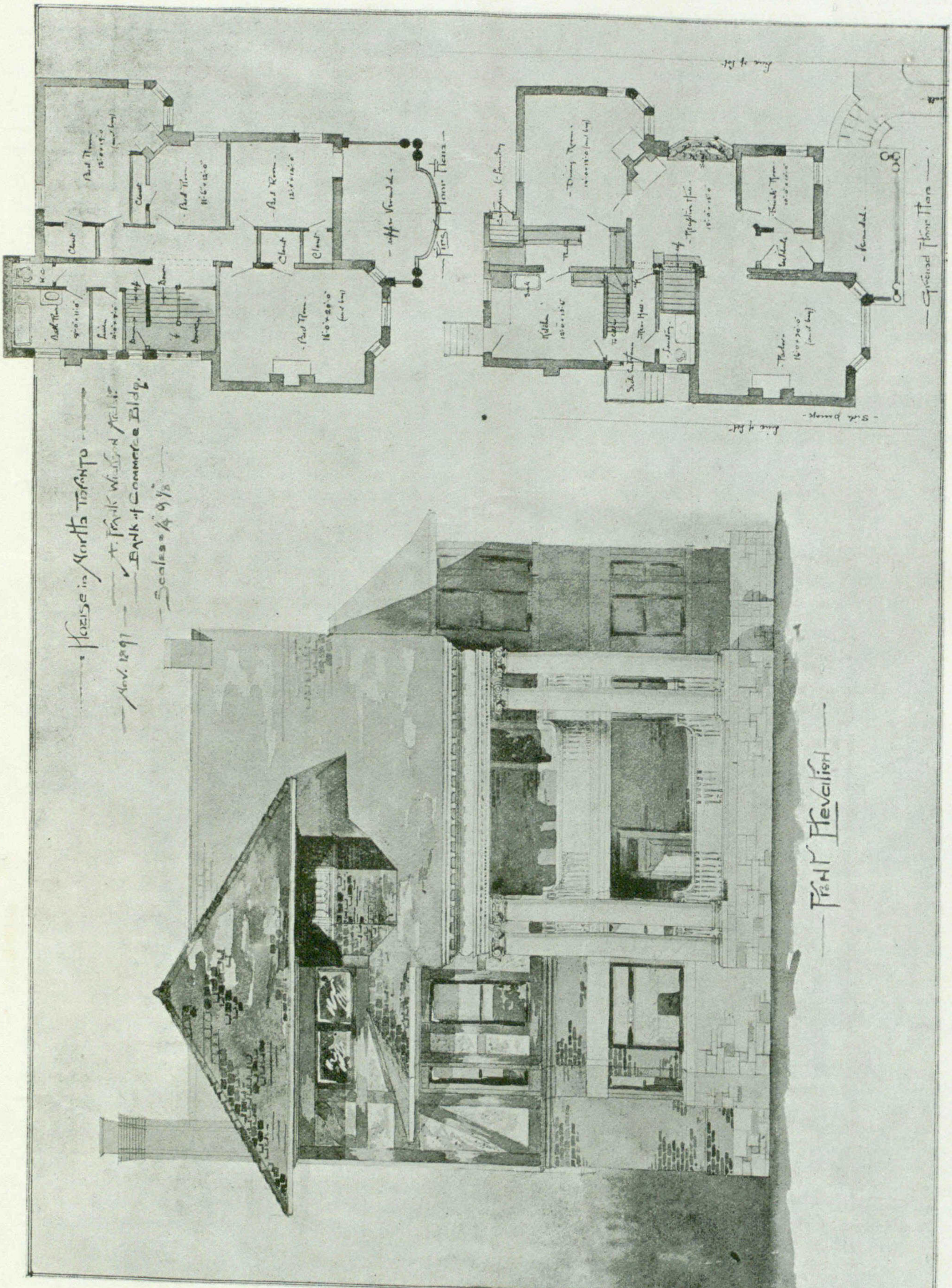
Mr. G. A. Reid, President of the Ontario Society of Artists, has completed an attractive new residence and studio on Indian Road, near High Park, Toronto.

Mr. Wm. Grove, whose father, Mr. David Grove, is one of the largest contractors in Berlin, Germany, and the agent for the Dominion Radiator Co., of Toronto, recently visited Toronto, and inspected many of the public buildings of that city. Mr. Grove's firm installed the heating and ventilating system in the new Parliament Buildings in Berlin at a cost of about a quarter of a million dollars. Comparison shows that in Germany the standard of prices for work of this character is higher than in Canada. Mr. Grove states that hot water heating is steadily growing in favor in Germany.

Messrs. Toro Iwamura, a professor and lecturer in the Tokio Academy of Fine Arts, and Akaira Sano, an architect in the employ of the Japanese government, recently visited Toronto and inspected the public buildings of that city with the object of gaining information to be employed in the erection of a colossal new palace for the Crown Prince. It is estimated that fifteen years will be occupied in its construction. These gentlemen have been commissioned by the Government of Japan to visit all the capitals of Europe. They state that the government does not give great encouragement to foreign art, being desirous of preserving the old Japanese examples.

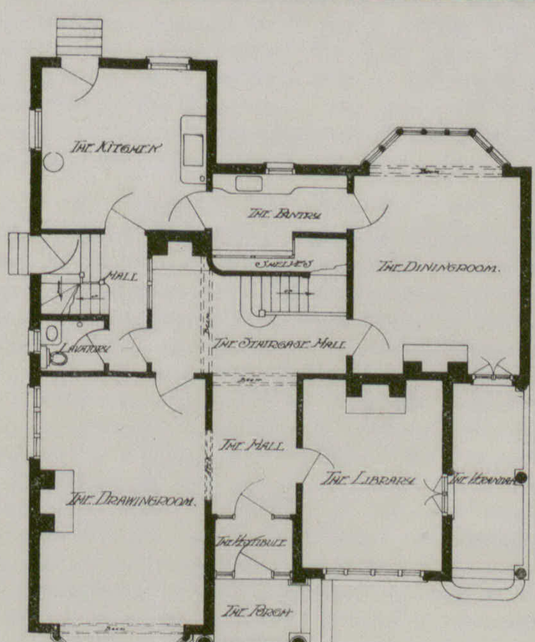


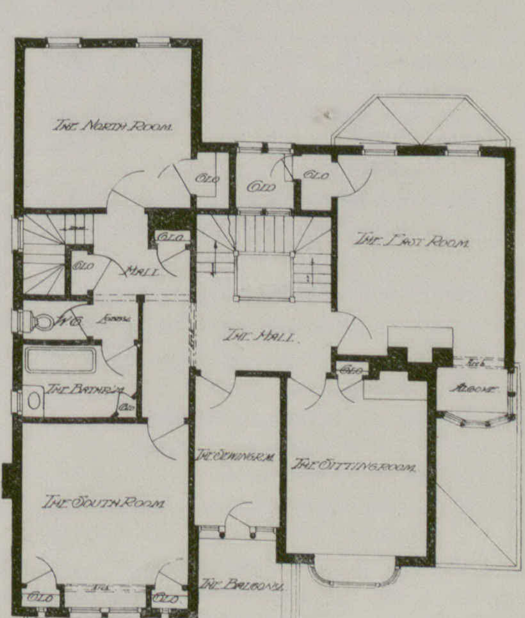
Carved Oak Mantelpiece in Old House at Dartmouth, England, Erected 1646.



HOUSE IN NORTH TORONTO.

A. FRANK WICKSON, ARCHITECT.





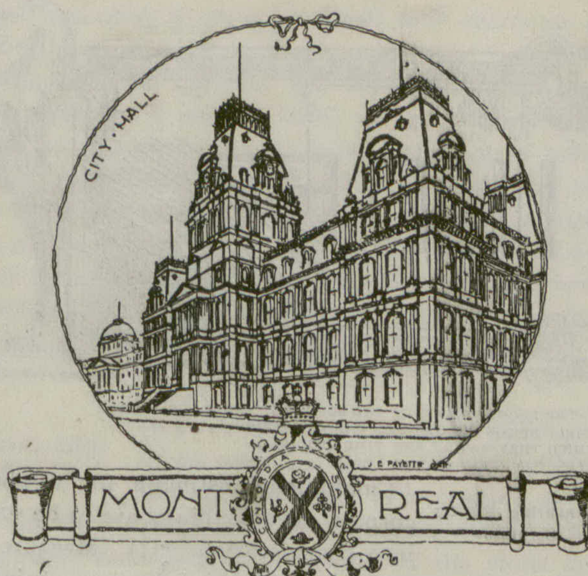
GROUND FLOOR PLAN

FIRST FLOOR PLAN

RESIDENCE ON LOWTHER AVENUE, TORONTO.

MESSRS. CHADWICK & BECKETT, (MEMBERS OF TORONTO ARCHITECTURAL EIGHTEEN CLUB), ARCHITECTS.

D EVERY MONTH FOR WORK DONE BY MEMBERS



Branch Office of the CANADIAN ARCHITECT AND BUILDER, Imperial Building.

OCTOBER 12, 1900

R. I. B. A. EXAMINATIONS IN CANADA.

The Royal Institute of British Architects has decided to hold qualifying examinations for Associateship in the Colonies. Montreal has been selected as the examinations centre for the Dominion ; the first examinations will be held in June, 1901 (from Friday, 21st, to Thursday, 27th). The subjects embraced in the examinations are : (a) Design; (b) Architectural Styles; (c) Construction; (d) Building Materials, Sanitary Science, Specifications and Estimating.

These " Special Examinations " are open to artists of not less than 25 years of age working in the Colonies, either as Architects in practice or as Assistants. "

An Associate of the Royal Institute is admitted (under the charter of the Association) to full membership of the Province of Quebec Association of Architects without further examination.

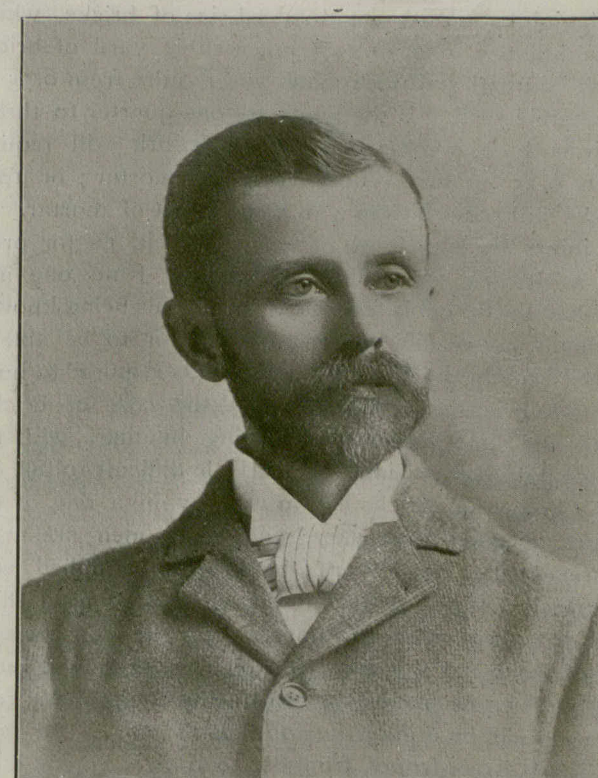
As some who might otherwise wish to take advantage of these examinations may be deterred by lack of special facilities for study in preparation for them, the Professor of Architecture in McGill University has arranged to give a special course of lectures this winter, if a sufficient number of students comes forward, the course to embrace the subject of Architectural Styles, their Features, Mouldings, and Ornament. The lectures will comprise a study in detail of the three great divisions of historical architecture, Classic, Mediæval, and Renaissance, in accordance with the programme of the Royal Institute. Three lectures will be given per week, illustrated by diagrams, casts, lantern views, photographs, etc. For students attending the course the Architectural Library will be available for reading and reference ; it is open in the evening from 7.30 to 10.30, as well as during the day.

The days and hours proposed for this special course are Tuesday, Wednesday, and Friday, either from 8 to 9 a.m. or from 5.30 to 6.30 p.m.; but these may be altered to suit the convenience of the class. The first lecture was given on Tuesday, October 2nd, at 5.30 p.m., in the Classroom, Engineering Building. The fee for the course is fifteen dollars.

ARCHITECTURAL CASTS.

The collection of architectural casts in the Architectural Department of McGill University, has been supplemented by several purchases made by Prof. Capper during his recent visit to Europe. These include a cast of the centre slab of the southern portion of the frieze of the temple of Apollo Epikourios at Rhigaleia. The subject, which is in high relief, is the combat between Theseus and the Queen of the Amazons. This frieze is perhaps the most important example of advanced fifth century Greek architectural sculpture after the frieze of the Parthenon at Athens, of which a large and representative selection has already been placed in the collection at McGill. A cast of a charioteer from the frieze of the Mausoleum at Halicarnassus, dating from the fourth century, is remarkable for its spirited treatment.

A draped female torso is reproduced from the original bronze in the National Library at Paris, and a number of representative busts, which will be specially useful for purposes of comparative study of ancient art, have been purchased in Paris and London. Amongst these is the head from Tello on the Euphrates, at least two thousand years older than the Christian era. The original, which is in the Louvre, is known from the cuneiform inscription as Gudea. The bust well illustrates the differences between ancient Chaldean and Egyptian work, the latter being admirably exemplified by the bust already in the collection of Khafra, the Pharaoh who built the second pyramid, whose death is approximately 4,000 B. C. There is also a series of Greek heads, an Ephebus from a fifth century bronze in the Louvre, of the Attic school ; the famous Bologna head of bronze, which Professor Furtwaengler thinks an ancient copy of an early masterpiece of Pheidias, of the Lemnian Athena. Besides these, there are copies of the " Sorrowing Demetei," now in the British Museum, dating from the fourth century B.C., the Aberdeen head, also in the British Museum, which is ascribed to Praxiteles, and may be from his own hand ; and a full sized head and bust of the famous Venus of Melos (Milo), a reduced full length copy of which the university already possesses. There can be no doubt that these form a considerable addition to the architectural room and that they will greatly assist in the illustration and elucidation of the new course of lectures on Ancient Art, which are to be given for the first time at the university this winter.



MR. G. EMILE TANGUAY,
President of the Province of Quebec Association of Architects.

HISTORY OF ART AND ARCHAEOLOGY

On this subject a series of lectures are to be given during the coming winter by Prof. Capper, head of the Architectural Department of McGill University. The first of these lectures illustrated with excellent views of Egyptian and Grecian Architecture, was delivered recently before a large audience of ladies and gentlemen.

PERSONAL.

Mr. J. Emile Vanier, the well known civil engineer, of this city, was accompanied by his family recently sailed for Paris.

ILLUSTRATIONS.

RESIDENCE IN NORTH TORONTO.—A. FRANK WICKSON, ARCHITECT.

WAREHOUSE ON FRONT STREET WEST, TORONTO.—MESSRS. GORDON AND HELLIWELL, ARCHITECTS.

HOUSE ON LOWTHER AVENUE, TORONTO.—MESSRS. CHADWICK AND BECKETT (MEMBERS OF TORONTO ARCHITECTURAL EIGHTEEN CLUB), ARCHITECTS.

CARVED OAK MANTELPIECE IN OLD HOUSE AT DARTMOUTH, ENGLAND.

The house and room in which this old mantlepiece are to be seen are situated in the street called the Butterwalk, at Dartmouth, in Devonshire. The room also contains a handsomely carved oak cornice. The oak is as black as ebony. In this old house, the erection of which was commenced in 1635 and completed in 1646, Charles II is said to have held his court in 1671.

THE BUILDER

[THIS DEPARTMENT IS DESIGNED TO FURNISH INFORMATION SUITED TO THE REQUIREMENTS OF THE BUILDING TRADES. READERS ARE INVITED TO ASSIST IN MAKING IT AS HELPFUL AS POSSIBLE BY CONTRIBUTING OF THEIR EXPERIENCE, AND BY ASKING FOR PARTICULAR INFORMATION WHICH THEY MAY AT ANY TIME REQUIRE.]

Quantity of Mortar Required for 1 M Bricks

THE amount of mortar required to lay 1000 bricks will vary with the size of the bricks used, and with the thickness of the joints. With the standard size of bricks, which should be 8¼ in.x4 in.x2¼ in., a cubic yard of brickwork laid with half-inch joints will require from 0.35 to 0.40 cubic yard. If the joints are one-quarter to three-eighths thick, a cubic yard of brickwork will require from 0.25 to 0.30 cubic yards of mortar; or 1000 bricks will require from 4 to 5 cubic feet of mortar. If the joints are one-eighth of an inch thick, as for pressed brickwork, 1000 bricks will require from one and one-half to two cubic feet of mortar. This being known, it should not be difficult for an estimator to be able to to tell exactly the cost of the materials required to build up 1000 bricks in a wall, having the cost of bricks, sand and lime at hand, including hauling, with the above data before him. It is a little difficult to tell exactly how many bricks a man will lay in a day of ten hours, as conditions vary, and some men are much more expert than others; but if well supplied with material, and no scaffolds to adjust, and a long wall to work at, from 15 to 16 hundred may be considered a pretty good day's work. If, however, there are many openings to fit around, or neat facing to do, from 1000 to 1200 will be a good average day's work. In good ordinary street fronts, from 800 to 1000 is a good day's work; but in the finest front work, when there are numerous angles, doorways, belting courses or cornice work, from 200 to 400 is a fair day's work. In large works, such as factories, warehouses, or similar buildings, or where walls are very thick and the work coarse, a good man will lay from 1,700 to 2,000 bricks a day; this, however, is rather the exception than the rule, and the lower figure is the safest to estimate upon. A good laboring man will mix mortar and carry it and bricks for three bricklayers, if mortar and bricks are not more than 25 feet from the building, and provided he does not have to carry water or climb a ladder. In all cases, however, the lime must have been slaked and is in a putty state, and this is an item the estimator must consider. To slake lime and run it off and have it ready for the laborer to make into mortar, as a matter of cost, depends on the quantity made at each slaking. As the brickwork of a building rises so also does the cost. Whatever may be the figures obtained as the cost of laying 1000 bricks for the first story, 5 per cent. should be added to it for laying the bricks of the second story, and 12½ per cent. for the third story, and a corresponding percentage for the work laid in higher stories. Getting the figures giving the cost in situ of brickwork, is one of the easiest problems in estimating, yet, how seldom two estimators give in figures alike?

Measuring Plaster Cornices.

IN making an estimate for a plaster cornice, several things are to be taken into consideration. (1) Measure the whole length around the wall, and deduct one projection of the cornice each way for the main length. If the girt of the mouldings from the ceiling to the wall line is under six inches, take it by the foot running measure, but if more than six inches, charge by the foot superficial. When there are eaves to the cornice, charge then by the foot superficial, bending a tape-line round in the concave; count all angles and mitres above four, taking measurements on longest lines. When there are enrichments in connection with the cornice, other than running mouldings, such as lambrequins or set ornaments, charge them extra according to their value, at so much per running or superficial foot. All quirks, arrises, heads or ovolos should be charged by the running foot. Pateras, which save mitring of enriched soffits are not to be taken unless in a frame or coffer; these must be charged under their own department. Plastering on brick walls to be measured from top of ground to lowest member of cornice, but where the walls are lathed, the whole height of wall must be measured. Stucco should be measured by the yard superficial, and charged according to the style and quality of the work.

For Estimating Masons' Work.

THERE can be no set price given for stone-work that will suit all locations and all styles of work and qualities of of materials. The estimator must ascertain for himself the prices current of labor and materials in his own neighborhood, for the style of work he is figuring on. The following will be useful rather as aids in obtaining the quantities and defining the style of work, than in giving him the price for it, but, after obtaining the quantities, and getting the local prices, the cost of work may be readily found. Walls made up of rubble stone are sometimes measured by the toise, (French), which contains 87.16 cubic feet; some measures only allow 84 feet. In Ontario it is chiefly measured by the cord of 100 feet in the wall or 128 feet in loose stone, a difference that should be noted. Sometimes stone-work is measured by the perch, and again by the cubic foot or cubic yard. Walls measuring less than 1 foot 6 inches in thickness are always counted for the builder as 18 inches thick, but, the man furnishing the stone is entitled to the cubic feet only. Walls over 1 foot 6 inches thick and not over 2 feet 6 inches thick, are measured as 2 feet 6 inches in thickness. Footings are always measured extra according to their size. If very large stones are used, an extra charge is made per foot on them. Face work of a superior kind on rubble masonry is always measured separately, and charged according to style of finish and character of work. Quoin stones, made from picked quarried stones and hammered or dressed, are counted as on other dressed work of a similar kind. A good way is to charge the wall right up as so many cords, at so much per cord, and then add cost of picking and dressing the stone afterwards. Walling of block stones is charged up at so much per cubic foot, according to description, similar to ashler prepared and set, including all beds and joints, but the face is charged extra at per foot superficial, according to the way it may be dressed.

Working Ashler Masonry.

In ashler work, where it is plain and of an even surface produced without sinking more than is necessary to remove the mere irregularities of the stone, the price will be regulated according to the quality of the stone and the amount of labor bestowed upon it. For limestone or easily washed sandstones, the prices will not be hard to determine, but with granites and other hard stones the cost of working can only be got at by experience and a knowledge of local conditions. All sunk work in ashler, is the cutting or chiseling below the plain surface, as in rebating, or the weatherings of string courses, copings or cornices. The width, depth, shape of the face of cutting and hardness of stone must all be considered when making an estimate of this work. It is always best to estimate by the superficial foot on this work, for most of it will vary in width and depth, with the exception, perhaps, of weatherings and string-coursing. Circular work, so-called, will include all work having convex or concave surfaces, such as the shafts of columns, arch stones, circular curbs, circular or elliptical stair work, groins, tower work, or other similar work, and the estimator will require to be generous with himself in figuring up this description of work, both as regards labor and material, and ample allowance must be made for unforeseen contingencies. It is always a dangerous method, or rather want of method, to "lump" this kind of work, there are so many opportunities for leakage. The cost of moulds and models must be counted on, extra wastage of material must be considered, and the labor required to do the work will be of the most expensive kind, all of which tend to swell the bill of cost. Circle on circle work, such as arch work in a tower, or the forming of a spherical niche head in a circular wall, always means a great waste of material, and the employment of the most skilled labor obtainable, factors that must be considered when making an estimate of this kind of work. The better way to estimate circle on circle work in stone, for amount of material required, is to make a cube covering the whole dimensions of the similar work both in elevation and plan, and then add 25 per cent. to the contents which will give just about the amount of materials required to complete the work. Straight moulded work, such as cornices, running mouldings, and similar work, may be counted by the running foot, and the cost determined by the girt and the number of members in the cornice. Circular moulded work, such as the mouldings around the necks of columns, cornices around towers, or circular oriels, may be charged by the running foot, and the price per foot determined by the girt of the moulding and the number of members in it. Circular work of all kinds costs from two to three times as much as straight work of the same face, and work having a double curvature or circle on circle work, costs from three to five times that of straight work having the same face. The correctness of an estimate for this kind of work will depend largely on the skill and experience of the estimator, who is supposed to have a thorough knowledge of the character of the work he is figuring on. It is not safe for any young contractor to make an estimate on work of this kind if he has had no experience in this department, and he is advised to consult some person of experience, some old builder, or better still, some city architect, who is not interested in the work, and who is known to have erected stone work of the kind under discussion. The cost will be but little, and it may help to prevent serious disappointment and loss. In stone buildings of the better class, the simple walls, not including windows, doors, cornices or other embellishments, may be rated at the cubic foot where the work is of one kind, and when the work or material differs from the front wall, rate it at per cubic foot at a greater or lesser rate as the case may demand. Ascertain the full cost of one window and opening, then rate all similar windows likewise, the same with doors and openings. The total cost of a single column multiplied by the number of columns, gives the figures required. The cost of one foot of cornice or belting course or running moulding, obtained, multiplied by length of work, gives the whole cost. Carvings and other sculptured work should always be estimated by the piece.

ADHESIVENESS OF GLUE.

A WRITER in one of our foreign exchanges says that the adhesiveness of glue under favorable circumstances is equal to a force of at least 715 pounds per square inch. In an experiment performed, a force of 1,260 pounds, applied gradually, was found necessary to separate two cylinders of dry ash wood, the ends of which presented a surface equal to 1.76 square inches, and which were glued together end to end and allowed 24 hours to set. Even this weight was sustained for two or three minutes before the joint gave way, and it was found, on examining the separated surfaces, that the glue was very thin and had not entirely covered the surface. The cohesive strength of glue appears, therefore, in this experiment to have been rather more than 715 pounds per square inch, while the cohesive strength of the wood thus united in a lateral direction was found to be only 562 pounds, thus showing that if the joint had been between the sides instead of the ends of the pieces of wood the wood would have given way before the glue. In this case, however, the glue was newly made and the season very dry, while in some former experiments made in the winter season with glue which had been frequently made, with occasional additions of glue and water, the cohesive force indicated was only 350 to 500 pounds per square inch.

The body color of a recently repainted house is a light shade of French gray, made from white lead, raw umber and a little lampblack; the trimmings are ivory white, and the blinds are a dark green, having an olive cast. The same color, but a trifle darker, has been used for the sash and also for the front door. The rough cast stone base is a dark olive, while the floor of the piazza is just a trifle darker than the body color. The house is set among large trees, and the general effect of the whole is specially pleasing. On the opposite side of the street another house has been painted a rich cream color, the trimmings being a lighter shade of the same, and the blinds and the sash bronze green. The brick base is a warm reddish brown, just a trifle too strong to be agreeable.

LOW PRESSURE HOT WATER HEATING.*

By J. Nelson Russell.

In upholding the claims of low pressure hot water heating this evening, as being the most suitable for the majority of installations, I have endeavored to take up some points which are outside the beaten tracks, and I trust that my remarks may be sufficient to give food for discussion and exchange of ideas.

The popularity of this method of warming is unquestionable, and, in my opinion, it will hold its position for years to come, in spite of the advancements in the methods of heating by steam and other agents.

That there must be reasons for this, and this is not merely due to the wishes, and perhaps caprices, of those engineers who claim its advantages, is patent to all, since no system will stand the full test of time unless the advantages claimed for it are borne out in practice.

Any apparatus, to be to the satisfaction of the client, and to the credit of the contractor, must, beside being efficient and fulfilling the guarantees given, be easily attended to and economical.

EASILY ATTENDED TO.

To fulfill this condition, an apparatus must be in as large a measure as is practicable, unaffected by fluctuations of the fire, must be able to be attended to in the evening, and yet warmth provided through the night. In small installations, it should have no parts that require skilled attendance whatever, or in larger plants, where such attendance is available, it should be reduced to the slightest degree.

Upon this head the system of low pressure hot water undoubtedly takes premier place.

As water is one of the finest agents we have at our disposal for the taking in and giving out of heat at all temperatures, we have therefore the best material to deal with.

In a system with runs of pipe for the heating surface, the contents of the apparatus is sufficient to enable an almost constant temperature to be maintained, the boiler power being, of course, in correct proportion.

In a radiator system, although the contents for the same heating surface is much less than in a pipe scheme, yet it is in excess of that of high pressure hot water or a steam scheme, and, in the event of the fire lowering below the power required to maintain the apparatus at full temperature, all the heat conserved in the circulating water is available ; whereas the effect in a high pressure apparatus is much more rapid, and in a steam apparatus on the reduction of the temperature to 212 degs., the steam, after giving off its latent heat, returns to water, and to the boiler, and is of no further use for radiation in the apparatus until the fire is re-lighted.

With regard to the attendance to the apparatus, the putting on of fuel, the regulating of the draught, and the cleaning of the grate, these must be seen to in any scheme.

In the low pressure hot water system, the water will circulate at whatever temperature the fire is capable of raising it to, and if the fire is too fierce, the open air pipe is brought into use, and the apparatus will be freed from the steam and excess of heat until such time as the excess is lowered.

With a gravity steam apparatus you may say that such excess is kept in check by the automatic damper control, and to this I agree, but automatic devices are not infallible, and there may come a day when the safety valve may be brought into action, if in the meantime it has not stuck fast.

With the system of this paper, skilled attendance is certainly at a minimum, and an apparatus once installed will work, year in and year out, with intermittent attention to air cocks, safety valve, and cold water service.

Compare this with the high pressure hot water, with its yearly pumping through by skilled labor, and with its periodical filling, which if not attended to, will in time prevent circulation, with the inevitable result of the destruction of the furnace coil and its replacement.

ECONOMICAL.

This is a side of the matter which affects the client far more than the contractor. Give him a scheme which is effective, easily attended to, and yet burns more fuel than one of similar proportions upon another system, and he has cause of complaint, however satisfactory everything may be.

Let us look into the points upon which there may be waste of heat.

The proportions and design of the boiler, and the use of the heat in the gas from the fuel, are, of course, large factors for economy or waste.

Take for granted that, so far as those items are concerned, we have a gravity steam system, a high pressure hot water system, and a low pressure hot water system, each to do equal duties, and each of the highest class of design and workmanship.

Is it possible to say that either has the preference for economical working above the others ?

Is there any possibility of waste of heat from the radiators or coils, which contain a large proportion of the heating surface of any installation ?

It is an almost universal practice that these should be placed upon the side of the room which is the cooling side and in the majority of cases they are placed beneath the glass surface, the greatest cooling factor of all, and, as we have not only to consider the warming of the room, but also the checking of cool cross draughts as well, this is undoubtedly the correct position, but for economy in heat it is just the one place of all which gives opportunity of waste.

The rising column of heated air from the radiator is brought at once in contact with the greatest cooling factor, increasing the difference in temperature between the interior and exterior of the glass, and thereby increasing also the rapidity of the heat transmission, the whole of which is waste, pure and simple.

This is the result also, only in a lesser degree, if the radiator is placed upon an outer wall between windows.

Is there any means of prevention, without placing our heating surface elsewhere ?

Yes, a partial one.

How ?

Lower the temperature of the ascending air column from the radiator by reducing the temperature of the water or steam in the radiator itself.

It is evident that if we have a steam radiator working at a pressure of 10 lbs. per square inch, i. e., 240 degs. in one room, and another at atmospheric pressure, i.e. 212 degs., in a similar room, the ascending air column and the heat transmission through the glass in the first case will be higher than in the second.

If we have a third room with a radiator worked by

*Paper read before the Institution of Heating and Ventilating Engineers of Great Britain.

hot water at a temperature of 170 degs. we shall have a lower heat transmission than in either.

It is therefore possible to effect economy of heat, and therefore fuel, by working heating apparatus at low temperatures.

This is doubtless one of the items that tend to the economy given by the atmospheric heating system, upon which we had a recent paper from our president, but even then the steam system upon those lines is only able to obtain temperatures approaching those at which hot water systems are worked, and not to get beneath them.

Therefore, on this head, I place hot water in the premier position for economy.

Secondly, heat is transmitted from a radiator or other heating agent by three well-known methods :—Conduction, radiation, convection.

CONDUCTION.—This is affected by the thickness and the nature of the metal, and can be taken as alike for all.

RADIATION.—The heat units given off per square foot of surface is given us by Dulong and Petit for cast-iron for a difference of temperature of 90 degs., 115 by radiation against 100 by convection, and at 180 degs., 120 by radiation against 100 by convection.

These radiant heat rays pass through the air without being absorbed or raising the temperature of the air to any appreciable extent, giving up their heat to the object in the direct line of passage.

In the catalogue of one of the heating and ventilating engineers there is a quotation to the effect that "Heating should be done by means of radiant heat," but on this head I am not in agreement with them, unless they wish to infer that rooms should only be heated by open fires.

If a room is warmed by means of an open fireplace, the heat by convection is largely passed up the chimney, and therefore the radiant heat is a large and predominant factor in the heating of the rooms.

After leaving the fuel, it is, on striking the walls, furniture and individuals, at a greater temperature than that of the rooms, and capable of imparting heat, since it starts at a high temperature from incandescent fuel ; but in the case of a steam or water apparatus the temperature of the source of heat is only counted in hundreds of degrees, instead of in thousands, and the radiant heat correspondingly lowered.

As the walls of a room are always absorbing and passing the heat through them, and are at a lower temperature than the air of the room (at times when heating apparatus is required to be in use), it follows that those rays which reach the walls are there absorbed, passed through, and are not utilised in warming the air of the room.

If this be so, the more we can reduce the ratio of radiant heat emission, the more economical will our apparatus be, and one of the ways of doing so is to keep the temperature of our radiating surfaces low, and thereby to lower the heat units given off by radiation in proportion to those by convection, and in this item low pressure hot water is the most favourable.

CONVECTION.—Air in motion rubs against its other particles, and against objects with which it is in contact, and it is upon this method that we rely for the removal of heat from the heated surface to the air of the room.

The name of "radiator" is misleading, as it is through convection, and not radiation, that its duty is fulfilled.

Radiators should be of a pattern giving freedom of air access to all parts, so that the movement of the air is unimpeded.

The form of the radiator has also a bearing upon the two items of radiation and convection, patterns with the radiating faces parallel with each other as much as is possible being the most efficient as regards conservation of radiated heat, but all the patterns of that description upon the market at the present time have a greater disadvantage in connection with convection, in having such faces far too close together. If the distance were doubled or trebled the effect would be much improved.

We all doubtless have read the paper of Mr. M. O. Kasson, from which the following is taken :

"Select a room which is heated by a single radiator well out from the wall, and make the following experiments under the same conditions of outside temperature, or as nearly so as possible. After it has been ascertained what maximum temperature can be obtained in the room in a given time under the normal condition of the radiator, cool off the room to the temperature at which you started. Then cover the top of the radiator with a board, and turn on the steam again. You will find that it takes about 25 per cent. more time to reach the maximum temperature with the radiator handicapped in this manner, although you have covered only a small portion of its radiating surface. Then repeat the operation, covering the top and three vertical sides of the radiator, when, even though the boards do not touch the radiator, you will find that it will take about twice as much time to heat the room as in the first instance.

"To prove these two experiments, cover four sides of the radiator, leaving the top exposed and space for the air to enter at the bottom. In this case you will find that the temperature of the room is raised even more rapidly than when the radiator was not covered at all, because by boxing in the radiator, as just described, you have created a draft of air up through the heating surface, and thus materially aided the convection of heat."

Unfortunately he does not give us the data as to the amount of steam condensed, but if you try the experiment yourselves, you may be prepared to find that in the one in which the convection was assisted, the amount of steam condensed to do the same work would be the least.

The various makes of radiators on the market are listed at their exterior heating surface, but take one of each pattern, ascertain the actual heat duty, and how varied the results will be. We have far too many which are well described by Mr. Kasson's experiment of having a board on top—far too many with the inner surfaces boxed in to such an extent that the convection is slow.

I wish to point out to you, in closing, that the opportunities I have pointed out are small in themselves, doubtless, but multiply them by the total surface of the apparatus, and add the saving in the heat emission due to the reduction in temperature of the mains in positions where heat is wasted, and the result for the season will turn out to be an appreciable one after all.

Too many advertisers consider their advertising as an adjunct to their business. Here is where they make the fatal mistake ; advertising is not an adjunct, but a part of the business, as much as is the buying and selling of goods.—The Advisor.

THE BOND OF BRICKWORK.

'Tis a matter of great importance to the brickmaker that bricks be well laid and well bonded, writes Mr. George F. Tiffany in The Clayworker. The bond premarily depends on the cohesive nature of lime mortar. If the bricks are not wet when laid on the mortar will adhere whether the bricks be smooth or rough. Masons generally are of the opinion that mortar will adhere better to a rough brick than a smooth one. This is probably owing to the fact that a rough brick can be rapped to place with less liability of breaking the bond of the mortar. A smooth dry brick allows but little movement and it must be quickly made, or the brick will slip on the mortar and must be relaid with fresh mortar. In rapping a rough surface brick to line the mortar moves with it, but this is no evidence that the mortar, when set, will adhere more strongly to the rough brick.

One would naturally think that the air confined in the interstices of a rough surfaced brick would in some degree prevent the adhesion of the mortar. This would undoubtedly be the effect if the brick were not porous, so that the air could not escape through the rough brick. But the tenacity with which mortar adheres to glass, a perfectly smooth and nonabsorbent body, is evidence that brick may also be smooth and nonabsorbent and make equally as good a wall as rough brick.

One need not be a very close observer to learn that in the taking down of brick walls some brick will lift easily from their places, leaving a smooth and perfect mold of the brick in the mortar, while others have to be struck with a force that frequently breaks them in pieces, and, if lifted without breaking, take a portion of the mortar with them covering the whole surface of the brick ; the separation being in the mortar, and not between the mortar and the brick.

What makes this difference is a very important question. The defect has been attributed generally to the laying of dry brick. But the remedy has been known so long and is so simple that we are assured that other causes may produce this effect. Is not mortar oftentimes used in too new a state, that is, before the perfect working and mixing of the sand has been made? Is there not a giving off of gas from the mortar in the joint also a cause for this weakness?

It is more important to lay a brick under such conditions that the mortar will make a good bond than to make a true, smooth wall. What matters it how well the wall may look, if, in a short time, the arches crack and the sections slip by each other, not only presenting a very unsightly appearance, but proclaiming that the structure is unsound from cellar to garret. It might be profitable to consider the question, can a good mortar bond be secured when bricks are laid hot and the mortar freezes soon after the brick are laid? Is not the practice of building brick walls in the winter very objectionable?

If a brick wall is expected to withstand the ravages of fire the sand in the mortar must be a flint sand. A limestone sand will, of course, turn to lime and the slaking of the lime will break the mortar bond and disintegrate the mortar. Brickmakers who have unwittingly used lime sand in their clay for making brick will appreciate the importance of this warning. A sand that is affected by the action of acid will also be affected by the action of fire.

The steel structures in which the girders and posts are partially protected by fire-proofing have, in some degree, disappointed expectations in regard to their fireproof qualities, although practical men could plainly foresee that, if there was enough combustion to heat the lower part of such a building to redness, the whole fabric would collapse. The steel cannot be considered as a bond to the brickwork, for the principal constructive element is steel, which, expanding and contracting, makes every change of temperature tend to disrupt the brickwork. The steel structures serve a useful purpose as office buildings, and the writer does not wish to speak disparagingly of them, but rather to emphasize the fact, which all experience affirms, that there is no better obstruction to the passage of fire than a heavy, well-bonded brick wall.

We were once very painfully impressed with the importance of such walls. It was in the year 1857 or '58, at a fire in Lake street, Chicago. A brick store was being burned out. Its east wall projected high above the roof of an adjacent frame building from which people were carrying out the goods.

We said to a gentleman near by, "If that wall stands the fire will go no further, and suggested that braces should be set against it from the roof of the frame building. But very soon the wall toppled over on the roof, carrying it down with the floors of the building and burying a dozen brave men beneath its ruins. If that wall had been one-half brick wider, or better bonded, it might, perhaps, have stood the trial. Why are men so economical of space and material when life is imperiled?

"Ah, me! that land should be so dear,
And human life so cheap."

The word bond, in relation to brickwork, refers to the laying of brick across the wall, thus bonding two vertical courses together. The end of a brick, excepting on the corners of a wall, is unsightly. The English and the Flemish bonds secure much stronger walls than are generally found in the fronts of the buildings, but the long rows of headers in the one and the checker-board appearance of the other prevent their being much used for fronts. It is generally true in architecture and mechanics that the form which is most pleasing to the eye is also the simplest and best adapted in every way to the purpose for which the object was made. This does not appear to be true in brickwork. The vertical courses are very weak without headers to bind them together. The temptation to leave them out is too strong. Beauty and strength do not meet in harmony in a brick wall. Who has not been astonished at the lack of bond in a building that has been burned out, while looking at its shattered walls.

Often a chimney is seen standing erect and sound among the ruins, indicating so plainly if the walls had been as carefully built they might also be standing. There is no question that division walls should be made heavier, or at least have an occasional buttress, which would greatly increase their stability. Certainly they should be made so that they will stand when all combustible material in the structure has been consumed.

For the form of bond for such walls there is none better than the English bond. For store fronts and dwelling houses, for all walls having an exposed surface, and especially for all hollow walls of brick, we need a bond that does not require the cutting of brick to form the bond, that the wall will appear to be all stretchers, and that will cost no more to put in a bond course than a course all stretchers. The use of band iron for binding the face course to the wall of a hollow wall is not in keeping with the stable character of brickwork. We present to the architects and to the practical judgment of masons and brickmakers a form of bond which we believe meets all requirements.

A split brick is a standard form of fire brick and should also be of common brick. It is the principal form in the bond shown above. Whenever we wish to use a bonding course we use use a split brick, as a stretcher on the face of the wall, which covers the ends of the bricks laid across the wall.

Fig. 1 represents a solid one and one-half brick wall.

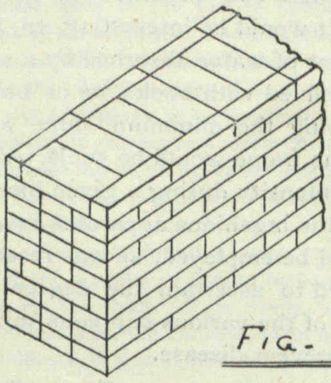


Fig. 1

It is faced alike on both sides, with all stretchers. Notice that this is done with a saving of face brick, as each split brick takes the place on the surface of the wall of two face brick used as headers. There is nothing so nice for a courtyard wall or for a brick and one-half wall in any place where even one side is exposed.

Fig. 2 is a brick and one-quarter hollow wall. All

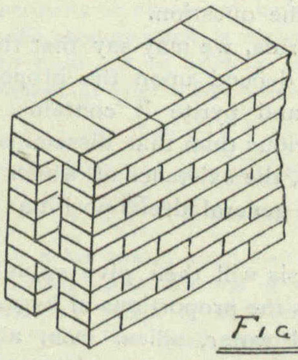


Fig. 2

stretchers on the face having a hollow space of one-quarter of a brick in width.

Fig. 3 is a one and three-quarter brick hollow wall,

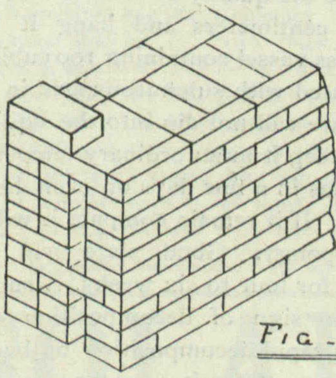


Fig. 3

all stretchers on the face, and having a space of one-quarter of a brick in width.

It will be seen that heavier walls, varying in width by a half brick, either hollow or solid, or with both, by one-quarter of a brick may be made.

MANUFACTURES AND MATERIALS

SLAG CEMENT.

THE manufacture of cement from iron slag has become quite an important industry in Germany and Belgium. The cement when mixed with three parts of sand is said to have an average tensile strength of more than 350 pounds to the square inch after 28 days, and more than 600 pounds at the end of a year. The product of the mills in Belgium and Germany is said to be sold months in advance of its manufacture. It is not a competitor of Portland cement for the finer kind of work, owing to its unfavorable color, due to the presence of oxide-of-iron, but is used for the rougher purposes such as foundations for buildings and streets. The rapid growth of iron manufacturing in Canada will probably in time lead to the manufactute here of this kind of cement. Some of the American iron manufacturing companies are said to be now giving attention to the subject.

ENGLISH CEMENT COMBINATION.

THERE has been considerable talk and speculation about the proposed combination of the Portland cement producers of Great Britain. Particulars are now at hand, and it is said that the new trust will control about 80 per cent. of the output of the United Kingdom.

The share capital is £5,000,000, divided into 250,000 7½ per cent preference shares of £10 each 250,000 ordinary shares of £10 each, while the company is authorized to issue £3,000,000 first mortgage 4½ per cent. debenture stock.

The association was formed for the purpose of purchasing the undertakings of concerns engaged in the manufacture ot Portland cement. With the exception of three, all the works are situated on the Thames amd Medway. It is believed that upwards of 80 per cent. of the entire output of Portland cement in the United Kingdom is produced on the Thames and Medway. The total production of cement on these rivers in 1899 has been estimated at 1,700,000 tons, whereas the estimate of production in 1895 was only 1,350,000 tons. This difference is due to the largely increasing demand for Portland cement. The production of the firms taken over by the association was, in 1897, 1,222.240 tons; in 1898, 1,337,268 tons, and in 1899, 1,404,569 tons, while their capacity now is about 1,570,000 tons. The profits are said to have shown a satisfactory and progressive increase. Notwithstanding, cable advices state that the offering of stock was not a success.

MANUFACTURING NOTES.

THE Boston Lumber and Brick Co. has been incorporated with a capital of $40,000 and headquarters at Sault Ste. Marie.

THE Canada Paint Co., of Montreal have been awarded a medal for their exhibit at the Paris Exhibition of mineral pigments mined in Canada. The exhibit is instructive, representing the minerals in their various stages of manufacture—first, as mined; second, as prepared for the oil in varnishes and colors; third, as made and applied.

A GREAT honor has been conferred on the Canadian Office & School Furniture Co., Preston, Ont., by the award at the Paris Exposition of a Silver Medal for school desks. The exhibit was made at the instance of the Government to supplement the educational display. The silver medal is the highest award which could be given by the judges, and the fact that a Canadian firm secured it is a matter of congratulation. The desks shown by the firm have attracted general attention, and in consequence, a number of applications for price lists and samples have been received from all parts of the world.

A new Portland Cement Manufactory is being constructed at Brookholm, near Owen Sound, by the Grey and Bruce Portland Cement Co.

The Metallic Roofing Company complain that owing to a discrimination of railway rates in their favor, manufacturers of architectural metal goods in the United States are able to pay the Canadian import duties and undersell the home munufacturers.

Mr. Samuel Cabot, of Boston, the well-known manufacturer of shingle stains, is sending out to architects and others interested, a series of half-tone plates, showing various examples of recent suburban architecture by well-known architects, illustrating the styles of building to which shingle stains are adapted.

The Gurney Foundry Company state that they have done a larger volume of business this year than ever before in their history, and are finding their premises too small for the requirements of their business. They have largely increased the capacity of their moulding shop. For two or three years past they have been obliged to rent outside storage accommodation. They have this year put on the market a new style of wood furnace embodying a number of improvements. The large demand throughout Canada for their goods has caused them to neglect, to some extent, the export branch of their business. There is found to be more profit in the goods sold in the home market. American competition is very keen in Great Britain and the American manufacturers, in addition to having been longer established, have a considerable advantage in freight charges being able to ship very cheaply by canal from Buffalo to New York and place their goods directly on the steamships in that city. The British manufacturers are also said to be waking up to the possibilities of their own market and are steadily improving the character of their goods.

DINING ROOM PROPORTIONS.

IN the dining-room there are certain practical points which to some extent dictate the proportions. Thus, in a small room it is more convenient for serving if the plan is nearer the square, whereas for a large dining table the plan may with advantage approach the double square, provided sufficient height can be given to the room. The largest room on any floor often fixes the height of all the rest, and Chambers recognises the impossibility on this account of employing the best proportions in the smaller rooms. The following suggestions are taken from Gwilt :—For square plan and flat ceiling, height to be not less than 4/5 the side, nor more than 5/6 ; for longer proportions the height may equal the width ; where a cove is employed the proportions should be increased. One of Palladio's rules for long rooms (as opposed to square) was to add length to width and take ½ the sum as height. The appearance of a room having too great a height may be improved by a predominance of horizontal lines in its decoration, and vice versa.

POROSITY AND DURABILITY OF SLATE.

DETERMINATION of the porosity and durability of slate when exposed to the influences of weather, is a question which interests the sanitary and building arts in an eminent degree. Mr. Lariviere made an interesting communication on this point to the Commission of Testing Methods for Building Materials, established at the Ministry of Public Works, and this is printed in a recent number of "Vie Scientifique."

It is difficult, says Mr. Lariviere to determine the porosity, because as a rule schists are but slightly porous, and because care must be taken not to confound the water between the layers of cleavage with the water really contained by the pores of the substance of which these layers are composed.

To estimate the degree of porosity, two identical plates are cut with a band saw from the same slate and then dried. When this is accomplished the weight p of one of them is found, and then the piece of slate is smeared on every side with an oily coating of known weight d, so that the weight p_1 of this coating can be found.

Having estimated the weight of all, it will be easy with these data to calculate that of the dry slate. The other piece of slate is employed to calculate the weight when saturated with water; in this case only the edge of the slate is coated with grease before saturation. Comparison of these two densities will give the volume of the pores. It would be interesting to ascertain by study the amount of water absorbed by a square meter of roofing slate fixed with hooks, as in building, on a frame-work having the minimum slope employed for such roofs. The frame would be subjected to a regular rain of known intensity during a given time. To obtain such a shower the ingenious apparatus invented by M. Schlœsing could be employed, as was recently done by Mr. Aime Girard to ascertain the degree of adherence to plant leaves of the various cupreous mixtures which are utilized to prevent disease.

As regards the resistance to effects of weather, the methods adopted to study the action of frost on stones do not seem able to give any precise indications with schists, for the very fact that they are but slightly porous.

Slate only become porous when decomposed by the effects of weather, so that specification of these effects would be the point needed. Unfortunately there are no methods to determine the resisting power of slate to such influences any more than for stone. Experience alone can decide the question.

However, as a rule, we may say that the duration of a slate seems to depend upon the proportion of carbonate of lime and pyrite it contains. Crystallized pyrite is less injurious than that disseminated throughout the substance, the existence of which is often only revealed by the general decomposition which finally takes place.

Chemical analysis will then give valuable data. In analysis of schists the proportions of hygrometic water and the combined water, silica, iron, alumina, lime, magnesia, alkalis, all are determined ; carbonic acid and sulphur should also be analyzed.

Professor Brunner, of Lausanne, recommends the following method, taken from Fresenius, to easily and rapidly estimate the quality of slates :—Take a sample of slate 7 by 3 centimeters and hang it by a cotton thread in a glass vessel containing 100 cubic centimeters of water saturated with sulphurous acid in such a manner that the slate will not dip into the liquid, then shut the glass and keep it in an ordinary temperature. Bad slate decomposes in a few days or even hours, becoming exfoliated. If it remain compact it will grow very friable and spongy. Good slate will preserve its primitive state for four to six weeks. A superior quality of slate has no sign of decomposition after several months. This rapid decomposition of bad slate is due to the presence of pyrite, carbonate of lime and magnesia. The pyrite is transformed into sulphuric acid which decomposes the other minerals. The carbonate of lime is transformed under the influence of humid air and carbonic acid into soluble bicarbonate.

CHIMNEY CONSTRUCTION.*

BY E. J. PHILIP.

THE construction of chimneys does not give us much thought, like many other things we have to deal with, until we have to construct one, and when you begin to look up facts it will surprise you how little real information there is to be had on the subject.

In the old country, where there are many large chimneys used for all purposes, there is on record much information both in reference to building, straightening and taking down. Most of the very high chimneys are used for other purposes than producing draft to burn coal, such as carrying off the poisonous gases from chemical works, etc. There is a book published called "Tall Chimney Construction," which gives the general details of many stacks built in the old country, and from these records you can make formula to guide you in designing a new stack.

Let us consider what is the proper method of designing a chimney for any given purpose. The first question is, "What is the chimney for, or what is it to do?" for this will govern some details of the shell. For instance, if it is to produce draft for ventilation, it will not require to be lined with fire-brick, nor will there be any benefit in putting in a loose lining.

We will suppose the chimney under our consideration is to induce draft to burn coal, as that is the most likely duty of any chimney that we will be connected with.

The size of the flue is the first dimension you will require, and it will depend on the quantity of coal to be burned and the velocity of the gases up the shaft. It is easily understood that as chimney powers increase, the dimensions do not increase proportionately. To illustrate this I will take some figures from a table in a reliable work :

A chimney 70 ft. high, 30″ diameter = 100 h.p.
" " 200 ft. " 66 in. " = 1000 h.p.

That is, the high chimney with five times the area equals ten times the power ; and while I am not sure that this proportion is right, it seems to illustrate the way the formula works. The only correct way is to calculate the number of cubic feet of gas going up the chimney at the average velocity, and the area of this column is the area of the chimney. The rate of combustion depends on the draft, and the draft depends on the height of the chimney and the temperature of the gases. The height of the stack is nearly always determined by the surroundings, as the stack must of necessity be above any buildings or hills, and I might say that the average stack is higher than is necessary. However, when there are no buildings or hills, the following formula will establish the height. This is known as Gale's formula :

$$= H\frac{120}{T}\left(\frac{F}{g}\right)^2$$

After getting the height, the area may be obtained by Kent's formula, which is : $A = \frac{.06F.}{\sqrt{H}}$ In this rule the effective area is obtained and is two inches less all round than the actual area. This two inches is to make up the friction of shaft. We now have area of chimney and height of it. I might say that experience has shown that to burn hard screenings requires 175 feet stack, for buckwheat 150 feet, and for soft coal 80 to 100 feet. This is a pretty fair basis to start from. We will suppose our chimney is, say, 100 feet high and 40 square feet area. It looks a simple matter to construct a stack having this information, and so it is, only you must go about it in the right way. To continue your calculations after getting the size, you start at the top and work down. Authorities say that a chimney having a flue over five feet in diameter shall be 1½ brick thick at the top ; from three to five feet in diameter, one brick ; and under three feet, half a brick. A chimney five feet or over would have this size for the first 25 feet down and would increase ½ brick for each 25 feet. This, according to calculations, is almost too much. It can run 30 to 40 feet each stage, but will depend on kind of material, that is, whether hard or soft brick, and whether built in cement or lime ; 30 to 40 feet will work with good material and workmanship. Having laid out the different thicknesses of wall, and knowing the batter, which varies with different builders and conditions from 1/16 to ⅜ of 1 inch, having this you can get the weight of shaft or chimney proper. In large chimneys it is usually specified what they shall weigh per cubic foot. After getting weight you can decide how much bearing surface you will require for the kind of soil you have at the foundation. Various bearing powers of soil are given as follows : Hard rock, native bed, 100 tons sq. foot ; clay, dry, 4 to 6 ; moderate dry, 2 to 4 ; soft, 1 to 2 ; gravel and coarse sand, 8 to 10 ; sand compact and well cemented, 4 to 6 ; clean dry sand, 2 to 4 ; quicksand and alluvial soils, ½ to 1 ton per square foot.

When the ground is soft you would require piling or timbering, and to spread it out over a considerable surface. The weight in tons divided by bearing power of soil gives surface required. Wind pressure is also an important factor in getting the area of the base. I will not go into the rules affecting wind pressure, but experience has shown that at the base of shaft proper its diameter shall be 1/10th of height for square chimney, 1/11 for octagon, and 1/12 for round. In considering wind pressure it is usually figured at from 25 to 56 lbs., by different authorities. This must be resisted by foundation, as you can see that if the chimney rocks over with wind it will throw its entire weight on one side of foundation. In considering wind pressure it is necessary to take into account whether chimney is protected by buildings or standing in an open field. If the chimney is built into a building, windage may be almost disregarded except for piece above the roof.

There has been a great deal written and many discussions as to the merits of different shaped flues, but experience and tests have shown that a parallel flue is the best or as good as any shape. The arguments for taper flues are something like this, that the gases slow down due to cooling as they go up, and consequently they require more room, and the flue should get larger; others say that the gases cooling down contract in volume, and therefore the flue should get smaller so as to take the same shape as the column of gas. Experience has shown that both are correct The gases contract and get smaller and consequently need less room, but they also slow down in velocity, due to their greater weight and therefore need more room. In this way they just balance up and require a parallel flue. Authorities say a round parallel flue is the best for all purposes, and the nearest approach is the next best.

The chimney should be finished with a cap of some material that will stand the weather. I like cast iron best, but a cap can be moulded of Portland cement, and if the stack is for smelting work, of fire clay. These materials stand well, and if there is a ladder on the chimney they can be kept in repair. A ladder should always be built on the shaft, as it makes a means of examining it at any time, and if repairs are needed they can be done easily.

Lightning conductors are also approved and disapproved ; but if a chimney is the highest object in its vicinity it is likely to take the discharge from a storm over it, and a properly erected conductor will carry it off, although many stacks are standing without any.

* Paper read before the Canadian Association of Stationary Engineers.

PUBLICATIONS.

The Engineering News Publishing Company, of New York, have issued the second of a series of Engineering Studies, by Charles Evan Fowler, M. Am. Soc., C.E. This part is devoted to illustrations and descriptions of notable Roman stone arches.

"Progressive Carpentry" is the title of a book of 90 pages, prepared by E. D. Meloy, architect and builder, Waterbury, Conn., and published by the David Williams Co., New York. The book, which is illustrated with numerous diagrams, is chiefly devoted to describing methods of roof construction.

Mr. D. A. Hewitt, of Toronto, has prepared and published in convenient book form, skeleton specification suggestions for architects, arranged in constructional order with index. The object of the author has been to provide the architect with an easier method of collecting data required in making a specification.

USEEUL HINTS.

A correspondent writes suggesting that a patina on copper can be formed by washing it a few times with salt water. This idea occurred to him on noticing the colour of what appeared to be a small copper covered spire, facing the sea, that he saw at Brighton.

A paste with which wallpaper can be attached to wood or masonry, adhering to it firmly in spite of dampness, is prepared as usual with rye flour, to which, however, are added, after the boiling, eight grammes of good linseed oil varnish and eight and one-half grammes of turpentine to every 500 grammes.

A gallon of paint made of finely ground Venetian red mixed in oil will cover one-fourth more (and do it better) than a gallon of paint made of dry Venetian red mixed in oil. It will take much less time to put it on, will wear out less brushes, will wear longer, and hold its color better. Hence, it is perhaps cheaper, as well as better, for all parties to use the article ground in oil.

An excellent effect in burlap decoration, says the Plumber and Decorator, is to hang the burlap on the lower two-thirds of the wall, using a white wall or a large figured paper for the upper third. If the burlap is dark red or green, a black moulding gives a pleasing finishing touch, and a narrow leather gimp, studded with brass-headed tacks and run under the moulding and around the casements and foot-board is very effective.

The weight of a round chimney can be figured by multiplying the weight of a cubic unit of masonry by the contents of the separate drums or shells, each figured by the formula $C=0.7854z\,(D^2-d^2)$. In this expression D and d are the mean inner and outer diameters, z the height of the shell; the thickness of the shell is assumed to be uniform. The weight and surface of architectural additions, caps, cornices and the like are to be neglected.

To Prevent Moisture Striking Through Brick or Plastered Walls.—After a prolonged dry spell, which has given the wall a good chance to dry out, put on a good coat of oil paint, which will soak well into the bricks, then putty up the joints and all the holes that may be in the bricks with glazier's putty stained the color of your paint. When this is dry, give a second coat, not quite as oily as the first and finish off with a coat of flat brick color, or if this is undesirable with a good glossy, oil paint.

For making a sea green shingle stain, the Painters' Magazine advises the use of Prussian blue, Dutch pink and yellow ochre, all finely ground in linseed oil, thinned down to a semi-paste with boiled linseed oil and liquid drier and finally reduced with benzine to proper consistency for dipping. The thinner the stain, the more will it penetrate into the wood. In place of the benzine, or, at least, in place of part of the benzine, creosote or coal tar naphtha may be employed to preserve the wood and prevent fungus growth.

M. Letorey, a French architect, has applied the captive balloon to the cleaning and decorating of cupolas, high roofs, towers and monuments. The balloon can be raised or lowered from a wagon by a windlass, and it can be steadied by stays from the side of the envelope. It has two platforms, or nacelles, one on the top, the other underneath, and these communicate by a ladder up a central tube. The "balloon scaffold," as it is called, might be useful and safe in many operations, such as now require steeple-jacks, for example, the wreathing of Nelson's column, and also in wireless telegraphy as an aerial.—London Globe.

The base of all hydraulic mortars is lime or the oxide of the metal calcium. Quick-lime contains 44 parts by weight of carb. dioxide and 56 parts of oxide of calcium. In slaking 18 parts by weight of water unite with 56 parts of quicklime, making 74 parts of calcic hydrate. The process of slaking is greatly facilitated by the degree of heat generated. Hydrate of lime contains 10 per cent. to 25 per cent. alumina. It differs from quicklime in that it hardens in water and is either argillaceous or siliceous.

A Chicago man who was desirous of escaping the nerve wrecking noises of the city streets, is said to have conceived and adopted the plan of filling all cracks and apertures in the house which might admit sound with a material so constructed as to afford access to air while shutting out noise. The material which the owner says discriminates between noise and air is in the form of strips of rubber, perforated with zigzag holes. Through this the air is admitted, while the noise is softened or completely deadened, the sound waves dying out in repeated reflections in the crooked passages. These strips of rubber have been placed over all cracks around the doors and windows of the house, and two months' experience with the plan has convinced the owner, he says, of its practicability.

A NOVEL CHIMNEY.

a chimney involving some features of construction which are rather novel, at least in this country, says Carpentry and Building, is the one which has been erected in connection with the new power plant of the Joseph Dixon Crucible Company, at Jersey City, N. J. The chimney is built of radially moulded bricks perforated in such a way as to insure regularity of draft by preventing radiation through the walls and thus diminishing the susceptibility to atmospheric changes. The bricks are moulded in sizes and shapes of sufficient number for the construction of a chimney of any diameter, and of conforming decreasing radius to the progress of the structural elevation. The perforations are intended not only to form dead air spaces, but also to give a better hold to the mortar, and, it is said, to increase the joint adhesion.

According to tests made, the crushing resistance of perforated brick and unperforated brick, of the same material, was 5,035 and 3,978 pounds per square inch, respectively. Furthermore, as the perforated bricks are much larger than the common form, there are fewer joints.

The builder is nothing if not conservative. A firm in the North which is supplying a customer with bricks, recently overheard the following conversation on the carman coming into the yard. "Are you still carting common bricks from Mr. Blank ?" "No ! They had no common bricks in stock, so we are fetching best for the insides and coming here for commons to face them with !"—British Clayworker.

Owing to the high prices of ebony, manufacturers have been searching for a long time for a substitute with a grain close enough to take the necessary polish. At last it was found that American " dogwood " could be stained, oiled, and polished until it equalled ebony both in appearance and utility. The wood, which comes in all sizes, is sawn into strips 1 inch square and 8 to 20 inches long. The strips are piled up out of doors, where they remain until thoroughly seasoned.

A NEW FIRE PROOF MATERIAL.

A new fire proof substance, called gypsine, has recently been officially tested in England with remarkable results, according to reports from that country. Its composition is plastic hydraulic lime, coke or sand and asbestos, compressed into bricks. To test its fire resisting properties a partition 10 feet long by 7 feet 9 inches wide was built of gypsine bricks laid in hydraulic mortar, with joints ¼ inch thick. The side of this partition, which was erected in the test hut, after having been coated with a thin layer of fire clay, was exposed to the action of fire for the space of one hour, during which time the temperature rose to 2,050 degrees F. This tremendous heat was powerless against the gypsine bricks, and all through the test the temperature of the outer surface of the partition was never once so high as to cause a match to ignite upon it.

NEW BUILDING MATERIAL.

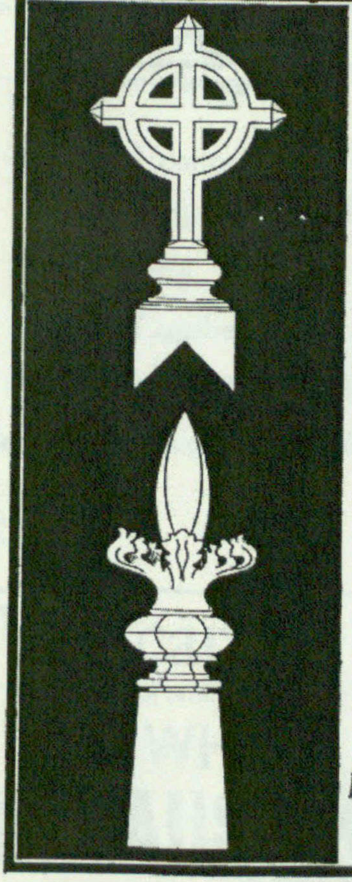
An asphalted pasteboard from Norway and a wood aud paper board from Sweden are new building materials of great probable usefulness. The first is made by compressing together several layers of heavy paper and asphaltum, the product being a smooth, solid plate, which is as strong as wood, and cheaper, which will not crack or rot and which is adapted for walls and ceil ng, for panels and for many other purposes. The second material is a board having a central laye closely fitted bits of wood, with a layer of cement and an outer layer of paper on each side. The p has been compressed and made waterproof. The boards are made 4 feet wide and 8 to 18 long, and are adapted not only for the interior lining of houses, but for making trunks, boxes, tables, and other light articles. The boards can be polished or painted.—Improvement Bulletin.

FORESHORTENING IN DRAWING.

As perspective has been defined to be the art of foreshortening objects, foreshortening may be explained as linear perspective applied to the human figure, this being the principal case which admits of striking perspective effect in such objects, because when, as for the most part happens, the limbs are beheld in their full, or nearly their full, extent, let the attitude be what it may, the outline is little affected by mere perspective; consequently, except in ceiling-pieces, where the figures are supposed to be above the spectator and seen from below the plane on which they stand, foreshortening—at least any considerable degree of it—is rarely required in delineating the human figure; while on the other hand it occurs more or less in almost all those of animals, their forms being more compounded and their bodies placed horizontally. An example of foreshortening may therefore at any time be obtained by standing either in front of or behind a horse, when the hind or fore-legs, as the case may be, will be nearly concealed by those towards the eye, and the back of the animal or its length be no longer visible. In sculpture, unless it be in reliefs, the foreshortening of the limbs depends entirely upon the station chosen by the spectator himself, whereas in painting it depends upon that chosen by the painter for him.

The solicitor of the Toronto Public School Board has stated that it is illegal for the board to expend money for marking with tablets historical spots as requested by the Canadian Club.

The First Methodist church, which has recently been completed at Los Angeles, Cal., embodies in its construction a number of interesting features, one of which is a canvas ceiling. The idea of using this material for such a purpose suggested itself to John Austin, of the firm of Austin & Skilling, the architects who drew the plans and superintended the construction of the building. The ceiling rises in a great dome broken by ornamental trusses and is daintily frescoed in soft colors, presenting a very pleasing appearance. In executing the work No. 6 tenting canvas was used, it being painted on one side and sized on the other, the frescoing thus making it thoroughly water proof and air tight. There are many advantages claimed for a canvas ceiling, some of which are its lightness and cheapness, the absence of danger of cracking and of sections falling by reason of becoming loose through vibration.



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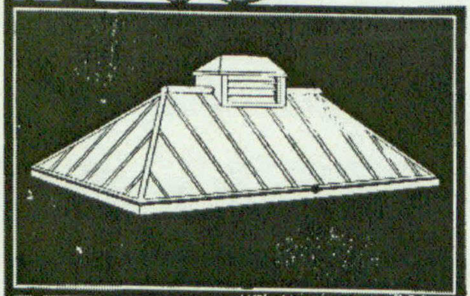

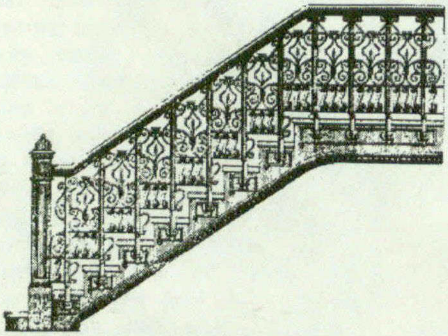

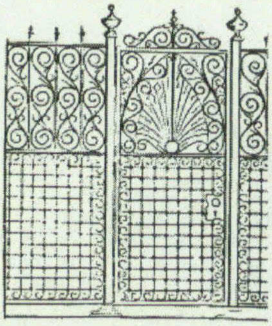

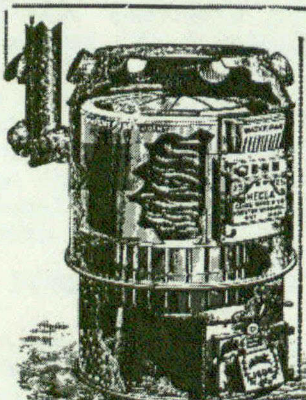

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