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THE DESTRUCTION OF HOUSE REFUSE BY INCINERATION.

By RAY R. KNIGHT, A.M., Can. Soc. C.E., Etc.

The question of the sanitary disposition of house refuse is one which is exercising the minds of those in civic control of the large cities throughout this country at the present time, and it is a problem which demands the closest attention and most active administration in order to lessen the rate of typhoid and other diseases.

The common house refuse dump is the germinating centre of the house fly, and the house fly is the most serious carrier of the germs of diseases such as typhoid, tuberculosis, infantile diarrhoea, etc.

To quote from a circular recently issued by the Department of Agriculture, Canada:

"House flies breed in such decaying and fermenting matter as kitchen refuse and garbage. . . . All such refuse should be burned or buried within a few days, but at once if possible. . . ."

The burying of refuse is a proposition which cannot be entertained by the larger cities, as large areas of ground would be necessary for this purpose, so that the city has to prepare for burning its refuse.

To effect this the incinerator or refuse destructor is requisitioned.

Before getting into the subject real of this article it will be necessary to define the term house refuse and to subdivide it so as to agree with the general practice in Canada.

The term "house refuse" is an "old country" one, including as it does the whole of the refuse from an inhabited dwelling, excepting faecal matter.

Strictly speaking such items as slaughter house offal, dead animals, street sweepings, trade refuse, and industrial wastes are not included.

In Canada, where American terms have become general, these matters are divided under three heads, viz.: Garbage, rubbish and ashes. These are generally held to include the following:

"Garbage" includes all refuse of an organic nature, consisting of food wastes or swill.

"Rubbish" includes all combustible matter, such as paper, wood, rags, leather and house sweepings, also glass, iron, crockery, and such like.

"Ashes" includes household fire, kitchen fire, and heating furnace ashes. (Factory, industrial or boiler ashes are not included.)

Items not included are faecal matter, slaughter house offal, dead animals, street sweepings, and sewage sludge.

The matters which come under the head of "garbage" are those which give rise to insanitary conditions. Rubbish and ashes do not offend in this respect, so that the question before the engineer is really the disposal of "garbage" by incineration. The first question to decide in the formation of a scheme for house refuse disposal is that of subdivision of the matter. Garbage has to be burnt, rubbish may either be burnt or dumped, and ashes may be required to assist in the combustion of the garbage or may be entirely dumped. Probably the best method to adopt is to burn all garbage and rubbish, and dump all ashes excepting a certain amount required for assistance in combustion. Such a plan would require the division of the receptacles at the house into two compartments, one for garbage and rubbish, the other for ashes.

The matter of division, however, becomes somewhat altered where power is to be developed at the incinerator plant, as in this instance it is essential to have the ashes incorporated with the garbage and rubbish. Whether the whole or only part of the ashes are required to produce high temperatures is a question which has no general solution, but which must be decided upon investigation. The fine ash dust is however of very little value as a fuel, so that it would be necessary to screen the ashes and use only the larger.

The incinerator plant which will be discussed in this article will include the boiler and its appurtenances for the production of power.

Having arrived at some conclusion (as definite as can be with regard to the changeable characteristics of the material to be dealt with) as to the necessary subdivision, the question of quantity has to be decided.

Canadian households produce far more house refuse than those in the "old country." This is probably due to the absence of open fires which would receive and destroy a good amount of waste and also to the fact that thrift is less practical here. Be the cause what it may, the quantities given in data furnished by English cities are of no use to the engineer designing a plant in Canada.

An instance of this may be cited. In England a town of 36,000 people produces about 66 to 75 cubic yards of refuse (garbage, rubbish and ashes) per day, whereas in Westmount, Que., the population is 18,000 (half the population) and the production is between 80 and 103 cubic yards per day. An average for the large American cities is 57.7 cubic yards per day for a population of 18,000. These comparisons are given not so much as guides for the engineer but to warn him that it is essential to ascertain the amount of refuse the town or city produces actually.

In spite of the fact that quantities of house refuse vary considerably as between different towns or cities, the general composition remains reasonably constant, so that data as to the calorific value can be applied (within certain limits) to the design of furnaces and boilers for generating certain powers.

It will be noticed that quantities of house refuse are given in cubic yards in this article. This is not general, but would seem to be the better method of measuring owing to the excessive variations in weight. It will be necessary, however, to reduce cubic yards to tons when the amount of power that can be generated has to be ascertained. For this purpose the following weights have been taken:

	Lbs. per cub. yd.
Garbage	1,250
Ashes	1,500
Rubbish	300

Refuse composed of 14 per cent. garbage, 56 per cent. of ashes, and 30 per cent. of rubbish by volume is assumed to weigh 1,100 lbs. per cubic yard.

The calorific value of house refuse, garbage, ashes and rubbish, is of course a variable quantity, but it is usually considered for estimating purposes that 1 lb. of refuse will evaporate one pound of water from and at 212 deg. F. One pound of good steam coal will evaporate 8 to 10 lbs. of water from and at 212 deg. F. The dominating principle, however, in the design of an incinerator plant is the complete destruction of everything, solid and gaseous, and not the production of power, and to do this a temperature of at least 1,250 deg. F. must be constantly maintained, as at this temperature it has been ascertained that gases are rendered innocuous. Higher temperatures, however, should be aimed at, and a temperature of at least 2,000 deg. F. should be maintained in the combustion flue. This, of course, has to be accomplished with the aid of forced draught. For many years the steam jet was used in connection with refuse destructor furnaces, air being forced by the steam through the fire bars, water gas effect being produced and two highly combustible gases evolved, viz., hydrogen and carbon monoxide. These gases assisted in raising the temperature. The air was admitted without being heated, which was a serious drawback when moist or wet refuse had to be dealt with.

It is the general practice now to use hot air blasts in destructor furnaces, the necessary power being provided either by positive blowers or fans. Steam in just sufficient quantity to preserve the fire bars should be used in the forced draught.

We have, therefore, in the design of an incinerator plant to burn the matters collected and dumped at the works, produce a high temperature so as to render all gases innocuous, and provide as much power as is consistent with good results from the aesthetic and health standpoint.

In order to accomplish this the following principles have to be incorporated:

Storage of Refuse at the Incinerator.—In view of providing power for electric lighting, or for heating buildings, it is necessary in order to produce power when it is required to store some part of the day's collection of refuse upon the premises.

Storage should be made in closed receptacles. One form which has been tried in England provides for the storage of refuse in "tubs," which are stored in tiers and conveyed by overhead gear to the furnaces when required, the tubs being sealed with lids to prevent the escape of noxious gases.

The usual method, however, for storage of refuse is in a wrought iron or steel hopper. In order to prevent gases, due to decomposition, escaping, and to prevent the access of flies to the contents of the hoppers, they should be covered with hinged lids, and I would go as far as to recommend that these lids be water-sealed.

Method of Introducing Refuse into the Furnace.—The hoppers for storing refuse are best located above the furnace in such a position that the contents can be raked into a "feeding hole" in the furnaces with the least possible trouble, and as expeditiously as possible, as the length of time the furnace remains open governs the temperature of the whole plant to a large extent. The longer cold air has means of access via the "feeding hole" the cooler will become that particular furnace, and being connected with others the cooling effect will be noticed there also.

Where power is not required and a "direct feed" type of furnace used the refuse is dumped directly from the cart into the furnace.

In either case the feeding hole should be provided with a water-sealed door, in order to prevent the escape of fumes from the furnace while burning is going on. The water seal troughs in connection with the doors are kept at a constant level by a ball cock feed cistern, so that water evaporated by the heat of the furnace is replaced. While feeding or tipping refuse is proceeding it is necessary to introduce a hopper to prevent matters lodging in the trough.

Drying Hearth.—Immediately below the "feeding hole" should be located the drying hearth, upon which the refuse which is to form the next charge should remain whilst the charge is burning on the grate. Refuse contains varying quantities of moisture. Garbage contains from 60 per cent. to 80 per cent. of water. The percentage amount of water in mixed garbage, ashes and rubbish will of course depend largely upon the amount of ashes and rubbish contained. In the green vegetable season when the proportion of ash is low, the amount of moisture would reach the higher figure, while in the winter probably the lower figure would represent the percentage.

It is impossible to entirely remove this moisture on the drying hearth by the general heat of the furnace, and that reflected by the reverberatory arch, in fact only a very small amount of moisture is removed in this way. In drying refuse, gases and offensive fumes are given off, so that it is essential that the furnace be so constructed that these gases and fumes are compelled to pass over the hottest part of the fires before they can gain access to the flues.

Grate.—General practice seems to favor a sloping grate, and I have no hesitation in saying that I consider a sloping grate far in advance of the horizontal type for incinerator furnaces. The slope assists pulling down the refuse from the drying hearth and also facilitates to a very large extent the "clinkering" operation.

The essential features in the design of the fire bars are the retention of as much of the fine particles of refuse as possible and the admission of the proper amount of blast equally distributed throughout the grate area.

The type of grate bar most favored is that in which cylindrical holes are formed at the surface with conical holes at the under side. This type of bar proves very efficient for incinerator furnaces.

The front of the grate is formed by a cast iron dead plate which is placed horizontally and forms a continuous grate to the clinkering door in the front of the furnace. This plate being "dead" the actual flame does not impinge upon the front clinkering door to such an extent as if the perforated bars were continued through to the front.

Ashpit and Blast Chamber.—Below the furnace is provided an ashpit which also forms the blast chamber. The ashpit should be hermetically sealed and a pressure of 1 inch to 1½ inches of water should be maintained while burning. The

hot air conduit and steam jets are arranged to discharge at the will of the operator into this pit. The mixture of steam and hot air that serves the best purpose in burning can be ascertained.

Clinkering and Pulling Down Doors.—The operation known as "clinkering" is that of clearing the furnace of a burnt charge. As soon as the whole charge is considered thoroughly burned through, it should be drawn out, and this is done in the following manner: The blast is shut off from the particular furnace to be clinkered, and the clinkering door is elevated. The firemen with slices, pokers and rakes with long handles pull out the burnt charge in the form of clinker into barrows or tip wagons, leaving only odds and ends of incandescent or red hot pieces on the grate. The clinkering door is then lowered, and the charge from the drying hearth pulled down upon the grate through the pulling down door with long handled rake. As soon as the new charge is evenly spread about, three or four inches thick, the blast is turned on and more refuse pulled down as the fire increases in brightness until the limit (about six or seven inches of clinker' is reached, when the furnace is clinkered again.

It is essential in the operators of an incinerator plant to "charge" and "clinker" the furnaces in a regular cycle, so that the hot gases from advanced fires assist in the combustion of the gases given off from a new charge burning up.

Reverberatory Arch.—The furnace is covered by a fire-brick arch which plays a similar part to the reverberatory arch in other furnaces. This arch can be kept at a very high temperature throughout with care and expeditious handling, and the less it is cooled in process of feeding and clinkering the quicker will the fire rekindle.

Type of Furnace.—The foregoing particulars have reference only to the unit furnace, which is capable of destroying 12 to 20 cubic yards per working day of 12 hours with a grate area of about 30 square feet. In order to burn the refuse of a town or city provision has to be made for a set of furnaces. The continuous furnace as separate from the separate "cell" type has proved itself far more economical in first cost and repairs, and is the type I would recommend. By a continuous furnace type is meant the arrangement of furnace units side by side with an opening at the side connecting one with the other, so that the gases from furnace No. 1 are discharged into furnace No. 2, and these form 1 and 2 combined into No. 3, and so on. Four furnaces connected in this manner would constitute the limit, and I am of opinion that three furnaces only should be so connected. By this means the heated gases of advanced fires will materially assist fires in a less advanced stage, if proper regard is had to a cycle of operation. In the "cell" type each cell has its own flue.

Combustion Chamber.—The gases from the furnaces are discharged into a combustion chamber. This chamber has no particular shape or design, but is simply a large enclosed flue where the gases intermingle and carry on further incineration which the furnaces have left incomplete. The temperature maintained in the combustion chamber is the index of efficient burning. There should never be a less temperature than 1,500 deg. F. in this chamber, and much better results will be obtained if the temperature is kept at 1,800 to 2,000 deg. F. In the winter such a temperature is easily maintained, but in the summer it is probably only the lower temperature that can be raised. The combustion chamber also acts as a dust pocket, and mattress, slaughter house offal and dead animal, burning chamber. A large door is provided, preferably at the top for the purpose of admitting these larger articles. A door about 3 ft. 9 ins. by 3 ft. is usually found large enough to take a horse. Two outlets from this chamber are provided, the one leading to the boiler, the other to the by-pass flue. Each of these outlets should be provided with a damper to regulate the direction of the hot gases.

Boiler.—A water tube boiler with the ordinary setting and with a bridge and baffles so arranged as to direct the gases through the spaces between the tubes is usually provided in connection with incinerator plants. It is essential that a grate be provided under the boiler so that steam can be raised by a coal fire to start up the works after shutting down or after Sundays or where the power is entirely depended upon, as a stand-by. Description of the boiler and its setting is superfluous here. Superheaters and economizers may be added.

Air Regenerator.—The gases after passing through the boiler are led to the air heater. The gases if by-passed also lead to this apparatus. In the regenerator which is usually a cast-iron or steam tube arrangement of pipes so arranged as to expose the maximum amount of surface to the gases, the air for working the blasts is heated. The air is drawn from the upper parts of the building so as to take any escaped fumes or smoke, by a fan or positive blower and discharged into the regenerator and led to a concrete conduit below the furnaces. Each furnace is provided with a valve for admission of the blast. The air should be heated to from 500° to 600° Fah.

Main Flue.—After leaving the regenerator the gases are discharged into the main flue which carries them to the base of the stack.

In the main flue a dust pocket should be introduced. A right angle turn at the base of the stack with an extended flue, the floor of which is depressed about 3 feet, will answer this purpose. A door should be fitted to this pocket, for the periodical removal of dust.

Stack or Tall Chimney.—The usual remarks for furnace chimneys apply here. A stack from 60 to 100 feet high lined with fire-brick up to 60 feet is sufficient. The height of the chimney largely depends upon the aesthetic side of the question. With a good quality of garbage and a well handled plant and not too much cooling of gases for power production, a 60 ft. shaft is sufficient, but having regard to the occasional lack of care and other matters, I would suggest 100 feet as the height. A damper should be provided at the base of the stack, and for test purposes a piece of wrought iron tube should be left in, connecting with the inside of the stack.

Flues Generally.—In all flues provision must be made for expansion and contraction of the firebrick linings. Test or "peep" holes should be built into the flues at intervals for observations.

Firebrick Work.—The furnaces should be constructed of firebrick throughout. The best quality of firebrick should be used, as the varying temperatures are a severe test. Poor quality bricks will crack and fall out. Arches should be formed with radiated bricks, the taper being formed in the length of the brick. Fine ground fireclay should be used for mortar with the addition of sodium silicate in proportion of 1 to 20 by volume. The addition of fine powdered glass in proportion of three of fireclay to one of glass by volume has proved very successful in furnace building. The glass forms a flux at high temperatures and attaches itself to the bricks. The life of furnace brickwork is extended materially in this way.

The combustion flue should have a lining of best quality firebrick 9 inches thick. The boiler and all flues should be lined with firebrick (not necessarily best quality) 4½ inches

thick. The firebrick linings must not be bonded with the ordinary brickwork.

Opinion is divided as to the utility of the air space between the firebrick lining and the outside brickwork. Cheaper and better work and a more stable result after working can be obtained without the cavity, and the loss of heat being so small as to be almost negligible it would appear that the cavity could be left out. I consider work with cavities and wire bonding with 9 inch firebrick work (which is essential) costs 25 per cent. more than ordinary work, with the lining built against the outside work.

Buck stays and ties must be used to hold the furnaces and combustion chamber together. The whole should be free to "breathe" and it is essential to keep the boiler setting free from the effect of movements of other parts of the plant or strains may be set up, and injury to the tubes brought about. The whole plant should be free to expand or "breathe" as it is called.

The Cost of Incinerator Plants, and Working.—For the purpose of preparing an estimate for the erection of a destructor plant the following figures may be useful as a guide. Care should be taken however to add for local conditions and diifficulties. The prices are considered at Toronto, Ontario.

1. Two grate furnace plant with flues, hopper storage, boiler, regenerator, and chimney, capable of burning 80 cubic yards of refuse (garbage, ashes and rubbish) per day of 24 hours with 100 horse power boiler with steam fitting, $17,500.

1. Three grate ditto to burn 120 cubic yards with 150 horse power boiler, $23,500.

1. Six grate ditto to burn 240 cubic yards with two 150 horse power boilers, $39,000.

In addition to the above, prices for land, buildings, drainage, water supply, engines, dynamos, etc., auxiliary coal fed boilers, approach roads, and elevator for horse and cart where levels require it must be included.

The building should provide space for the plant which in the case of a two grate plant would be about $19' \times 24' \times 30'$ to eaves; three grate plant about, $25' \times 24' \times 30'$ to eaves; six grate plant about, $80' \times 24' \times 30'$ to eaves. There should in this building be a tipping platform, and a feeding platform. In addition a boiler house, an engine and generator house with appurtenances must be provided, also engine and fan room, bathroom, W.C. lavatory, urinal, office, store and mess room.

The total site for buildings and future extensions and clinker storage should be about 1 to 1½ acres.

The staff necessary for operating an incinerator plant apart from the generating station and auxiliary boilers for 24 hours in eight hour shifts is as follows:

Number of furnace units.	Superintendent.	Laborers on feeding platform.	Firemen clinkering fires.	Laborers removing clinker.	Laborers Cleaning and assisting in removing clinker.	Engineer for fan and engine and boiler (assisted by engineers in generating station).	Amt. of refuse burnt. Total per 24 hours.
2	1	2	2	1	1	1	80
3	1	2	3	1	1	1	120
6	1	4	6	2	2	1	240

This staff is based on the assumption that the greatest load on the plant is during eight hours from 5 p.m. to 1 a.m. and that during the remainder of the day the plant is running light. The costs of flue cleaning once a fortnight and boiler cleaning as often as is necessary, have to be added. Interest on capital, depreciation and repairs have to be included in the costs. I consider in good class work the furnaces will require renewal once in 4 years and the combustion flue once in 8 years. Odds and ends of patching will be required in the meantime. The location of an incinerator is a point which has to be left to the discretion of the engineer to do what is best under the circumstances. It may be well to point out though that a modern refuse destructor properly managed is free from any nuisance from the health standpoint. The aesthetic nuisance however has to be overcome and though a site may be good from its position, being central it is probably better to locate the works in a neighborhood where from its character the plant would not be objected to. The cost of land is also a prohibitive feature sometimes.

In a large city it will be found economical to divide the city area into subdivisions of about 3 mile radius and provide an incinerator for each area.

The cost of burning refuse without deducting for fuel saved at generating stations and including interest and principal on 30-year debentures will vary between 30 cents and 40 cents per yard cube.

CRACKED CONCRETE CHIMNEYS.

In a report dealing with the cracked concrete stack of an English manufacturing plant, Sanford E. Thompson discusses conditions and some possible remedies which are of interest to those manufacturers who are burdened with big stacks built on the unhappy principle of a dry-mixed concrete. In this particular case of the London chimney, the structure had been put up on the dry-mix plan that was in vogue some years ago. The lower third of the stack was of greater diameter than the upper portion, and in the region of the offset, and above it, there were many long vertical cracks. The internal temperature of the stack was pretty evenly maintained throughout the year by the usual operation of the power plant, and there was some leakage through the cracks from the outside. The main concern of the owners, however, was as to the stability of the stack.

Danger from shearing stresses was considered very remote, since such stresses would not reach a critical point until long vertical cracks had formed on opposite sides of the chimney; and even then, an adequate amount of horizontal reinforcement would prevent the disruption of the stack. Corrosion and consequent weakening of the reinforcing steel was considered the point of most danger, the probability of this being rather large in case of concrete mixed so dry that it did not make a perfect bond with the reinforcement. With wet-mixed concrete the reinforcing steel is usually covered with a film of cement which will for a long time prevent corrosion of the steel by gases and moisture making their way in through the cracks.

As to remedies, the placing of a fire-brick lining was considered undesirable; such a lining would protect the concrete of the stack to some extent against the heat, but as good concrete easily resists a steady temperature of 600 or 700 deg. F., there was no need of a lining on this score. Moreover, it was considered that the presence of the lining might be mischievous, through the new expansion strains which it might transmit to the concrete strucure.

Repair by placing a shell of new concrete on the outside of the stack was considered the best course to follow. It is possible in building such a reinforcing shell, to shut off all access of atmospheric gases and moisture to the reinforcing members of the original structure, and to use reinforcing steel in such a way as to make good the weaknesses that have developed in the original structure owing to cracks, or to a presumption of an insufficient bonding of the reinforcement due to too dry a mix.

REPORT OF ANNUAL MEETING OF CANADIAN SOCIETY OF CIVIL ENGINEERS.

(Continued from last week.)

Friday Morning's Session—January 26th, 1912. PRESIDENT C. H. RUST in the chair.

MR. TYE: It seems to me we are giving everybody an opportunity of discussing these reports. We are referring these reports back to the different branches for discussion, including this branch here, so that every member will have an opportunity of discussing it. The point is that you cannot discuss them here to-day. So we are giving you all a chance in this amendment of Mr. Duggan's to discuss them to your heart's desire—the Good Roads report and every other report.

MR. MARCEAU: I quite agree with Mr. Tye that these reports should be referred to the different branches for discussion and suggestions.

DR. GALBRAITH: Unfortunately for myself I did not hear Mr. Duggan's amendment very well. How is the vote on these reports to be decided?

MR. JOHN KENNEDY: While the action we have taken as regards these reports is a very good one in every respect, I have not a word to say about it, but what shall we do about the Senate matter? It has been before the Senate for some considerable time and can we do anything towards getting the bill held over or something of that sort, because the bill is very much the contrary of what I fancy the majority of engineers think to be practicable. Can we do anything in the matter? Can our council take any hand in the matter and ask that it should be held over? I am sorry I have not a proposition to make, but the case is a rather serious one, and something really ought to be done.

THE PRESIDENT: I quite agree with you, Mr. Kennedy, that it is a very drastic method, but some engineers, I believe, are rather in favor of it. I appeared personally before the Senate some two years ago, at their request, and I pointed out my opinion in connection with the matter, and I also called the attention of the City of Toronto Council to it, but they have not taken any action. In fact, a good many of the outside public generally, I think, approve of Senator Belcourt's resolution, but if the society of the whole should pass a resolution suggesting that the matter be postponed until we have had an opportunity of taking it up with the committee, it might probably be a good thing if we can do it. Mr. Chipman has been taking some interest in this matter and I would like to hear his views on it.

MR. CHIPMAN: I have read with great interest the report of the committee as they appeared in the transactions. I regret to say, however, that there are some inaccuracies in it which should not have gone to the public. With reference to the streams in the west, there was a remark made that typhoid fever was caused by the floods in the streams. Now, we all know, who have lived in that country, that typhoid fever is epidemic in many towns distant from those streams, and in those towns cited the typhoid epidemic was in sections of the city that were not served with the water supplied from the river at all.

With respect to the pollution of Lake Ontario, there is a contradictory report in that statement that Lake Ontario water is the purest on the face of the earth, and there is another statement to the effect that it is badly polluted. I don't think a report like that does any great credit to the society. Remarks of that kind, I think, should have been edited in some way by the committee before they were presented.

With respect to the city of Guelph, it is true that the city of Guelph was in trouble respecting its sewage disposal, but the facts were not all stated. The works were not properly conducted as all municipal works are at times, through the economy of the municipal council, the cause of the nuisance was due to another source altogether from the muncipality. Now, there is a greater nuisance there to-day —ten times greater from a brewery than there is from the sewage disposal works. The sewage disposal works are quite up-to-date at the present time—even enlargements have been made.

With respect to this report I think we should receive it but not adopt it, as was done last year. The chairman of the committee is not here. Mr. Kennedy and I are the only two of the committee who are present. I think we should be permitted to report again next year.

THE PRESIDENT: I want to get your ideas as to whether this meeting should take any action in regard to Senator Belcourt's bill. That is what I was referring to, which prohitits the discharge of sewage of all kinds into any body of fresh water. Mr. Kennedy suggested that the society should take some action in the matter.

MR. CHIPMAN: I don't think at the present stage we should take any action in a matter of this kind. We are all studying these problems, and I do not think there would be anything gained by taking any action in the matter at the present time.

MR. TYE: I think it would be well for the society to take some action in the matter. I think it would be well if we appointed a committee to deal with the subject, if it is necessary to appear before the Senate and guide their legislation and help them. I think that the Senate would be quite willing and in fact glad to have the services of a committee from this society. This committee should be composed of men like Mr. Chipman, who are authorities on the subject, and who could help the Senate, and I think it is part of our duty to help guide legislation on such an important subject. Our committee composed of the proper men would certainly know more about it than the members of the Senate, and I beg to move that a committee be appointed to consist of Mr. Chipman, Mr. Kennedy and Mr. Lea, to deal with this subject before the Senate, and that their expenses be paid by the society.

MR. ST. GEORGE: You would not wish the society to get the Senate to withdraw the bill for the present. You see, they have had it so many years before them now. If the society do anything to hamper them in passing legislation, they might give time to these different smaller municipalities, but it might not be advisable to stop the bill. The committee might give advice to the Senate with reference to giving certain municipalities the necessary guidance.

MR. LEOFRED: You must not forget that the Provincial Governments are now spending much money and they are appointing officers every year with a special view of studying the question and obtaining legislation which would be adopted both by the Proincial and Dominion Governments. So I think it is scarcely wise for this society to interfere in the matter. The very best medical authorities in the country are working on the matter now, and are paid by the Provincial and Dominion Governments to study the

question, and I think we are not quite in our place to go before the Senate and interfere at this moment. We are not supposed to be such great authorities in sanitary matters, and in the analysis of bacteria as connected with the pollution of rivers and streams. I do not think we have the necessary knowledge in that matter to speak before the Senate, when there are so many eminent medical men, and chemists studying the question, to improve the situation. I do not see, for my part, what the civil engineers would have to gain by adopting such legislation as would prevent cities and towns from making an outlet for their sewage system into any river. There is still a great deal of controversy on the matter, and just now the cities and towns have not got the means to exactly satisfy the provisions of this bill.

MR. ST. GEORGE: I have great pleasure in seconding Mr. Tye's motion in regard to this committee. I feel confident that the society can leave it in the hands of the men named.

MR. JAMIESON: I thoroughy agree with Mr. Tye's motion, and that it is in the right line, namely, to put this committee at the disposal of the Senate to give them advice in the matter.

MR. KEEFER: I think, Mr. President, that it is a very excellent suggestion of Mr. Tye's to have an advisory committee, and that this society should show its willingness to co-operate with the government and assist them to prevent the pollution of our rivers and streams, because, of course, that is a very serious and important matter. The only question is the manner of doing it.

THE PRESIDENT: You have heard the resolution. What is your pleasure, gentlemen?

MR. JOHN KENNEDY: It seems to me the committee is a little small.

THE PRESIDENT: I would suggest that Mr. Tye be added to that committee.

MR. CHIPMAN: I wish to put myself right before the society, before this resolution is passed. I do not wish you to understand that I oppose or was not in sympathy with Senator Belcourt's bill, but simply that I did not think we should pass any resolution advocating the passing of that bill at the present time. I am quite in sympathy in assisting him in every way, and I think there are no men in the Dominion better qualified or in a better position to assist the government than we are.

MR. TYE: I did not mean by my resolution that we should appoint this committee and bind its hands, but I meant to leave it entirely in their hands to do entirely as they thought best under the circumstances as they find them.

THE PRESIDENT: Is it your pleasure that this motion should carry?

Carried.

THE PRESIDENT: There is a letter here from Mr. Forrester. Mr. Forrester sends a letter on steel pipes.

THE SECRETARY: I wrote to Mr. Forrester and suggested that he appear at the annual meeting, and he said he could not do so.

(The letter is referred to the incoming council.)

THE SECRETARY: I have here a letter from Mr. McIntyre.

THE SECRETARY: I have a letter here from Mr. P. M. Sauder, who writes to submit a resolution.

MR. JOHN KENNEDY: It seems to me this should be referred to the Conservation Committee.

MR. MITCHELL: I move that this should be submitted to the Committee on Conservation.

Carried.

THE PRESIDENT: There is a resolution here by Mr. Leofred.

THE SECRETARY: It has been moved by Mr. Leofred, seconded by Mr. Skaife, that the council take steps so that members of the Canadian Society of Civil Engineers be exempted to serve as jurors in the courts of justice of the Province of Quebec.

MR. HOLGATE: I think it would be rather trying to ask our council to assist us to escape our duties as citizens, and try to avoid matters of this kind. I do not think the society should take this matter into serious consideration.

MR. LEOFRED: It seems to me we should take some action in this matter, because all professional men practically are exempted from serving as jurors. The land surveyors are exempt, and I believe even dentists are exempt, and therefore I think engineers should be exempted.

MR. HOLGATE: If all juries were composed of engineers, I think we would have much better decisions.

THE PRESIDENT: Is this a Provincial matter or a Dominion matter?

VOICES: It is a Provincial matter.

THE PRESIDENT: Well, it seems to me we should let the Quebec branch deal with this matter.

MR. ST. GEORGE: I move with the approval of the annual meeting that this motion be referred to the local branch of Quebec as it is a provincial matter and they can do as they like about it.

MR. PARENT: Mr. Chairman, if this matter is to be submitted to the Quebec Branch, will we have the sympathy of this society? It is not only necessary that we have the approval of the society, but that we have its sympathy.

MR. TYE: I am very much in sympathy with what Mr. Holgate said. I don't think we should set an example of trying to shirk our duty, as citizens. I think the standard of juries should be raised, and not debased.

THE PRESIDENT: What is your pleasure, gentlemen?

(On a standing vote the president declared the motion lost.)

THE PRESIDENT: The next order of business is the reception of the reports of the scrutineers.

MR. MACKENZIE: May I ask a question?

THE PRESIDENT: Certainly.

MR. MACKENZIE: Is there any committee in existence now under which this subject would probably come—the disintegration of concrete surfaces in the intertidal space in sea water? If not, then I think the time has come when we should have a committee who would look especially into this matter. It is a fact with which we are not all acquainted, and there may be some difference of opinion upon it.

MR. JAMIESON: I think our committee on cement and concrete specifications have power to deal with this matter, and we have accummulated a large amount of data and information on this subject, but we have not yet been able to get sufficient definite information to make any report on it.

MR. JOHN KENNEDY: I agree with Mr. Mackenzie that it is a subject of the very greatest importance, and if that committee is not competent to deal with it—I mean if it is not within its powers—then some committee ought to be appointed.

MR. MACKENZIE: I think there is not any more important matter in the engineering profession in this country than this very subject, and the committee, I believe, must have had that power for some years, and so far as I can find out not very much has been done of a nature that would assist the engineers who are building such structures.

In the United States the engineers there—those who are working along the sea coast—have very definite ideas, so much so that they have abandoned the use of concrete in sea water to a large extent, and are using stone instead.

MR. JAMIESON: I may say in regard to the remarks of the last speaker that this is a comparatively new question, and that there are extensive tests being made in Germany

now, and the Scandinavian Committee composed of engineers and cement manufacturers, are now conducting a long-term test on this same subject, and also a great deal of work is being done in the United States. We must rely a good deal on that and get the result of all their tests, as far as possible, which we have been doing, and I think I have got all the data on that subject to date. By next year we will be able to do something definite.

MR. MACKENZIE: I beg to say that there is data scattered over this country which has not been collected; there is data scattered over this country which can be seen and the results noted. So far as I know, it has not been as yet.

MR. LEOFRED: I move that Mr. Mackenzie be added to the committee of the study and effect of sea water on cement work.

MR. JAMIESON: The committee already has power to add to its numbers, but we would be very glad to add Mr. Mackenzie to that committee.

THE PRESIDENT: The next order of business is the reception of reports of scrutineers on by-laws.

THE PRESIDENT: The next order of business is the report of the ballot for the election of members.

THE SECRETARY: I want to call the attention of the meeting to a little informality in regard to this. Mr. McAllister, who acted as the chairman of this committee, was not elected as the chairman. The gentleman who was elected did not report, and perhaps the society was out of session before it was noted that the chairman was not attending to business. A substitute had to be got for him, and Mr. McAllister acted as substitute. Perhaps the meeting would confirm the appointment of Mr. McAllister.

Carried.

THE PRESIDENT: I have much pleasure in declaring these gentlemen elected for the coming year, and I would ask the new president, Mr. Tye, to take the chair.

(The new president, Mr. Tye, here took the chair, amidst applause.)

MR. TYE: Gentlemen, I wish to thank you very much for your kind reception. I can only hope that you will be as well pleased when the year is over. (Applause.)

THE SECRETARY:. Mr. President, the matter of the election of a Nominating Committee is one that is always dealt with under the by-laws by this meeting, and the mode of procedure under the by-laws is suggested by council. The mode of procedure which the council has adopted for the last two years is to request the branches to suggest two names at least for each office, and the annual meeting selects that one which commends itself. That provides for districts 3, 4, 5, 6, and 7. The recommendation with regard to district No. 1, which is the headquarters, has been made during the last two years by the local members of the council. Recommendation has also been made by the same local members of the council for district No. 2, which is the lower provinces and in which there is no branch. I have recommendations under that method for all the districts except the Quebec Branch No. 3, I understand that representatives of the Quebec Branch are prepared to make a nomination.

For District No. 1 I have one name only, that of J. L. Allan. For District No. 2 I have the nomination of Mr. R. S. Lee. For District No. 4, Mr. James White. The Ottawa branch sent only one name. For District No. 5 I think Mr. Haultain is prepared to make a nomination. He verbally gave me the name of Mr. T. C. Irving, Jr. For District No. 6 Mr. Frank Lea and Mr. E. P. Fetherstonhaugh. For District No. 7 Mr. J. C. Kennedy, Mr. E. C. Cartwright and Mr. H. L. Deutcher.

THE PRESIDENT: Is it your pleasure that you make any additional nomination to District No. 1?

MR. JAMIESON: Is it in order now to discuss this question? This does not seem a satisfactory way of proceeding, and it does not seem to give satisfactory results inasmuch as there has not been the full number nominated. Why not adopt the procedure of the American Society, which is to send out a paper for suggestions from all the members in each of the districts, and whoever has the greatest number of votes is usually appointed?

THE SECRETARY: That is done, Mr. Jamieson.

MR. JAMIESON: Well, over on the other side these papers are sent out and they prove very satisfactory. It gives every member of the society an opportunity to suggest for the Nominating Committee, and we must not lose sight of the fact that the Nominating Committee should be very carefully selected and every member of the society ought to be given a voice in the selection. It is essentially a point where they ought to have a say, because from that time on they do not have any say.

I would move, if it is in order to make a motion now, that this society adopt the same procedure as the American Society in regard to the Nominating Committee.

MR. SHANLY: I would like to say a word on the subject. If I remember rightly there was a time in this society when we used to send out circulars to all the members at the same time that the ballots went out, asking them for nominations for the Nominating Committee. The result, as I remember it, was if a man got half a dozen votes he might be elected. I remember I was proposed as a member of the Nominating Committee for one of the outlying districts, and there were, I suppose, a dozen other names submitted, each of them having one vote. I myself and one other member had two votes, and the tie was left to the decision of the annual meeting, and I was elected, I suppose, because I happened to be present. Therefore, I actually represented only two members of the society on that Nominating Committee. Now, if we send out ballots, as Mr. Jamieson suggests, it seems to me we will have the same trouble over again. We will have any number of names suggested and none of them will have an important majority.

MR. JAMIESON: Well, while that is true in the past, that is not necessarily true to-day. Conditions have very materially changed. It is, of course, up to the members themselves. Of course, if the members do not feel disposed to have a voice in the matter, very well and good, but this system is working well in the United States and they do get in larger returns. They get in a very large vote, and now the members are taking a great deal of interest in it, because it was satisfactory in the past. It was not the same procedure as I am proposing now, and the old, unsatisfactory system does not mean that the present one will be unsatisfactory.

THE PRESIDENT: Is it not more satisfactory to leave it to the branches and let them decide on whom they want?

MR. SHANLY: The trouble is we get a scattered vote. Each man votes independently.

MR. JAMIESON: Well, it will be representative, anyway.

MR. SHANLY: Under the present system the selection of the members nominated is left, as largely as possible, to the local branches. They are supposed to be in touch with their own members, and they can discuss the matter among themselves and send in a ballot which will represent the majority of their members. On the other hand, when each member votes independently you cannot get a majority.

MR. JAMIESON: That is exactly what I propose now.

THE PRESIDENT: And each district attends to their own part of the business themselves. Why should the council do that? Why not leave it to the branches? Then

the branches feel that they are represented, and that nobody else is interfering.

MR. JAMIESON: The American Society finds it very satisfactory, anyway.

MR. JOHN KENNEDY: Is there a branch in every district?

THE SECRETARY: Except at headquarters, and the lower provinces are without a branch. All the others are covered. In fact, in one district there are two branches.

MR. MYERS: I second the motion.

THE PRESIDENT: The business before this meeting now is the election of a representative for district No. 1.

MR. JAMIESON: Well, I asked if I was in order.

THE PRESIDENT: Well, I don't think it is in order at the present time. Has anybody else any other names to suggest?

THE SECRETARY: Mr. J. L. Allen is the representative for district No. 2. I am sorry there was an error.

THE PRESIDENT: Well, have you any other names to suggest for district No. 2, in addition to that of Mr. J. L. Allen? Is it your pleasure that Mr. J. L. Allen be the member for district No. 2?

Carried.

THE PRESIDENT: Now, for district No. 1, Mr. R. S. Lea.

Carried.

THE PRESIDENT: For district No. 3.

MR. PARENT: I am authorized by the Quebec branch to propose the name of Mr. E. A. Hoar.

Carried.

THE PRESIDENT: For district No. 4, Mr. James White has been suggested.

Carried.

THE PRESIDENT: For district No. 5?

MR. RUST: I move that Mr. T. C. Irving, Jr., be appointed.

Carried.

THE PRESIDENT: For the Manitoba district—district No. 6—the name of Mr. Frank Lea, and Mr. Fetherstonhaugh are suggested.

MR. LeGRAND: I beg to move that Mr. Frank Lea be appointed.

THE PRESIDENT: All in favor of Mr. Frank Lea please stand up.

Carried unanimously.

THE PRESIDENT: For district No. 7, the Vancouver branch, the names of Mr. J. C. Kennedy, Mr. C. E. Cartwright and Mr. H. L. Deutcher have been suggested.

THE SECRETARY: Mr. Cartwright is not eligible.

THE PRESIDENT: Very well, all in favor of Mr. J. C. Kennedy will please stand up.

Carried.

THE PRESIDENT: The only other business are votes of thanks to the railways of the Eastern Passenger Association, the Canadian Pacific Railway, the Montreal Tramways Company, the Dominion Bridge Company, the Canada Car Company, the McGill University and Doctor Barnes.

MR. MONSARRAT: I have very much pleasure in moving a hearty vote of thanks to be offered to these various companies and institutions and to Doctor Barnes.

MR. LeGRAND: I second the motion.

Carried unanimously, amidst applause.

MR. JAMIESON: Might I ask to put my motion that the Nominating Committee should be elected by ballot by the members at large from each district—that the members in each district should vote by ballot on their nominee for the Nominating Committee? In other words, that the secretary of each district should suggest the names.

THE PRESIDENT: Is not that an amendment to the by-laws?

MR. JAMIESON: Yes, I presume that would mean an amendment to the by-laws.

THE PRESIDENT: I am afraid that your motion is not in order at the moment. You will have to give notice of your motion before the first of October, so that it might be brought up at the next annual meeting.

MR. KEEFER: There is one motion I would like to make, and that I have very great pleasure in making, and that is, to thank the retiring officers of the society for the very able manner in which they have discharged their duties.

Carried, amidst applause.

MR. RUST: Mr. President, and gentlemen, on behalf of the retiring officers and myself, I wish to thank you very much for the kind way in which this vote has been proposed. We did the best we could, and that is about all I have to say.

MR. LINDSAY: I feel, as one of the visiting members, that I voice the sentiment of all of the visiting members in expressing our appreciation of the kindness extended to us by the Montreal members. As an Irishman, I suppose I wear my heart on my sleeve, but I am sure you have all made us very much at home here, and I assure you I appreciate it very much.

MR. LeGRAND: As a good Frenchman, I second the motion.

THE PRESIDENT: I declare the meeting adjourned.

THE DESIGN OF TALL CHIMNEYS.

(Continued from last issue.)

Prussian Government Rules.—In April, 1902, the Prussian Government issued regulations for the construction of chimney stacks. Square stacks to be designed for a wind pressure of 25½ lb. per square foot, with the centre of pressure at the centre of gravity of diametral vertical plane. Octagonal stacks 71 per cent. of the above pressure, and circular stacks 67 per cent.—Engineering Record.

Thickness of Brickwork.—Up to 150 ft. high, or 5 ft. inside diameter, the top length is generally one brick (9 in.) thick; above that height or diameter, the top length should be one and a half bricks thick, and the thickness should be increased by a 4½-in. set-off at every 20 ft. below the top. The outlet at top, and the throat or internal diameter at each set-off, should be of the calculated size to give the necessary area plus allowance for friction. Sometimes one hears it recommended that the top of the chimney should be contracted, to cause the expulsion of the gases at a greater velocity, and so to prevent down draught. It is said also that as the gases cool in their passage up the chimney they require a smaller sectional area to keep the velocity uniform. In general no attention is paid to either of these theories, and the section is kept as uniform as the other requirements will permit.

Batter.—If the diameter of the throat is kept uniform, and a 4½-in. set-off occurs at every 20 ft., the intermediate portions being of uniform thickness, a batter of 1 in 53.33 will be given, but the London County Council insist on a minimum batter of 1 in 48 = 2½ in. in 10 ft., and, besides that, it will be requisite in most cases to provide a firebrick lining for at least the bottom 15 ft. or 20 ft., having a thickness of 4½ in. and a clear space from the outer brickwork of 1½ in. to 2 in., necessitating a still greater batter.

Chimney Cap.—The chimney cap or cornice, by the London County Council rules, must not project more than the thickness of the brickwork upon which it rests. It may be of cast-iron castings, bolted together and filled with brick-

work, or of granite or other good weathering stone, the separate blocks being cramped together with galvanized iron cramps, or with an iron hoop sunk into the top and protected with cement, or of brickwork in cement.

Diameter at Base.—There is also an important rule of the London County Council which says: "The width of a shaft at the base, if square on plan, must be at least one-tenth, and if circular on plan, at least one-twelfth of the total height"

Firebrick Lining.—The firebrick lining must be entirely self-supporting, and have a clear space behind to allow for expansion and contraction independently of the main structure, which would be prevented if dirt and dust were to get behind it. It is therefore necessary to cover the top of the space by an over-sailing course of bricks built out from the inside of the main shaft, protecting the space, but allowing a clearance above the lining of ⅛ in. for every 5 ft. of its height, to permit of its expansion when heated. The average height of this lining is one-fifth height of shaft + 10 ft. A common height is 20 ft., and thickness 4½ in.; when of greater height it is necessary to make the lower part 9 in. thick. No air bricks should be inserted in the outer wall, as is sometimes done with the idea of cooling the air space, any such openings being very detrimental to the draught. The only possible inlet for air to the chimney shaft should be through the fire-bars or over the surface of the incandescent fuel.

The smoke inspectors of the London County Council have lately recommended openings into the chimney shafts near the bottom to reduce the smoke nuisance. The real effect is to dilute the smoke with air before it reaches the chimney top, so that it is not so black when expelled, but it does not reduce the actual amount of carbon emitted except so far as it tends to spoil the draught and so reduce the fuel consumption and boiler efficiency.

Stability.—Having drawn out the vertical section to suit the conditions, it will be essential to test the stability by calculation, but this is a somewhat complex matter and requires some preliminary data that will now be dealt with.

Materials and Weight.—The weight of each portion of the shaft—i.e., between each set-off—should be obtained separately so that the figures can be used singly or together. The weight will depend very much upon the material. Many chimney shafts are built of ordinary stock bricks and ground stone-lime mortar, and may be taken at 112 lb. per cubic foot. Others are built of solid machine-pressed bricks, and lias-lime mortar, and may be taken at 126 lb. per cubic foot. Some builders prefer perforated radial bricks and Portland cement mortar, weighing, say, about 100 lb. per cubic foot. Others consider that cement is too unyielding and that a shaft has greater ultimate stability if it sways lightly in a gale, which they fear the use of cement mortar might prevent. The bond usually adopted is one course of headers to four courses of stretchers, but sometimes tall chimneys are built in English bond, and occasionally in all headers.

The 450-ft. chimney at St. Rollox, Glasgow, is built in old English bond. The 300-ft. chimney at Johnson's Cement Works, Greenhithe, is built in Flemish bond. At Gosling's Cement Works, Northfleet, a 220-ft. chimney is built in stretching bond. At Barker's brick works, Worcester, the 160-ft. chimney is built with three stretchers, to one header. At the Surrey Commercial Docks, the 110-ft. chimney is constructed with all headers on the circular face. For the 100-ft. chimney at Farringdon Street Goods Station, Beart's patent perforated radiating bricks were used in the circular shaft, laid all headers on external face.

Hoop iron, galvanized or painted with cement wash, may be inserted at intervals of 5 ft. in height. The work should not be carried up too quickly, 3 ft. per day being quite sufficient unless the work is in cement.

The solid contents C of any portion of a circular shaft, having bottom outside diameter in feet D, top outside diameter d, uniform thickness t, and height h will be

$$C = \pi t h \left(\frac{D + d + \sqrt{Dd}}{3} - t \right)$$

and the weight will be C × weight of 1 cub. ft. of the material.

Safe Load on Material.—Assuming best workmanship and material, the maximum safe load may be taken as follows, being about 50 per cent. higher than would be allowed for live loads or inferior conditions.

	Tons per ft. super.
	Compression.
Granite	25
Portland and compact limestone	20
Hard York stone	15
Blue brick in cement	12
Stock brick in cement	10
Stock brick in lias mortar	8
Stock brick in grey lime mortar	6
Cement concrete 6 to 1	9
Deep clay (foundations not less than 10 ft. from surface), gravel and compact earth	3
Made ground rammed in layers	1½
	Tension.
Grey lime mortar (1 to 2)	1.0
Lias lime mortar (1 to 2)	1.5
Portland cement mortar (1 to 3)	2.0

Foundation.—It is important to note that a tall chimney should stand on an independent foundation, in order that the settlement or compression of the soil may be uniform. When a chimney is built close alongside a boiler-house, or within the four walls of a warehouse, it is sometimes placed on an extension of the other foundations and bonded in with other work, but this invariably leads to unequal settlement and subsequent cracks in the brickwork. It is evident that an ideal site would be on virgin soil of uniform character, preferably firm gravel, and not over old excavations or a filled-in water-course, or over old shaft workings, although all these positions have been adopted from carelessness or necessity.

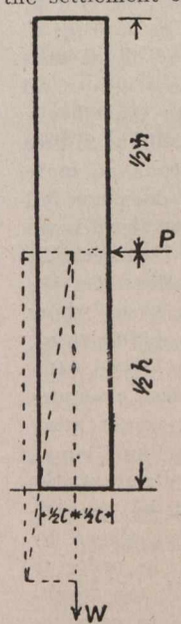

Fig. 6. Resultant of Thrust.

Principles of Stability.—The principles of stability can best be illustrated by taking a solid square brick pier, say 3 ft. square and 30 ft. high, weighing 1 cwt. per cubic foot. The total weight will be $3 \times 3 \times 30 \times 1 = 270$ cwt., the area of base $3 \times 3 = 9$ sq. ft., the mean pressure on base $\frac{270}{s} = 30$ cwt. per square foot. The resultant of the weight of all the parts passes vertically through the centre of gravity of the mass and cuts the centre of the base. If the wind be assumed to blow horizontally against one side the effect will be collected at the centre of the face and act with a leverage of half the height, as shown in Fig. 6, and the resultant of the two forces P and W will gradually approach the outer edge of the base as the wind pressure increases. Assuming that the pier could overturn on the outer edge as a fulcrum, without crushing, we have a case of simple leverage,

$W \times \frac{1}{2}t = P \times \frac{1}{2}h$, or $P = W\frac{t}{h} = 270 \times \frac{3}{30} = 27$ cwt., and as P is made up of $3 \times 30 \times p$, we have $p = \frac{27}{3 \times 30} = 0.3$ cwt. or 33.6 lb. per square foot.

Graphically the resultant will pass through the extremity of the base, as shown by dotted lines. Now, this is simple, but it is not true; the brickwork on the extreme edge would crush, and the pier would therefore overturn with a somewhat lower pressure. In practice we do not want our structures to overturn, and in order that they shall be safe when first built, we cannot allow any tensile stress on the inner edge. We therefore want to find what position the resultant must occupy for the pressure on inner edge to be reduced to zero. It will be observed that the wind, being a horizontal force, cannot add anything to the vertical force due to the weight of the structure, but it can increase the intensity of the pressure on a part of the base by forcing the resultant over towards one side and so altering the distribution. While the resultant is in the centre of base the pressure is uniform, as shown by the ordinates in Fig. 7, and as the resultant travels over to one side the pressure increases at one edge and diminishes at the other, as in Fig. 8, until finally the ordinates form a triangle, as in Fig. 9. This occurs in a rectangular base when the resultant falls at the extremity of the middle third, and is the origin of all false notions with regard to the efficacy of the middle third. The resultant falling within the middle third means no more than that the pressure then does not fall below zero on the inner edge; there is no guarantee that it may not be exceeding the safe load on the outer edge. On the other hand, there are many cases where the resultant falls beyond the middle third, and the structure is still only loaded within safe limits. In each of these examples the area of the shaded part, representing the forces of reaction, will be found equal, and it follows as a necessity that the maximum pressure indicated by the triangular Fig. 9 is double that shown by the parallelogram Fig. 7. In order to find the wind pressure to limit the resultant to this position we have to consider the altered leverage of the resistance; the weight of wall acting through its centre of gravity, Fig. 10, has now only a distance of $\frac{1}{6}t$ to the resultant, or centre of reaction, which is the virtual fulcrum; we therefore have the equation.

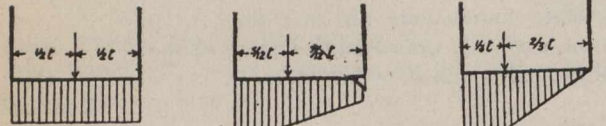

Fig. 7. Fig. 8. Fig. 9.

Resultant of Thrust: Reaction According to Position of Resultant.

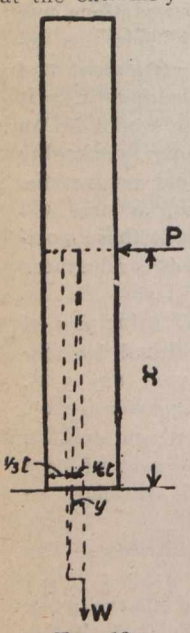

Fig. 10. **Resultant of Thrust.**

$W \times \frac{1}{6}t = P \times \frac{1}{2}h$ whence $P = \frac{W \times \frac{1}{6}t}{\frac{1}{2}h} = \frac{Wt}{3h} = \frac{270 \times 3}{3 \times 30} = 9$ cwt., and $p = \frac{9}{3 \times 30} = 0.1$ cwt. $= 11.2$ lb. per square foot.

as the maximum wind pressure instead of 33.6 lb., as found for simple overturning. This will produce a maximum intensity of pressure upon the base of $30 \times 2 = 60$ cwt. $= 3$ tons per square foot, which is below the safe limit, but we cannot increase it without reducing the pressure below zero on the inner edge, and although this might under certain circumstances be permissible, it is not generally considered desirable in the case of tall chimneys.

It will be well to use this illustration of a solid pier a little longer while we consider another point. Referring to the last figure, we can put the result another way. Making a plan of the base, as in Fig. 11, we can draw a triangle inside as shown by the ordinates, or shading lines, and if the base of the triangle represent the maximum pressure, then the ordinates show how the pressure reduces towards the inner edge. But we may look at it from another point of view, by assuming all the energy of resistance to be taken up by the particles within the triangle, so that they are all exerting the same pressure, while those outside the triangle are exerting none. This would give the same result, and it explains better what is meant by resistance of area. The centre of gravity of the shaded triangle is the centre of effort of the resistance.

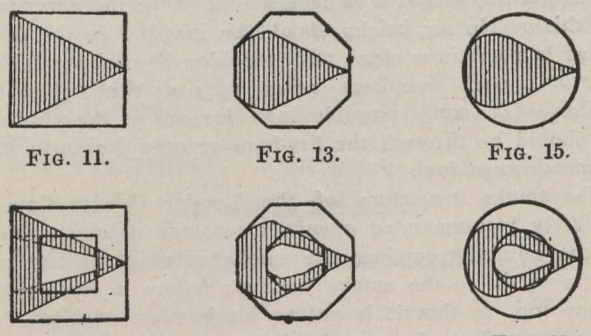

Fig. 11. Fig. 13. Fig. 15.

Fig. 12. Fig. 14. Fig. 16.

Resistance Areas of Different Sections.

Application to Chimney Shafts.—The reason so much time has been spent over the plain brick pier is that we shall be able to deal with complex chimney shafts the more readily. Nearly all the different forms of bed joints can be reduced to a few simple diagrams. These are collected together in Figs. 11 to 16, the shaded part being the resistance area, or measure of effective resistance, of each. Another form of section may occasionally be found—viz., square, with two buttresses on each face—the resistance area of which would be found in a similar manner to the preceding, and the centre of gravity would be found experimentally by cutting out the area in drawing paper and suspending it from two points. These shaded portions have been described as resistance areas, although they correspond exactly with the inertia areas for a neutral axis coinciding with one edge. The reason is that in calculation account is taken of the actual conditions—viz., a uniformly distributed load, and a bending moment producing compression on one side and tension on the other side of a neutral axis passing through the centre of gravity of the section.

General Formula for Stability.—The general formula for a structure subject to a direct stress, and also to a bending moment is

$$K = m + \frac{M}{Z} \qquad k = m - \frac{M}{Z}$$

where K = maximum intensity of pressure in tons per sq. ft.
k = minimum intensity of pressure in tons per sq. ft.
m = mean ditto, due to direct stress, tons per sq. ft.
M = bending moment in foot-tons.
Z = modulus of section in foot-units.

This applies to all cases where the stress on the inner edge is not reduced below zero, and to such other cases as permit of a tensile stress.

d = deviation of centre of pressure when pressure becomes zero at opposite edge.

A = area of bed joint.

then $d = \frac{Z}{A}$

Also let—

W = superincumbent weight in tons.

A = area of section in square feet.

l = distance from resultant to edge of section in feet.

D = outside diameter or width in feet.

d = inner diameter or width in feet.

Then for solid square, Fig. 11—

$A = D^2$, $l = \frac{1}{2}D$, $Z = \frac{1}{6}D^3$

for hollow square, Fig. 12—

$A = D^2 - d^2$, $l = \frac{2D^2 - D^2}{6D}$, $Z = \frac{D^4 - d^4}{6D}$

for solid octagonal, Fig. 13—

$A = 2(\sqrt{2}-2)D^2$, $l = \frac{3}{8}D$, $Z = \frac{\sqrt{2}-1}{4}D^3$

for hollow octagonal, Fig. 14—

$A = (2\sqrt{2}-2)(D^2-d^2)$, $l = \frac{3}{8} \times \frac{D^2-d^2}{D}$, $Z = \frac{\sqrt{2}-1}{4} \times \frac{D^4-d^4}{D}$

for solid circular, Fig. 15—

$A = \frac{\pi}{4}D^2$, $l = \frac{3}{8}D$, $Z = \frac{\pi}{32}D^3$

for hollow circular, Fig. 16—

$A = \frac{\pi}{4}(D^2-d^2)$, $l = \frac{3}{8}\frac{D^2-d^2}{D}$, $Z = \frac{\pi}{32}\frac{D^4-d^4}{D}$

and if A be made use of to find Z,

Z = for solid square ..... $A \times \frac{1}{6}D$

" hollow square ..... $A \times \frac{1}{6}\frac{D^2-d^2}{D}$

" solid octagonal ..... $A \times \frac{1}{8}D$

" hollow octagonal ..... $A \times \frac{1}{8}\frac{D^2-d^2}{D}$

" solid circular ..... $A \times \frac{1}{8}D$

" hollow circular ..... $A \times \frac{1}{8}\frac{D^3-d^2}{D}$

It will be found that—

	Square.	Octagonal.	Circular.
l = for solid section	$\frac{1}{3}$D	$\frac{3}{8}$D	$\frac{3}{8}$D
" average hollow	$\frac{1}{4}$D	$\frac{1}{3}$D.	$\frac{1}{3}$D
" infinitely thin	$\frac{1}{6}$D	$\frac{1}{4}$D	$\frac{1}{4}$D

and many designers are satisfied with these approximations, but for important work the exact distance should be obtained graphically or by exact calculation.

Ascertaining Stability.—Now the stability can be worked out from these diagrams and formulæ in two ways. Taking the 3-ft. brick pier as an example of a solid, square-bed joint, $Px = Wy$, but $y = \frac{1}{2}D - l = \frac{1}{2}D - \frac{1}{3}D = \frac{1}{6}D$, and $x = \frac{1}{2}h$, $\therefore P = W \times \frac{\frac{1}{6}D}{\frac{1}{2}h} = \frac{W}{3} \times \frac{D}{h}$, &c., as already worked out, when p was found = 11.2 lb. per square foot, and K = 3 tons per square foot. And by the second method $m = \frac{W}{A} = \frac{270}{9} =$ 30 cwt. = 1.5 tons, $M = p \times h \times D \times \frac{1}{2}h \times coeff = 11.2 \times 30 \times 15 \times 1 = 15{,}120$ ft.-lb. = 6.75 ft.-tons.

$$Z = \frac{1}{6}D^3 = \frac{3^3}{6} = \frac{27}{6} = 4.5 \text{ ft. units.}$$

$$K = m + \frac{M}{Z} = 1.5 + \frac{6.75}{4.5} = 3 \text{ tons per square foot as}$$

before.

In practice it will generally be necessary to work the other way round, and to make allowance for the taper of the portion under consideration, the stability of a chimney being usually measured by the maximum safe wind pressure. We know the maximum pressure on the bed joint will be twice the mean pressure, $K = \frac{W}{A} \times 2$, then the area must be such that K does not overstep the limits previously laid down by the tables of safe loads on materials.

(To be continued.)

STRENGTH VALUES FOR STRUCTURAL TIMBERS.*

By McCarvey Cliver, Director Forest Products Laboratory.

This circular brings together in condensed form the average strength values resulting from a large number of tests made by the Forest Service on the principal structural timbers of the United States. These results are more completely discussed in other publications of the Service, a list of which is given at the end of this circular, while most of them have also been furnished to the American Railway Engineering & Maintenance of Way Association and to various committees charged with the revision of the building laws of different cities. Their publication in the present form makes them available for quick reference by engineers, architects, builders, and other users of structural timbers.

The tests were made at the laboratories of the Forest Service, in co-operation with the following universities: Purdue University, Yale Forest School, University of California, University of Oregon, University of Washington, University of Colorado, and University of Wisconsin.

The Yellow Pine Manufacturers' Association, the E. P. Burton Lumber Co., the Redwood Manufacturers' Association, Oregon & Washington Lumber Manufacturers' Association, and the Pacific Coast Lumber Manufacturers' Association furnished, without cost, much of the material upon which the tests were made. Tests upon treated timbers, poles, crossarms, round mine timbers, and other structural forms are now being carried on.

Results.—Tables 1 and 2 give the average results obtained from tests on green material, while Tables 3 and 4 give average results from tests on air-seasoned material. The small specimens, which were invariably 2 by 2 inches in cross section, were free from defects such as knots, checks, and cross grain; all other specimens were representative of material secured in the open market. The relation of stresses developed in different structural forms to those developed in the small clear specimens is shown for each factor in the column headed "Ratio to 2" x 2"." Tests to determine the mechanical properties of different species are often confined to small clear specimens. The ratios included in the tables may be applied to such results in order to approximate the

*From Circular 189 Forest Service, U.S. Forest Service.

strength of the species in structural sizes, and containing the defects usually encountered, when tests on such forms are not available.

A comparison of the results of tests on seasoned material with those from tests on green material, shows that, without exception, the strength of the 2 by 2-inch specimens is increased by lowering the moisture content, but that increase in strength of other sizes is much more erratic. Some specimens, in fact, show an apparent loss in strength.

Table 1.—Bending Tests on Green Material.

Species.	Sizes.		Number of tests.	Per cent of moisture.	Rings per inch.	F. S. at E. L.		M. of R.		M. of E.		Calculated shear.	
	Cross section.	Span.				Average per square inch.	Ratio to 2" by 2".	Average per square inch.	Ratio to 2" by 2".	Average per square inch.	Ratio to 2" by 2".	Average per square inch.	Ratio to 2" by 2".
	Inches.	*Ins.*				*Lbs.*		*Lbs.*		*1,000 lbs.*		*Lbs.*	
Longleaf pine	12 by 12	138	4	28.6	9.7	4,099	0.83	6,710	0.74	1,523	0.99	261	0.86
	10 by 16	168	4	26.8	16.7	4,193	.85	6,453	.71	1,626	1.05	306	1.01
	8 by 16	156	7	28.4	14.6	3,147	.64	5,439	.60	1,368	.89	390	1.29
	6 by 16	132	1	40.3	21.8	4,120	.83	6,460	.71	1,190	.77	378	1.25
	6 by 10	180	1	31.0	6.2	3,580	.72	6,500	.72	1,412	.92	175	.58
	6 by 8	180	2	27.0	8.2	3,735	.75	5,745	.63	1,282	.83	121	.40
	2 by 2	30	15	33.9	14.1	4,950	1.00	9,070	1.00	1,540	1.00	303	1.00
Douglas fir	8 by 16	180	191	31.5	11.0	3,968	.76	5,983	.72	1,517	.95	269	.81
	5 by 8	180	84	30.1	10.8	3,693	.71	5,178	.63	1,533	.96	172	.52
	2 by 12	180	27	35.7	20.3	3,721	.71	5,276	.64	1,642	1.03	256	.77
	2 by 10	180	26	32.9	21.6	3,160	.60	4,699	.57	1,593	1.00	189	.57
	2 by 8	180	29	33.6	17.6	3,593	.69	5,352	.65	1,607	1.01	171	.51
	2 by 2	24	568	30.4	11.6	5,227	1.00	8,280	1.00	1,597	1.00	333	1.00
Douglas fir (fire-killed)	8 by 16	180	30	36.8	10.9	3,503	.80	4,994	.64	1,531	.94	330	1.19
	2 by 12	180	32	34.2	17.7	3,489	.80	5,085	.66	1,624	.99	247	.89
	2 by 10	180	32	38.9	18.1	3,851	.88	5,359	.69	1,716	1.05	216	.78
	2 by 8	180	31	37.0	15.7	3,403	.78	5,305	.68	1,676	1.02	169	.61
	2 by 2	30	290	33.2	17.2	4,360	1.00	7,752	1.00	1,636	1.00	277	1.00
Shortleaf pine	8 by 16	180	12	39.5	12.1	3,185	.73	5,407	.70	1,438	1.03	362	1.40
	8 by 14	180	12	45.8	12.7	3,234	.74	5,781	.75	1,494	1.07	338	1.31
	8 by 12	180	24	52.2	11.8	3,265	.75	5,503	.71	1,480	1.06	277	1.07
	5 by 8	180	24	47.8	11.5	3,519	.81	5,732	.74	1,485	1.06	185	.72
	2 by 2	30	254	51.7	13.6	4,350	1.00	7,710	1.00	1,395	1.00	258	1.00
Western larch	8 by 16	180	32	51.0	25.3	3,376	.77	4,632	.64	1,272	.97	298	1.11
	8 by 12	180	30	50.3	23.2	3,376	.79	5,286	.73	1,331	1.02	254	.94
	5 by 8	180	14	56.0	25.6	3,528	.83	5,331	.74	1,432	1.09	169	.63
	2 by 2	28	189	46.2	26.2	4,274	1.00	7,251	1.00	1,310	1.00	269	1.00
Loblolly pine	8 by 16	180	17	45.8	6.1	3,004	.75	5,394	.69	1,406	.98	383	1.44
	5 by 12	180	94	60.9	5.9	3,030	.74	5,028	.64	1,383	.96	221	.83
	2 by 2	30	44	70.9	5.4	4,100	1.00	7,870	1.00	1,440	1.00	265	1.00
Tamarack	6 by 12	162	15	57.6	16.6	2,914	.75	4,500	.66	1,202	1.05	255	1.11
	4 by 10	162	15	43.5	11.4	2,712	.70	4,611	.68	1,238	1.08	209	.91
	2 by 2	30	82	38.8	14.0	3,875	1.00	6,820	1.00	1,141	1.00	229	1.00
Western hemlock	8 by 16	180	39	42.5	15.6	3,516	.80	5,296	.73	1,445	1.01	261	.92
	2 by 2	28	52	51.8	12.1	4,406	1.00	7,294	1.00	1,428	1.00	284	1.00
Redwood	8 by 16	180	14	86.5	19.9	3,734	.79	4,492	.64	1,016	.96	300	1.21
	6 by 12	180	14	87.3	17.8	3,787	.80	4,451	.64	1,068	1.00	224	.90
	7 by 9	180	14	79.8	16.7	4,412	.93	5,279	.76	1,324	1.25	199	.80
	3 by 14	180	13	86.1	23.7	3,506	.74	4,364	.62	947	.89	255	1.03
	2 by 12	180	12	70.9	18.6	3,100	.65	3,753	.54	1,052	.99	187	.75
	2 by 10	180	13	55.8	20.0	3,285	.69	4,079	.58	1,107	1.04	169	.68
	2 by 8	180	13	63.8	21.5	2,989	.63	4,063	.58	1,141	1.08	134	.54
	2 by 2	28	157	75.5	19.1	4,750	1.00	6,980	1.00	1,061	1.00	248	1.00
Norway pine	6 by 12	162	15	50.3	12.5	2,305	0.82	3,572	0.69	987	1.03	201	1.17
	4 by 12	162	18	47.9	14.7	2,648	.94	4,107	.79	1,255	1.31	238	1.38
	4 by 10	162	16	45.7	13.3	2,674	.95	4,205	.81	1,306	1.36	198	1.15
	2 by 2	30	133	32.3	11.4	2,808	1.00	5,173	1.00	960	1.00	172	1.00
Red spruce	2 by 10	144	14	32.5	21.9	2,394	.66	3,566	.60	1,180	1.02	181	.80
	2 by 2	26	60	37.3	21.3	3,627	1.00	5,900	1.00	1,157	1.00	227	1.00
White spruce	2 by 10	144	16	40.7	9.3	2,239	.72	3,288	.63	1,081	1.08	166	.83
	2 by 2	26	83	58.3	10.2	3,090	1.00	5,185	1.00	998	1.00	199	1.00

Table 2.—Compression and Shear Tests on Green Material.

Species.	Compression || to grain.						Compression ⊥ to grain.					Shear.		
	Size of specimen.	Number of tests.	Per cent of moisture.	Cr. str. at E. L., per square inch.	M. of E., per square inch.	Cr. str. at max. ld., per square inch.	Stress area.	Height.	Number of tests.	Per cent of moisture.	Cr. str. at E. L., per square inch.	Number of tests.	Per cent of moisture.	Shear strength.
	Inches.			*Lbs.*	*1,000 lbs.*	*Lbs.*	*Inches.*	*In.*			*Lbs.*			*Lbs.*
Longleaf pine	4 by 4	46	26.3	3,480	.....	4,800	4 by 4	4	22	25.3	568	44	21.8	973
	2 by 2	14	34.7	.....	.....	4,400	.....	.....	.....	.....	.....	.....	.....	.....
Douglas fir	6 by 6	515	30.7	2,780	1,181	3,500	4 by 8	16	259	30.3	570	531	29.7	765
	5 by 6	170	30.9	2,720	2,123	3,490	.....	.....	.....	.....	.....	.....	.....	.....
	2 by 2	902	29.8	3,500	1,925	4,030	.....	.....	.....	.....	.....	.....	.....	.....
Douglas fir (fire-killed)	6 by 6	108	34.8	2,620	1,801	3,290	6 by 8	16	24	33.7	368	77	35.8	631
	2 by 2	204	37.9	.....	.....	3,430	.....	.....	.....	.....	.....	.....	.....	.....
Shortleaf pine	6 by 6	95	41.2	2,514	1,565	3,436	5 by 8	16	12	37.7	361	179	47.0	704
	5 by 8	23	43.5	2,241	1,529	3,423	5 by 8	14	12	42.8	366	.....	.....	.....
	2 by 2	281	51.4	.....	.....	3,570	5 by 8	12	24	53.0	325	.....	.....	.....
	.....	.....	.....	.....	.....	.....	5 by 5	8	24	47.0	344	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 2	2	277	48.5	400	.....	.....	.....
Western larch	6 by 6	107	49.1	2,675	1,575	3,510	6 by 8	16	22	43.6	417	179	40.7	700
	2 by 2	491	50.6	3,026	1,545	3,696	6 by 8	12	20	40.2	416	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 6	6	53	52.8	478	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 4	4	30	50.4	472	.....	.....	.....
Loblolly pine	8 by 8	14	63.4	1,560	365	2,140	8 by 4	8	16	67.2	392	121	83.2	630
	4 by 8	18	60.0	2,430	691	3,560	4 by 4	8	38	44.6	546	.....	.....	.....
	2 by 2	53	74.0	.....	.....	3,240	.....	.....	.....	.....	.....	.....	.....	.....
Tamarack	6 by 7	4	49.9	2,332	1,432	3,032	.....	.....	.....	.....	.....	24	39.2	668
	4 by 7	6	27.7	2,444	1,334	3,360	.....	.....	.....	.....	.....	.....	.....	.....
	2 by 2	165	36.8	.....	.....	3,190	.....	.....	.....	.....	.....	.....	.....	.....
Western hemlock	6 by 6	82	46.6	2,905	1,617	3,355	6 by 4	6	30	48.7	434	54	65.7	630
	2 by 2	131	55.6	2,938	1,737	3,392	.....	.....	.....	.....	.....	.....	.....	.....
Redwood	6 by 6	34	83.6	3,194	1,240	3,882	6 by 8	16	13	86.7	473	148	84.2	742
	2 by 2	143	72.1	3,490	1,222	3,980	6 by 6	12	14	83.0	424	.....	.....	.....
	.....	.....	.....	.....	.....	.....	6 by 7	9	13	74.7	477	.....	.....	.....
	.....	.....	.....	.....	.....	.....	6 by 3	14	13	75.8	411	.....	.....	.....
	.....	.....	.....	.....	.....	.....	6 by 2	12	12	66.5	430	.....	.....	.....
	.....	.....	.....	.....	.....	.....	6 by 2	10	11	55.0	423	.....	.....	.....
	.....	.....	.....	.....	.....	.....	6 by 2	8	12	56.7	396	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 2	2	186	75.5	569	.....	.....	.....
Norway pine	6 by 7	5	29.0	1,928	905	2,404	.....	.....	.....	.....	.....	20	26.7	589
	4 by 7	8	28.4	2,154	1,063	2,652	.....	.....	.....	.....	.....	.....	.....	.....
	2 by 2	178	26.8	.....	.....	2,504	.....	.....	.....	.....	.....	.....	.....	.....
Red spruce	2 by 2	58	35.4	.....	.....	2,750	2 by 2	2	43	31.8	310	30	32.0	758
White spruce	2 by 2	84	61.0	.....	.....	2,370	2 by 2	2	46	50.4	270	40	58.0	651

Table 3.—Bending Tests on Air-Seasoned Material.

Species.	Sizes.		Number of tests.	Per cent of moisture.	Rings per inch.	F. S. at E. L.		M. of R.		M. of E.		Calculated shear.	
	Cross section.	Span.				Average per square inch.	Ratio to 2" by 2".	Average per square inch.	Ratio to 2" by 2".	Average per square inch.	Ratio to 2" by 2".	Average per square inch.	Ratio to 2" by 2".
	Inches.	*Ins.*				*Lbs.*		*Lbs.*		*1,000 lbs.*		*Lbs.*	
Longleaf pine	8 by 16	180	5	22.2	16.0	3,390	0.50	4,274	0.37	1,747	1.00	288	0.75
	6 by 16	132	1	23.4	17.1	3,470	.51	6,610	.57	1,501	.86	388	1.01
	6 by 10	177	2	19.0	8.8	4,560	.68	7,880	.68	1,722	.99	214	.56
	4 by 11	180	1	18.4	23.9	3,078	.46	8,000	.69	1,660	.95	251	.66
	6 by 8	177	6	20.0	13.7	4,227	.63	8,196	.71	1,634	.94	177	.46
	2 by 2	30	17	15.9	13.9	6,750	1.00	11,520	1.00	1,740	1.00	383	1.00
Douglas fir	8 by 16	180	91	20.8	13.1	4,563	.68	6,372	.61	1,549	.91	269	.64
	5 by 8	180	30	14.9	12.2	5,065	.76	6,777	.65	1,853	1.09	218	.52
	2 by 2	24	211	19.0	16.4	6,686	1.00	10,378	1.00	1,695	1.00	419	1.00
Shortleaf pine	8 by 16	180	3	17.0	12.3	4,220	.54	6,030	.50	1,517	.85	398	.98
	8 by 14	180	3	16.0	12.3	4,253	.55	5,347	.44	1,757	.98	307	.76
	8 by 12	180	7	16.0	12.4	5,051	.65	7,331	.60	1,803	1.01	361	.89
	5 by 8	180	6	12.2	22.5	7,123	.92	9,373	.77	1,985	1.11	301	.74
	2 by 2	30	67	14.2	13.7	7,780	1.00	12,120	1.00	1,792	1.00	404	1.00
Western larch	8 by 16	180	23	18.3	21.9	3,343	.57	5,440	.53	1,409	.90	349	.96
	8 by 12	180	29	17.8	23.4	3,631	.62	6,186	.60	1,549	.99	295	.81
	5 by 8	180	10	13.6	27.6	4,730	.80	7,258	.71	1,620	1.04	221	.61
	2 by 2	30	240	16.1	26.8	5,880	1.00	10,254	1.00	1,564	1.00	364	1.00
Loblolly pine	8 by 16	180	14	20.5	7.4	4,195	.81	6,734	.72	1,619	1.10	462	1.45
	6 by 16	126	4	20.2	5.0	2,432	.47	4,295	.46	1,324	.90	266	.84
	6 by 10	174	3	21.3	4.7	3,100	.60	6,167	.66	1,449	.99	173	.54
	4 by 12	174	4	19.8	4.7	2,713	.52	5,745	.61	1,249	.85	185	.58
	8 by 9	180	9	22.9	4.9	2,903	.56	4,557	.48	1,136	.77	93	.29
	6 by 7	144	2	21.1	5.0	2,990	.58	4,968	.53	1,286	.88	116	.36
	4 by 8	132	8	19.5	9.1	3,384	.65	6,194	.66	1,200	.82	196	.62
	2 by 2	30	123	17.6	6.6	5,170	1.00	9,400	1.00	1,467	1.00	318	1.00
Tamarack	6 by 12	162	5	23.0	15.1	3,434	.45	5,640	.43	1,330	.82	318	.75
	4 by 10	162	4	14.4	9.7	4,100	.54	5,320	.41	1,356	.84	252	.59
	2 by 2	30	47	11.3	16.2	7,630	1.00	13,080	1.00	1,620	1.00	425	1.00
Western hemlock	8 by 16	180	44	17.7	17.8	4,398	.69	6,420	.62	1,737	1.04	406	1.06
	2 by 2	28	311	17.9	19.4	6,333	1.00	10,369	1.00	1,666	1.00	382	1.00
Redwood	8 by 16	180	6	26.3	22.4	3,797	.79	4,428	.57	1,107	.96	294	1.05
	6 by 12	180	6	16.1	17.7	3,175	.66	3,353	.43	728	.64	167	.60
	7 by 9	180	6	15.9	15.2	3,280	.69	4,002	.51	1,104	.96	147	.53
	3 by 14	180	6	13.1	24.4	.....	.....	5,033	.64	.....	.....	291	1.04
	2 by 12	180	5	13.8	14.4	3,928	.82	5,336	.68	1,249	1.09	260	.93
	2 by 10	180	5	13.8	24.8	3,757	.79	4,606	.59	1,198	1.05	186	.67
	2 by 8	180	6	13.7	20.7	4,314	.90	5,050	.65	1,313	1.15	166	.60
	2 by 2	28	122	15.2	18.8	4,777	1.00	7,798	1.00	1,146	1.00	279	1.00
Norway pine	6 by 12	162	5	16.7	8.1	2,968	.56	5,204	.61	1,123	.97	286	1.02
	4 by 10	162	5	13.7	12.0	5,170	.98	6,904	.82	1,712	1.48	317	1.13
	2 by 2	30	60	14.9	11.2	5,280	1.00	8,470	1.00	1,158	1.00	281	1.00

Table 4.—Compression and Shear Tests on Air-Seasoned Material.

Species.	Compression || to grain.						Compression ⊥ to grain.					Shear.		
	Size of specimen.	Number of tests.	Per cent of moisture.	Cr. str. at E. L., per square inch.	M. of E., per square inch.	Cr. str. at max. ld., per square inch.	Stress area.	Height.	Number of tests.	Per cent of moisture.	Cr. str. at E. L., per square inch.	Number of tests.	Per cent of moisture.	Shear strength per square inch.
	Inches.			*Lbs.*	*1,000 lbs.*	*Lbs.*	*Inches.*	*In.*			*Lbs.*			*Lbs.*
Long-leaf pine	4 by 5	46	26.3	3,480	.....	4,800	4 by 5	4	22	25.1	572	52	20.2	984
Douglas fir	6 by 6	259	20.3	3,271	1,038	4,258	4 by 8	16	44	20.8	732	465	22.1	822
	2 by 2	247	18.7	3,842	1,084	5,002	4 by 8	10	32	18.1	584	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 4	8	51	20.2	638	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 4	6	49	21.0	613	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 4	4	29	24.8	603	.....	.....	.....
Short-leaf pine	6 by 6	29	15.7	4,070	1,951	6,030	8 by 5	16	4	17.8	725	85	.....	1,135
	2 by 2	57	14.2	.....	.....	6,380	8 by 5	14	3	16.3	757	.....	.....	.....
	.....	.....	.....	.....	.....	.....	8 by 5	12	5	15.1	730	.....	.....	.....
	.....	.....	.....	.....	.....	.....	5 by 5	8	6	13.0	918	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 2	2	57	13.9	926	.....	.....	.....
Western larch	6 by 6	112	16.0	.....	.....	5,445	8 by 6	16	17	18.8	491	193	15.0	905
	4 by 4	81	14.7	.....	.....	6,161	8 by 6	12	18	17.6	526	.....	.....	.....
	2 by 2	270	14.8	.....	.....	5,934	5 by 4	8	22	13.3	735	.....	.....	.....
Loblolly pine	6 by 6	23	.....	3,357	1,693	5,005	8 by 5	16	12	19.8	602	156	11.3	1,115
	5 by 5	10	22.4	2,217	545	2,950	8 by 5	8	7	22.9	679	.....	.....	.....
	4 by 8	8	19.4	3,010	633	3,920	4 by 5	8	8	19.5	715	.....	.....	.....
	2 by 2	69	.....	.....	.....	5,547	.....	.....	.....	.....	.....	.....	.....	.....
Tamarack	6 by 7	3	15.7	2,257	1,042	3,323	2 by 2	2	57	16.2	697	60	14.0	879
	4 by 7	3	13.6	3,780	1,301	4,823	.....	.....	.....	.....	.....	.....	.....	.....
	4 by 4	57	14.9	3,386	1,353	4,346	.....	.....	.....	.....	.....	.....	.....	.....
	2 by 2	66	14.6	.....	.....	4,790	.....	.....	.....	.....	.....	.....	.....	.....
West hemlock	6 by 6	102	18.6	4,840	2,140	5,814	7 by 6	15	25	18.2	514	131	17.7	924
	2 by 2	463	17.0	4,560	1,923	5,403	6 by 6	6	26	16.8	431	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 4	4	6	15.9	488	.....	.....	.....
Redwood	6 by 6	18	16.9	.....	.....	4,276	8 by 6	16	5	25.4	548	95	12.4	671
	2 by 2	115	14.6	.....	.....	5,119	6 by 6	12	6	14.7	610	.....	.....	.....
	.....	.....	.....	.....	.....	.....	7 by 6	9	5	14.8	500	.....	.....	.....
	.....	.....	.....	.....	.....	.....	3 by 6	14	2	12.6	470	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 6	12	2	16.2	498	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 6	10	4	14.3	511	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 6	8	2	13.2	429	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 2	2	145	13.8	564	.....	.....	.....
Norway pine	6 by 7	4	15.2	2,670	1,182	4,212	2 by 2	2	36	10.0	924	44	11.9	1,145
	4 by 7	2	22.2	3,275	1,724	4,575	.....	.....	.....	.....	.....	.....	.....	.....
	4 by 4	55	16.6	3,048	1,367	4,217	.....	.....	.....	.....	.....	.....	.....	.....
	2 by 2	44	11.2	.....	.....	7,550	.....	.....	.....	.....	.....	.....	.....	.....

NOTE.—Following is an explanation of the abbreviations used in the foregoing tables:
F. S. at E. L.=Fiber stress at elastic limit.
M. of E.=Modulus of elasticity.
M. of R.=Modulus of rupture.
Cr. str. at E. L.=Crushing strength at elastic limit.
Cr. str. at max. ld.=Crushing strength at maximum load.

due to seasoning. If structural timbers are seasoned slowly, in order to avoid excessive checking, there should be an increase in their strength. In the light of these facts it is not safe to base working stresses on results secured from any but green material. For a discussion of factors of safety and safe-working stresses for structural timbers, the reader is referred to the report of the committee on wooden bridges and trestles of the Railway Engineering & Maintenance of Way Association published in the Association Bulletin 107.

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The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

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CONTENTS OF THIS ISSUE.

THE EMPLOYMENT OF ENGINEERS.

At various times, in the columns of *The Canadian Engineer*, we have referred to the employment of engineers from outside Canada. In many cases our remarks have been challenged as being unfair to the outside engineer. Let us quietly and dispassionately look over the situation and see how matters stand.

In a recent address to the students in engineering in the University of Toronto, Mr. M. J. Patton, representing the Conservation Commission, stated that in gathering information and data from various sources for the compiling of the recently published "Reports on the Water Powers of Canada," those in charge of the work were surprised to observe that so large a proportion of plans for the hydro-electric development being carried on in Canada were prepared by foreign engineers. One of the students, in reply, said he hoped the Conservation Commission in their work would remember to conserve positions for the Canadian engineers, as it was becoming very difficult for the young graduate to obtain work along an engineering line. The above example, coming as it did from an official source, carries some weight, and we are constrained to ask, Why it is that our own consulting engineers are not doing this work?

One of the main objections to the employment of foreign engineers is the fact that a knowledge of local climatic conditions is essential to the success of engineering work. The design of hydro-electric installations, of sewage disposal works, and of many other departments of the engineering profession, are governed in a great measure by ice, snow and frost, and no man can do full justice to the work unless he is thoroughly acquainted and accustomed to the conditions. A consequence of this lack of knowledge is to be seen in the results of the recent installation of a central heating system for one of our large institutions of learning. This system was designed by a firm of consulting engineers from the United States, although the institution in question is government supported, and has on its list of engineering graduates dozens of men whose experience and training fit them for this work. This firm installed a gravity heating system against the opinion of many of their graduates, and the institution in question is now reaping the harvest in lack of heat and increased coal bills. Many similar instances might be quoted, but this particular one is rather flagrant. If the institutions which are turning out engineers will not use their own graduates, where can work be found for them?

We publish a letter this week from a Canadian, at present employed in the United States, who feels that we were unjust in our remarks a short time ago. The writer, however, does not appreciate our stand in the matter. There is certainly no objection to men from other countries coming to Canada and taking up their abode here. In fact, many of our engineers have done this very thing. They have, however, become Canadians. Likewise, many Canadians have left this country to take up work in other lands, and the writer of the letter mentioned is one of these. The engineers who come here to stay, and who come to take junior positions, will in turn become Canadians. On the other hand, it will be found that there is strong objection to foreign consulting engineers doing work in this country which can be done equally well by our own engineers.

The public bodies of the country should be the first to appreciate this principle and lend it their hearty support.

EDITORIAL COMMENT.

The series of articles on "Contracts for the Supply of Electric Power from the User's Point of View" is finished in this issue. We shall be glad to furnish the article in pamphlet form if there is sufficient demand from our readers.

* * * *

The old haunt of the student in vacation time has been cut off. The new regulations for fire rangers in Ontario have been issued by the Department of Lands, Forests and Mines, and in all the long list of rules the word "student" does not appear. The student in his intervals between study must find some other means of employment than canoeing and meandering through the northern wilds.

* * * *

The first of a series of articles on the "Principles of Specification Writing" is printed in this issue of *The Canadian Engineer*. When the series is complete we will publish the series in pamphlet form. The subject of specification writing is an exceedingly important one, and far too little attention is devoted to it. We are pleased to note that the Faculty of Applied Science and Engineering of he University of Toronto has taken the matter up, and Mr. C. R. Young, the author of this series in *The Engineer*, will deliver a short course on the subject to the students in engineering.

LETTER TO THE EDITOR.

The Editor:

Sir,—Many Canadian engineers engaged in their profession in the United States, like myself, temporarily or otherwise, will regret your ironical remarks on the appointment of a St. Paul man to the city commissionership of Moose Jaw.

It is to be hoped that many Canadian engineers at home will approve of the broadmindedness of the city of Moose Jaw in selecting the man who was considered to be best fitted for the position, irrespective of nationality.

The West has welcomed farmers and others from the United States to aid in building up the country. The engineer has been defined as a man who makes two blades of grass grow where only one grew before. Why is it not as consistent to select an engineer from the United States to help build up a city as it is to import American farmers to develop the country?

DONALD F. McLEOD, City Engineer.
Ithaca, N.Y.

IMPORTANT NATIONAL QUESTIONS DISCUSSED

Many unusually important points were brought to the attention of the new council of the Toronto Board of Trade on Thursday by Mr. G. T. Somers, the president. After quoting statistics respecting Toronto's remarkable growth, Mr. Somers urged the initiation of an actual movement for the immediate settlement and development of Northern Ontario. He showed that the continued industrial and business growth of Toronto and Southern Ontario would depend to some extent on the North, especially in view of the manufacturing tendencies in Western Canada.

The president also referred to the great loss of life and the large number of accidents in Toronto last year and quoted a recent article of The Monetary Times which told that in six years, 36,710 people have been killed or injured in Canada in accidents on steam and electric railways, at fires, and by industrial accidents. This is at the rate of 9,177 per annum. In other words, every day during that period 25 persons have been killed or injured. The Board, he said, could help to minimize this appalling record, so far as Toronto is concerned, by assisting to improve traffic rules, automobile speed regulations, the abolition of level street railway crossings in congested areas, and in many other ways easily apparent.

It was hoped, continued Mr. Somers, that early and serious consideration would be given by the Dominion Government to the enlargement of the Welland Canal. In this connection, he suggested that in planning for the enlargement of the Welland Canal it might be well for the government engineers to consider the question of incidental power production. Great plans for the development of power plants on the St. Lawrence above Montreal indicated that the Cornwall and Soulanges Canals may be cut out of the system and replaced by deep waterways created in connection with the building of power dams. If the expectations of the promoters of these and kindred projects were realized, the deepening of the St. Lawrence channels might be a source of profit to the people of Canada instead of a heavy bill of expense. While the proximity of Niagara and its great power plants must lessen the immediate value of power developed in connection with the enlargement of the Welland Canal, it must not be forgotten that the operation of the canal would require the pouring of a large volume of the waters of Lake Erie over the escarpment at Thorold. Should there be any truth in the rumor that six or seven locks of great depth and capacity are to be substituted for the large number of small locks on the present canal, the waste water from these locks might well become an important source of revenue to the government if utilized for power production.

Mr. Somers suggested the study of the lake levels by the Associated Boards of Trade, stating that a reduction of two or three feet in harbor depth is a serious calamity. Many excellent suggestions were also made regarding the good roads movement and these, we expect, will receive the attention of the Dominion Government and other authorities.

It was pleasing to note that Mr. Somers recommended earnest attention to the question of fire waste, and advised the support of the Board of Trade to the appointment of a provincial fire marshal. Too few public men and bodies are giving their thought to Canada's appalling record of fire losses.

The strengthening of the pure food and drug laws, the bringing of radial railways to the heart of Toronto, the appointment of a properly qualified industrial commissioner for Toronto, the present conservative valuation of Toronto real estate, were other matters discussed by the president, who also reminded his hearers that the advice of the Royal Commission on technical education is eagerly awaited. It is hoped that the membership of the Board will be 3,000 by the end of the year.

In connection with the radials, Mr. Somers said there were remunerative opportunities awaiting the enterprise of market gardeners around Toronto. Only a comparatively small proportion of the garden produce consumed in Toronto is grown in the immediate neighborhood. Secretary Wilson, of the United States Department of Agriculture, the other day drew attention to the question of utilization of lands near large cities, so that their markets for foodstuffs could be supplied with home-grown products. Only recently 15,000 tons of potatoes reached New York from Scotland for New York City consumption.

THE PRINCIPLES OF SPECIFICATION AND AGREEMENT WRITING.

By C. R. Young, A.M. Can. Soc. C.E.*

First Article.

INTRODUCTION.

Present Status of Specification Writing.

Probably no detail of engineering work is given less attention in proportion to its importance than the preparations of specifications and agreements. Most engineers regard the task as a piece of unavoidable drudgery to be met with rare stoicism and gone through as quickly as possible. Hence, in office vernacular, specifications are said to be "ground out," not "written." In addition, they must only too often be prepared in an absurdly small remnant of time left between the completion of the plans and the calling for tenders, or, indeed, even after the invitations to tender have been issued or the advertisements published. Little thought can thus be given to the foundation of specifications on fundamental principles, and although each new undertaking of the engineer or architect nearly always differs materially from any other upon which he has been engaged, necessitating perhaps some important departure from former practice, no attempt is generally made to prepare a specification fully comprehending all the new and changed conditions. Instead, an ample collection of old specifications is gathered together and from this one and that one clauses are chosen which appear to be adapted to the case in hand, and with the good offices of the scissors and the paste are jumbled together to form the new document. It is therefore not remarkable to find that litigation arising out of Construction Contracts is sufficiently frequent and protracted to elicit a great deal of popular comment unfavorable to the engineer or architect responsible for the work.

Necessity for Increased Care and Thoroughness.

The engineer's success and his reputation with the general public, upon which his ultimate success depends, alike demand greater care in the preparation of specifications and agreements. Nowhere is haste more productive of sinister results than in this work. There are occasions in the consideration of any engineering undertaking when only the general features are of importance and indeed when the widest and most general view possible of the entire project should be taken in order that it may seem as a whole in its true perspective and in proper relation to existing conditions. But when it comes to the preparation of specifications and agreements, the "promoter" attitude of mind must give way to the close and painstaking scrutiny of details. In this work clearness, definiteness and strictest accuracy in all particulars are of the utmost consequence. Such a result can be secured only by the exercise of care and thoroughness in the work. The slighting of details and the covering up of ignorance and lack of proper consideration of the subject by such expressions as "the work shall be done to the satisfaction of the engineer," while apparently effecting a present saving of time are almost certain to later entail a much greater loss of time to all concerned and perhaps considerable financial loss as well.

*Consulting Structural Engineer, 318 Continental Life Building, Toronto.

Scope of the Proposed Discussion.

In the hope that some assistance might be afforded to those who are interested in the improvement of the present character of specification and agreement writing, the writer proposes to discuss the principles of the subject in this and succeeding papers. What is said will not concern the merits of, or the desirability of specifying, any type of construction, design, detail or method, but, rather, the art or science of fully, accurately and unambiguously describing the features and details which already have been adopted. The method to be followed will therefore not be the quotation of a number of authoritative specifications from which the reader could select such portions as appeared to be adapted to his own work, but, instead, it is proposed to state and illustrate in so far as possible the **fundamental principles** upon which all specifications and agreements should be based. By a thorough understanding of these principles, and only by such means, is it possible for anyone to prepare satisfactory instruments of this kind.

Because of the limitations of available space it will be necessary to confine the present discussion to the commoner forms of construction contracts. While it is fully recognized that many things might profitably be said concerning the distinctive features of specifications and agreements for the various forms of "secured-cost" contracts, attention will be chiefly directed to the "unsecured-cost" contract, the one most commonly employed, and the one nearly always adopted in public works.

The Engineer's Limitations.

It is obvious, of course, that the engineer cannot safely dispense with the services of the solicitor, as a result of gaining some little acquaintance with the principles of contract law. No one with experience will dispute the old observation that "A man who is his own lawyer has a fool for a client." For most contracts, however, a lawyer is not consulted in any event, and if the engineer has some familiarity with the essentials of proper specifications and agreements, his work is likely to be much more satisfactorily performed than if he does not possess such information.

PRELIMINARIES TO THE CONTRACT.

Procedure of the Owner in Allotting the Work

When a person, company, municipal corporation or government, and which for brevity we may call the Owner, desires to carry out a piece of engineering construction, he, or it, procures the services of an engineer or architect specially skilled in the particular class of work under consideration and who in continuous consultation with the Owner develops designs and details conforming to the needs and purposes of his client. The latter not generally possessing the knowledge, experience, plant or organization essential to the successful and speedy prosecution of the actual work of construction prefers to delegate the risks and responsibilities incident to such a project to someone else especially qualified to undertake them, and at the same time, before commencing work, to ascertain with some accuracy the final cost and the time of completion. It is not in general desirable for him to entrust both the preparation of designs and the actual work of construction to

one person or firm, because on one hand, the engineer or architect is not likely to possess the special experience or organization required for the efficient performance of the work in the field, and on the other hand, most construction firms are not especially well qualified to advise the Owner concerning the more troublesome engineering or architectural features of the project. Further, the value of a check would be lost, if the Owner were to place his case wholly in the hands of one person. If the latter proved dishonest, the Owner might be grossly deceived with little risk of detection. Thus it has come to pass that the Owner commonly places the actual work of construction in the hands of a third party, called the Contractor, who supplies all materials, performs all labor, and delivers up to the Owner in a stated time the desired structure, work or article, complete and ready for use.

The Preparation of Plans, Specifications, and Agreements.

In order that the Contractor may know precisely what is required by the Owner, and also that the Owner may ensure his being supplied with what he agrees to pay for, the latter's engineer (or architect) prepares graphic or written statements of the work to be performed and of the business relations which the Owner proposes shall subsist between himself and the Contractor during the progress of the work. Those requirements which can best be shown graphically, such as dimensions, shape and size of parts or quantity and distribution of materials are preferably embodied in **plans**, while the quality of materials, workmanship and methods of construction lending themselves readily to written description are set forth in **specifications.** In the latter are also stated certain general relations, as of authority, which it is proposed shall govern the Owner and the Contractor or their representatives in the actual physical construction of the work. A formal **agreement** is also drawn up and attached to the specifications setting forth the general nature of the proposed arrangement between the parties, including the financial or other valuable consideration involved and to this it is expected that both the Contractor and the Owner will affix their signatures upon the award of the contract.

Because of the complexity and multiplicity of details in most constructional projects it is essential that everything affecting the extent or cost of the work should be clearly set down in writing or on plans before the award of the contract, not only for the information of the Contractor in making up his bid, but for the subsequent guidance of the Contractor, the Owner's inspector and all others having to do with the work. While oral agreements may be satisfactory for trifling pieces of work where the parties are both of unquestionable integrity, the uncertainty of memory and sometimes the willingness of one party to take an unfair advantage over the other demands that all the requirements of the Owner and all understandings between the Owner and the Contractor should be reduced to writing or shown on sketches or plans.

The Closing of the Contract.

Having entertained bids or proposals for the work up to a specified date, the Owner awards the contract upon the advice of his engineer, and the successful bidder is required to sign the agreement, specifications and plans which then collectively become the **Contract.** The agreement is sometimes termed "the contract," but since the specifications and plans are declared in the agreement to be a part of the contract, this practice is therefore manifestly erroneous.

THE COMPOSITION OF AN ENGINEERING CONTRACT.

Length and Amount of Detail.

The character of the work in hand is the most important factor in determining the length and amount of detail in an engineering contract. Where the work is simple or of small extent a letter from the Contractor to the Owner offering to supply all materials and perform all labor for a certain consideration may be sufficient. If the communication refers to a plan or sketch furnished by the Owner it should contain the Contractor's pledge to execute the work in accordance with such plan or sketch. On the other hand, the Contractor may himself submit a plan with his letter setting forth what he proposes to do for the compensation mentioned. The specifications are also of very brief character when the Owner purchases a machine, article or commodity covered by letters patent or which is subject to some degree of artificial or natural monopoly, and which is therefore produced in accordance with the Contractor's and not the Owner's ideas. Unless competition is very keen, manufacturers are not eager to supply machines or other articles to special plans and specifications prepared by the engineer, for this means changing the character of their product, methods and processes which had perhaps been arrived at and constituted shop standards after many years of experiment and observation. In some instances the process of manufacture and the materials employed are secret, and, since the purchaser could have no knowledge of these, they manifestly could form no part of the specifications. The purchaser therefore does not usually submit plans to the bidder in the case of machinery, patented appliances, and many other articles and commodities, but limits his specifications to a brief statement of the required performance or ability to meet certain specified tests.

Where the piece of construction is built in accordance with the engineer's, and not with the contractor's, ideas, such as railroads, canals, tunnels and often bridges and buildings, plans and specifications of an extensive character must be prepared, and the difficulty of framing a proper contract is considerably augmented. Added to the necessity of clearly specifying what is required in, and of, every part of the finished work is the need of ensuring that unfavorable natural or climatic conditions, difficulties of transportation or labor troubles, all of which greatly affect field operations, shall not preclude the attainment of the desired result. Although, in theory, it is only in the result that the Owner is interested, he must also reserve the right to prevent the Contractor from continuing in a course which is reasonably certain to culminate in failure. Many contingencies must therefore be provided for in work constructed to order in the field, and the specifications grow into many typewritten or printed pages. The agreement is also properly more detailed than that pertaining to the simpler classes of work already mentioned.

The length and fullness of the specifications will also depend on the nature of the arrangement with the Contractor. If the engineer prepares the complete designs and the Contractor is only required to construct the work at his shops or in the field in accordance with such designs, the specifications need only deal with construction. On the other hand, if the Contractor is re-

quired to prepare the designs and do the actual work of construction as well, the specifications must of necessity be much fuller than in the first case. Experience has shown that the latter method is objectionable on a number of grounds. In the first place it leaves the Contractor free to adopt many faulty features of design which for the sake of brevity could not all be expressly forbidden in the specifications, but which would have been rendered impossible by the engineer designing the work himself. Again, unless all contractors bid on the same design, viz., that of the engineer, those who have least to lose will submit low bids on questionable or flimsy designs of their own, which may inadvisedly be accepted by the Owner to his subsequent sorrow. This method also entails much trouble in case changes are desired, for unless the engineer has clearly shown by plans of his own exactly what he requires, the Contractor will generally contend that his own plans supply all that was called for in the specifications. Thus, it is desirable wherever possible to have bids based not only on specifications but on full detail drawings prepared by the engineer, rather than on the Contractor's design or even on general drawings prepared by the engineer.

Another feature of the arrangement between the Owner and the Contractor materially affecting the length and amount of detail of the contract is the manner in which the Contractor receives his profit. If the contract is a so-called "lump-sum" one, the amount of detail and the care and preparation of the necessary documents is much greater than for "secured-cost" contracts, such as those on a "cost-plus-a-percentage" and "cost-plus-a-fixed-sum" basis. On a "lump-sum" contract the Contractor naturally strives to reduce the cost to a minimum since the difference between his bid and the cost is all gain. Special care must therefore be taken in preparing the specifications to prevent the Contractor scamping the work in order to increase his own profit.

In accordance with the complexity of the work and the character of the contracting parties, construction contracts may thus be composed of agreements, specifications and plans in varying proportions. For all, there should be some form of agreement, although perhaps quite simple, since in this is disclosed the intention of the parties and the general basis on which the arrangement is made. Lacking such written statement, the settlement of disputes is often attended with great difficulty, as an attempt must be made to prove by oral evidence what might have been established by a few lines of writing.

AN ACTUAL SAVING OF WOODEN FORMS.

There are three general types of coal pockets in use today, the all-timber, the all-concrete, and the combination type of concrete and timber. A great many of the latter design have been erected according to plans of Monks & Johnson, architects and engineers, of Boston, who are able to reduce the cost of coal pockets considerably by using the forms for the reinforced concrete work in constructing a part of the wooden walls and bins of the coal pocket. The cost of all reinforced concrete coal pockets range from $6.00 to $7.50 per ton of capacity, but in the combination type, where the supports and the floors are of concrete but the walls are of timber, the cost is generally about $5.00 per ton of capacity, and this in no small part is due directly to the actual saving of the forms by incorporating them in the coal pocket itself.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.

Annual Meeting, January 9, 1912.

The third annual meeting of the American Society of Engineering Contractors was held in New York City on the 9th day of January, 1912.

In the forenoon members of the society visited, in a body, the new Grand Central terminal, at the invitation of Mr. W. L. Morse, Terminal Engineer of the N.Y. Central & Hudson River R.R. Co. They were escorted by Mr. E. D. Sabine, first assistant terminal engineer; Mr. W. C. Goddard, terminal architect's engineer, and their assistants.

It is needless to say that great interest was evinced by the members who were fortunate enough to view the remarkable work accomplished and still going on, which work will result in probably the greatest railroad terminal in the world. Particular interest was manifested in the method of coating all the steel columns, beams, etc., in the lower level with cement. The mortar is applied directly through the "cement gun" by the agency of a blast of compressed air.

At the afternoon session, which was devoted to a business meeting, the address of the retiring president of the society, Mr. W. R. Harris, was read. Mr. Harris, who, for nearly one year, has been located in the Canadian Northwest at Regina and Saskatoon, Sask., was unable to be present. He stated that even in those distant provinces much interest is evinced regarding the work undertaken by this society, which is about to be manifested by the organization of branches.

We read and hear much these days relative to workmen's compensation for injuries sustained. Undoubtedly, many superficial observers show little interest in this question unless directly affected in legislation of this character with the result that many laws have been passed which, if enforced, will be bound to affect seriously contractors and, ultimately, the public. It goes without saying that every added expense saddled on the contractor through such laws is not going to be assumed by him, but must be paid by the owner, whether he be an individual or the public. This is simply a business proposition.

Mr. Harris related that during the last session of the local Parliament in Saskatoon a law was passed whereby all workmen, except farm laborers, are entitled to compensation for injuries, whether sustained through carelessness or not. This is class legislation of the worst kind, because the farmer, who employs the larger part of his force only a short time each year, is not affected, while the manufacturer and the contractor are liable. Furthermore, the law is unfair in its effect on the bids of various contractors. The man who is responsible and, therefore, is able to obtain liability insurance must pay the higher premiums caused by this Act, and, necessarily, must include such cost in his bid. On the other hand, the contractor who, because he is not financially responsible, or for some other reason, does not secure such insurance, would not have to figure on such an additional expense and is thereby able to reduce his bid accordingly.

The remedy is an organization like this society which, when necessary, will oppose reckless legislation and insure that, if general compensation statutes of this kind are deemed necessary, each man who employs labor shall be affected equally.

A point of interest to all engineers who have to specify tests for cement is one brought out by Mr. Harris. He stated that, under the present specifications, tests required for cement fail to provide the safeguards anticipated. For

instance, while the usual method of taking one barrel in every ten of a shipment as a sample of the material, the method of mixing the samples is not satisfactory. It is provided that, to determine the characteristics of a shipment, the individual samples may be mixed and the average tested. This may not be objectionable where the cement is used in massive concrete subject to compression only. In reinforced concrete, however, because comparatively thin members are used, this method should not be allowed.

The reasons given by Mr. Harris for his position are as follows:—

It is acknowledged that 80 per cent. good cement will carry 20 per cent. poor cement. If the average sample of a shipment shows only 20 per cent. bad material it is, according to standard specifications, allowable. However, the mixing which is done with the sample is, of course, not repeated with the bags of cement, since it would be impracticable to take a car load shipment, mix it and remeasure it to secure the proper proportion.

The result is that where mixing up a batch of concrete, the sacks used may contain as much as 50 per cent. bad cement, and just as likely as not this concrete may be placed in a portion of the structure where only the best material should be used.

Again, a shipment of cement may contain the products of different mills, cement which may be different in regard to setting time, fineness, etc. It is bad practice to use two brands of cement in the same concrete mixture, but if the products of several mills are placed in sacks of a common brand, it is impossible to tell by looking at the sack whether the contents of a car would run uniform or not, except by individual tests.

This question is of much importance to architects, engineers, contractors, and manufacturers of cement products. Mr. Harris recommended concerted action by this society with other technical societies to eliminate the foregoing defects of the present specifications.

After Mr. Harris' address was read the result of the election of officers was declared. The following officers were elected:—

President—Maj. C. E. Gillette, of Philadelphia, Pa.

1st Vice-President—H. J. Cole, of New York, N.Y.

2nd Vice-President—John Marshall, Regina, Sask., Can.

Directors—W. B. Bamford, of Belmar, N.J.; Carl Weber, of Los Angeles, Calif.; C. A. Mees, of Charlotte, N.C.

President Gillette then assumed the chair, and after some introductory remarks he called for a report of the treasurer, which was presented. This was followed by a report of the secretary, in which he outlined the work accomplished by the society during the past year Among other things, the secretary stated that 130 new members had been added to the rolls of the society during 1911, an increase of 20 per cent. of the active membership.

This was followed by discussions relative to various features of the work to be done by the society, among which is the gathering of cost-data.

Mr. Shannon, of Jersey City, and Mr. Bosch, of Harrisburg, both contractors, stated that, in their opinion, it could not be expected that contractors, generally, would care to divulge their costs, since they usually consider this information as their personal property, or what may be called their trade secrets. Mr. Frank B. Gilbreth, the well known contractor, however, took the view that contractors are bound to benefit from interchange of ideas and publication of costs. He stated that if many of the contractors who bid on construction work only knew more about costs there would be less ruinous bidding than there is at the present time. It has been the experience of large manufacturers that they have benefited from the publication of their costs in full detail, by the fact that competitors could see for themselves that the margin of prolt was not so large as to allow great risk to be taken.

It was agreed, however, that cost-data of itself has not much value unless together with it is given full details of the method of doing the work, the character of labor, hours of work and an explanation of all conditions that would affect the cost.

At the evening meeting the elected president, Major C. E. Gillette, delivered an interesting address in which he pointed out that the society, although it is an association of contractors and engineers is, primarily, organized to do something for the public good. Major Gillette also pointed out that, whereas every class of labor is organized, contractors alone are not.

He stated that this society should take steps to point out and eliminate waste in large works, waste which is often due to errors in design. Very few designs are made from the point of view of final cost, and in that respect much benefit should result from co-operation and interchange of ideas between engineers and contractors.

Another feature in contracting work, which causes the contractors great loss, and which, ultimately, affects the public, is unreasonable inspection. This requires attention, because unfair inspection has been the cause of much trouble in contract work. The United States Government, particularly, suffers from that trouble, and it is doubtless the reason why it must pay much more for structures of any kind than private individuals or corporations.

Major Gillette recommended that the society use its best efforts to write on the statute books of at least one State, a good, complete, real law that will require fairness, and the avoidance of favoritism and graft in public, government, state, and municipal contracts. By doing that one thing, the society will have justified its existence over and over again. Of course, it is appreciated that it is not possible to legislate honesty into public officials, but, at least, a valid and comprehensive law of this kind, backed by the active influence of a large organization, will doubtless serve to make the way of the trangressor much harder than it is at the present time.

The next point that the speaker referred to was the question of practical specifications. Only too often specifications are written that would require a miracle to carry out, in fact, they are an absolute impossibility; yet contractors are constantly asked to bid on such specifications and they must do it, if they want work. The result is that no end of trouble is experienced. Ultimately the cost must be shouldered by the public, who is powerless to prevent it. Therefore, it behooves an organization like this society to avail itself of the unexcelled opportunity that is now available to accomplish something of lasting benefit, not only to contractors, but also to the public.

The remainder of the evening was devoted to a talk by Mr. J. R. Wemlinger, on "Methods and Costs of Driving and Pulling Steel Sheet-Piling." This was illustrated by means of one hundred and twenty-five lantern slides, showing all known methods of installing sheet-piling of all kinds in United States and foreign countries.

The headquarters of the American Society of Engineering Contractors are at 13-21 Park Row, New York City.

AMERICAN WATER WORKS ASSOCIATION.

The thirty-second annual convention of the American Water Works Association will be held at Louisville, Ky., June 3rd to 8th, 1912, with headquarters at the Seelbach Hotel. Alex. Milne, President; J. M. Diven, Secretary.

CONTRACTS FOR THE SUPPLY OF ELECTRIC POWER FROM THE POWER USER'S POINT OF VIEW.

VI.

By H. E. M. Kensit, M.I.E.E.

The clause dealing with penalties for failure of or interruption in the supply is a thorny one, but usually fully understood in its legal aspects by the lawyers responsible for settling the contract. There are, however, certain considerations due to inherent necessities and probabilities in ordinary operation of the power plant that should be taken into account.

It should be borne in mind that any customer's own power plant must, and inevitably will, sooner or later break down or need stoppage at inconvenient times for repairs, and in many cases such stoppage may be seriously prolonged by the necessity of sending to distant points for new parts or skilled workmen. The risk of lengthy interruption in the supply from a power company is less than in the case of a private plant, because the power company has usually reserve plant, a full stock of spare parts, and skilled men at hand to carry out repairs. It is but seldom that a power company can be charged with negligence in regard to maintaining the supply, but nevertheless all moving machinery must need stoppage at times and all transmission lines must need repair from time to time.

The conditions of the penalty should, therefore, be reasonable, both as to duration of interruption and payment.

As the drafting of the penalty clause is generally a contentious matter, the following examples from some existing contracts may be useful for reference:—

(1). "Accidental Interruption.—This agreement to furnish electric energy is made expressly subject to interruptions or diminutions in the supply of said energy which may be due to causes beyond the reasonable control of the power company, provided that in any such case there shall be an abatement in the payment by the customer to the power company amounting to twice the sum which the customer would have paid for the actual time of each interruption for the quantity by which the supply of electric energy is diminished during the interruption. The power company shall not be liable for any further loss or damage with respect to such interruptions or dimensions beyond such abatement in the payment as aforesaid.

"Intentional Interruption.—If it becomes necessary for the purpose of repair or other good cause to make an intentional interruption, the power company shall give due notice to the customer and make such interruption at that time during the 24 hours following receipt of said notice as shall be reasonably selected by the customer, and such interruption shall not last for more than one hour in any consecutive 24 hours, nor shall the total number of such intentional interruptions amount to more than six in any calendar month, provided further that, should such intentional interruptions extend beyond the above specified periods a deduction shall be made from the payment for energy of a sum equal to twice the amount which the customer would have paid for a supply during the periods of interruption in excess of those specified above."

In the above case the supply was to a factory operating 24 hours a day, so that interruption at any hour represented loss to the customer.

(2). "That in case the producer shall not at all times furnish said energy as aforesaid, it will rebate to the customer such sum as equals the charge made by it against the customer for energy for and during the period of time only wherein energy has not been so furnished, and such rebate is hereby fixed as liquidated damages for and on account of such failure to furnish said energy, and shall be received by the consumer as in full settlement by the producer of all claims and demands of the consumer for injury and loss directly and indirectly resulting by reason thereof."

(3) "The power company shall not be liable for any penalty on account of breakdown of their generating plant, transmission line, transformers, or other apparatus, but the power company hereby agrees that should it make default after the above specified date for the commencement of supply in affording a full and sufficient supply of energy as provided in this agreement (such default not being due to breakdown or to stoppage for temporary purposes at a time agreed upon with the customer), the power company shall be liable to pay to the customer a penalty of $10 per hour during the continuance of such default. In the event of the power company failing to supply from any cause for a week at one time or 10 whole days in one month, the customer shall have power, by notice in writing to the power company, to cancel this contract."

(4). "In case the commission or the company should at any time be prevented from delivering said power or any part thereof.....by strike, lock-out, riot, fire, invasion, explosion, Act of God or the King's enemies, or any other cause reasonably beyond their control, then the commission shall not be bound to deliver such power during such time.....

"If and so often as any interruption shall occur in the service of the company due to any cause or causes, other than those provided for by the next preceding paragraph hereof, the commission shall recover and pay to the said corporations as liquidated and ascertained damages, and not by way of penalty, as follows: For any interruption of less than one hour, double the amount payable for power which should have been delivered during the time of such interruption; and for any interruption of one hour or more, the amount payable for the power which should have been delivered during the time of such interruption and twelve times the last mentioned amount in addition thereto." "Hydro-Electric Commission of Ontario."

The above clauses cover quite a wide range of conditions and ideas as to how they should be met.

When such a clause is under consideration both sides are financially interested and biased; the power user often forgets the risk he has been running of heavy loss from the breakdown of his private power plant and endeavors to exact the largest penalty possible for any interruption, however short; the power company wish to avoid all liability as far as possible.

Let us endeavor to examine in a disinterested way what are the conditions under which it is reasonable to exact a penalty for interruption of supply.

The interruption or diminution may occur from:—

(1). Intentional Stoppage for necessary repairs, connection of new customers, etc. The time of such stoppage can generally be arranged with the customer to cause him no inconvenience, but the clause should call for as long notice as possible and guard against too long a stoppage overlapping with working hours. If this occurs, or if it is a case of a works operating the whole 24 hours, then a rebate on the account for power is just and reasonable.

(2). Unforeseen Breakdowns of plant, lines or other apparatus. In spite of every diligence and foresight such occurrence must happen sometimes. When they do it generally causes more direct loss to the power company than to the the individual customer, and furthermore, unexpected and accidental total interruption causes heavy indirect loss to the power company in a loss of prestige and confidence which hinders obtaining new customers at favorable rates. It may usually be safely assumed that the power company will use

more than "reasonable diligence" to avoid such occurrences, and it is not reasonable to exact heavy penalties in such cases.

At the same time the power company have taken a contract to supply power continuously and the matter of breakdown is very largely, though not entirely, in their control; by expending capital in reserve plant and duplicate transmission lines, and employing competent and well-paid assistants they can very largely minimize the risk.

Furthermore, there is always some risk that a breakdown having occurred, the utmost possible will not be done to shorten the time of interruption; to do the utmost possible often involves heavy expenditure to save a few hours, such, for instance, as sending heavy parts of machinery by express instead of freight, executing expensive temporary work, paying high wages for overtime, etc.; it is but human nature that heavy expenditures to save a short time will be shirked if there is no counterbalancing penalty, and yet even a few hours interruption may mean heavy loss to a manufacturer.

The end to be desired, therefore, is not to heavily penalize a company for an unavoidable breakdown, but to secure that the length of interruption is as short as humanly possible.

This might be secured by arranging the penalty on a sliding scale; the penalty for the first hour could be very moderate and thereafter it could increase rapidly with every additional hour of interruption; thus, if it was to start at $10 for the first hour and to increase by 50 per cent., it would be $15 for the second hour, $22.50 for the third hour, and so on.

(3). Shortage of water, ice troubles, or in case of a steam station, shortage of coal, and similar causes.

Barring very exceptional cases, these causes may be considered under the control of the power company, and to be avoided by reasonable foresight and diligence. Contracts should not be taken for the supply of more power than is justified by low-water records for ten years or more, ice troubles can be guarded against by competent engineering and sufficient capital expenditure, shortage of coal can be guarded against by providing adequate storage and using foresight and prudence.

The customer should be protected against interruption and loss from such causes, and they might well be specially named in the contract.

(4). Undue Preference.—It sometimes occurs that a power company will favor one customer to the detriment of others. For the purpose of financing an enterprise advance contracts are frequently made at low rates and subsequently other contracts are obtained at more remunerative prices. When it comes, then, to a shortage of power obtainable from the plant as a whole or a shortage due to part of the machinery being "laid off," or to great pressure from a customer having a "pull," or to a question of supplying additional power under the terms of a contract made at low rates, this undue preference is liable to affect the customer, and any customer is entitled to liberal protection against such a contingency

(5). Diminution of the Supply.—It may be considered that variations in the voltage and frequency of supply are equivalent to a diminution in the supply, for such variations, if at all frequent or lasting an appreciable time, may cause more actual loss to the customer by affecting the quantity and quality of his output than an occasional total interruption. Most contracts contain stipulations on this point, but few, if any, specify any penalty for breach, and this being a matter decidedly under control of the power company, the customer should have, and should see that he secures, adequate protection in this matter.

Variations of voltage and frequency were discussed in the previous article of this series.

Summing up the principal points discussed above, it is suggested that the penalty clause should cover:—

(1). Intentional stoppage for necessary repairs, etc., involving a moderate penalty if the stoppage overlaps with the hours when supply is needed.

(2). Unforeseen breakdown, when a moderate penalty is justified, and it is suggested that this might be on a sliding scale depending on the length of interruption.

(3). Interruptions due to shortage of water, or coal, ice troubles, etc., which it is suggested should be specially named in the contract and provided for.

(4). Undue preference by the power company.

(5). "Diminution," due to irregular voltage and frequency.

The last three points are those which, in the opinion of the writer, are most frequently the cause of trouble and loss to the power user, and those on which he should be most fully protected in the contract.

It also appears advisable, though it is not usually done, to embody a clause providing that an interruption lasting more than a certain time, or interruptions occurring with more than stated frequency shall be sufficient cause for the customer to cancel the contract. This leaves the customer an opportunity to change his arrangements if the contract is not satisfactorily carried out.

RAILWAY EXTENSIONS IN BRITISH COLUMBIA.

The announcement of the provincial government's railway policy is awaited with considerable interest. Now that people are coming into British Columbia there is urgent demand for means of transportation to and from the vast unopened districts, rich with resources and abundant with possibilities. The government has proceeded slowly to date with railway matters, but now that there is a demand for lines, it will very probably present a policy that will meet with approval. It will provide for railways on both Vancouver Island and the mainland. The line on Vancouver Island from Nanaimo to Alberni is in operation, and another extension of the Canadian Pacific Railway is proposed to the northern part of the island, which will give transportation facilities to the greater part of that vast undeveloped portion of the province.

The Canadian Northern's line to Barclay Sound provides for the southwestern part, and a line along the west coast north from Alberni, will complete a satisfactory system, though to make it thoroughly adequate some branches will be needed. There are large fishing and lumbering interests on the west coast, and a line will be of great service. The sea voyage is very rough and more than one staunch steamer has been lost on the stormy shores north of Cape Beale.

On the mainland, the biggest proposition is the line to the Peace River district, necessary if Vancouver is to retain the trade of the northern part of the province. Mr. A. G. McCandless, president of the Vancouver Board of Trade, has taken a special interest in this project, realizing how important it will be to this city and Victoria. He outlined the advantages of such a road before the board, and headed a delegation that went to Victoria to bring the matter to the attention of Premier McBride and his colleagues. The reply of the Premier was significant. He stated that the policy of his government contemplated a line through the territory mentioned.

Not only will such a line of railway be the means of the coast cities reaching the Peace River district country direct, but it will open a great extent of country, which now has entry only by trail. True, the Cariboo road runs north from

Ashcroft to Fort George, and has served a good purpose. A railway though, will enable settlers to take up land in the Pemberton and Lillooet valleys, be the means of developing the timber and mineral areas, and will tap a district north of the upper reaches of the Fraser that are now practically unknown. Vancouver wants the construction of the Peace River line.

North Vancouver will be greatly benefited by the extension of the Canadian Pacific Railway around the head of Burrard Inlet into the city on the north shore of Burrard Inlet. Plans have been filed at the registry office in New Westminster for such a line. It will not be very long, but will give North Vancouver direct railway connection, something it does not yet possess. Little thought has been given to the Canadian Pacific Railway in the matter of railway facilities for North Vancouver, and the proposed route is one of the simplest in reaching that city. It was to bring railways to the north shore that the bridge across the second narrows of Burrard Inlet was proposed, the construction of which is almost assured. It was concluded that with a suitable bridge over the inlet, the Vancouver, Western and Yukon, which holds a charter for construction to the north, would cross the inlet from its Great Northern connection, and probably go farther north.

The contract has been let for the construction of a plant for the Portland Cement Construction Company, a branch of the Associated Portland Cement Companies of London. This will be the second plant on Tod Inlet, Vancouver Island, and will be directly opposite the operating works of the Vancouver Portland Cement Company, established eight or ten years ago, and of which Mr. R. P. Butchart is general manager. The new plant will be one of a series to be constructed by the Portland Cement Construction Company across Canada, and the approximate cost is placed at $1,000,000. The contract has been awarded to the McAlpine, Robertson Construction Company, which has offices in Vancouver, and which is a branch of Robert McAlpine & Sons, of Glasgow and London.

Doubling of its power supply is the improvement already under way by the British Columbia Electric Railway Company. The company has a large plant on the north arm of Burrard Inlet, and it is proposed to construct another tunnel to Lake Buntzen and duplicate its generating plant on the shore of the inlet. It is proposed also to increase the output of its auxiliary steam plant from 12,000 to 20,000 horsepower. This will give 105,000 horsepower, and the work will involve the expenditure of approximately $1,000,000. An effort will be made to complete the work at the end of the present year. Three Doble waterwheels, with a capacity of 14,000 horsepower each, will be needed and the contract for these has been let to the John McDougall Caledonian Iron Works Company, Limited, of Montreal. The generators will be manufactured by Messrs. Dick, Kerr & Company, London. This work will be the largest development enterprise in hand for the present in the province.

WORLD'S CONSUMPTION OF BUNKER COAL.

The suggestion that the opening of the Panama Canal may render feasible the establishment of a great American station for supplying coal from the mines of the United States to vessels of the world lends interest to an estimate prepared by the Bureau of Statistics, Department of Commerce and Labor, of the coal consumption on the oceans of the world. The statement estimates the coal consumed on the oceans of the world at approximately 75 million tons per annum, valued at over 250 million dollars.

An exact statement of the quantity of coal consumed by the merchant marine and navies of the world cannot be made, owing to the fact that comparatively few countries state the quantity of coal supplied to vessels for their own use, or for "bunkering" purposes. The United States statistics show about 9 million long tons supplied to vessels at ocean ports to be placed in their bunkers for their own use, and the British reports show about 20 million long tons supplied to vessels in the foreign trade and 2½ million tons to vessels in the coastwise trade. This would make for the two great coal producing countries of the world—the United States and the United Kingdom—a total of over 30 million tons supplied directly to vessels for "bunkering" purposes. In addition to this, however, a very considerable percentage of the coal sent out of Great Britain as "exports" passes to ports and stations in various parts of the world from which it is finally supplied to ocean vessels for fuel purposes. A paper presented before the Royal Statistical Society of England by D. A. Thomas, M.P., stated that:

"The great bulk of our export of coal is for the use of steamships, and it is within the mark to say that over half of our exports are for navigation purposes. . . .Cardiff alone ships over a million tons annually to Port Said, over a half million to Malta and Gibraltar, about the same quantity to Cape Verde and the Canaries, over 300,000 to Colombo, and large quantities to Aden, practically the whole of which goes to bunker steam vessels calling to coal at these depots."

As the British exports of coal, aside from that recorded as supplied to vessels for fueling purposes amounted in 1910 to over 62 million long tons, the above quoted estimate would seem to justify adding to the 30 million tons recorded as bunker coal by the United Kingdom and the United States another 30 million as the share of British exports which finally becomes bunker coal through purchase for bunkering purposes at ports or stations to which it was originally exported. While the Bureau of Statistics is unable to state the share of American coal exports which become vessel supplies (aside from that actually reported as bunker coal and not included in the export statement) it is quite probable that a considerable percentage of the coal from the United States which passes to the West Indian Islands and the coast of Mexico, is used for vessel fueling. Add to this the more than two million tons supplied by the Japanese mines to vessels engaged in the foreign trade, the more than 1 million tons supplied from Australia, the nearly 1 million tons supplied from India, plus the estimated consumption of about 3 million tons by the navies of the world, and the Bureau of Statistics estimate of an average of 75 million tons consumed on the oceans of the world seem a conservative one.

The United States is by far the largest coal producer of the world, its production in 1910 being 441½ million metric tons, against 264½ million by the United Kingdom, 222 million by Germany, 39 million each by France and Austria-Hungary, 24½ million by Russia, 23 million by Belgium, 15 million by Japan, 14½ million by China, 13 million by Canada, and 12 each by Australian and India, the grand total of production in 1910 for all countries for which statistics are available being a little over 1 billion tons, of which about 40 per cent. is produced by the United States, about 23 per cent. by the United Kingdom, and about 20 per cent. by Germany.

The coal beds of the United States contain large quantities of coal especially suited to steamship use by reason of steaming qualities, freedom from danger of spontaneous combustion, and proximity to the seaboard. Canada will figure higher in the list in due time, and the opening of the Panama Canal should assist that end.

LOSS OF HEAD IN THE FLOW OF AIR.

The following information on friction loss in the flow of air is abstracted from Catalogue No. 137 of the Green Fuel Economizer Co.:

Loss of Head by Friction of Air in Pipes.—Friction or resistance to the flow of air through a flue or conduit can be expressed as a negative head to be subtracted from the total head possessed by the air before passage through the pipe. The head lost in friction varies with the velocity, the roughness of the enclosing surface, curvature of the channel and the form of the cross-section; it also depends upon the viscosity, which varies with the temperature. Moreover, the drop in head follows at high velocities a law different from that holding for low velocities. That is, below the so-called critical velocity the drop is proportional to the velocity, while above the critical velocity it becomes proportional to the square of the velocity. In flues of ordinary cross-section and with the velocities common in fan practice, the flow is turbulent, that is, above the critical velocity. For this condition the following expression for loss of head due to frictional resistance may be used, namely,

$$Hf = U^2 Y L Z \div 2g Q,$$

in which Hf is head in feet of air, [2]U is the velocity in feet per second, g the acceleration of gravity (= 32.17), Y a coefficient of friction, L the length of the pipe in feet, Z the perimeter of the pipe in feet and Q the cross-section in square feet. Values of Y are given on the accompanying chart. This gives the head lost in friction only and is not to be confused with the total loss of head required to force air through the pipe, since the head required to give the fluid velocity through the pipe is ordinarily included in the latter. Also, it applies only to straight parts of the flue. Bends and obstructions in the pipe will cause additional losses of head.

$$Hb = \frac{U^2}{2g} (b_1 + b_2 + \text{etc.}),$$

wherein b equals 1.1 for right angled sharp corners.

0.3 for sharp angles of 135 degrees,

0.25 for a right angled bend of which the radius is equal to the diameter of the pipe.

0.15 for a right angled bend of which the radius is 2 to 4 times the diameter of the pipe,

0.07 for a right angled bend of which the radius is 5 to 6 times the diameter of the pipe,

Zero for bends of which the radius is more than 6 times the diameter of the pipe,

0.15 for a branch turning off at 135 degrees.

1.5 for a grill or register of which the free area is one-half the total area and the free area is equal to the cross-section of the pipe line,

0.75 when the area of the register is one and one-half times the cross-section of the pipe.

When the free area of the grill or register is 0.2 that of the total grill, b = 2 when the free area is equal to the area of the flue and 1.0 when it is equal to 1½ times the area of the flue.

For sudden changes in the cross-section of the flue, $b = [(Q_1 \div Q_2) - 1]^2$, in which Q_1 is the cross-section of the large pipe and Q_2 the cross-section of the small pipe and b is used in connection with the velocity in the large pipe.

Loss of Head Through Orifices, and Equivalent Orifices.—Since the head required to produce a given flow, S, of air through an orifice increases as the square of the flow, and since the head required to overcome the friction of bends, contractions and other obstructions in the air circuit also increases as the square of the flow, we may write the equation of the complete circuit as follows:

$$H = R S^2$$

wherein H is the total head required to force the volume S in cu. ft. per second through a circuit of which the total resistance is R. If R be expressed in appropriate units, 1 ft. head of air will produce a flow of 1 cu. ft. of air per second, through 1 unit of resistance.

Experiments made by W. N. Shaw indicate that such a unit or standard resistance would be that of an orifice in a thin plate of area a, where $a^2 = {}^1/_{27}$ or a = 0.189 sq. ft. If the aperture is circular and of diameter d, then $(\pi d^2) \div 4 = 0.189$, or d = 0.498 ft. In other words, a circular aperture of a diameter of about 6 inches, will have unit resistance according to the above definition. Since the head consumed

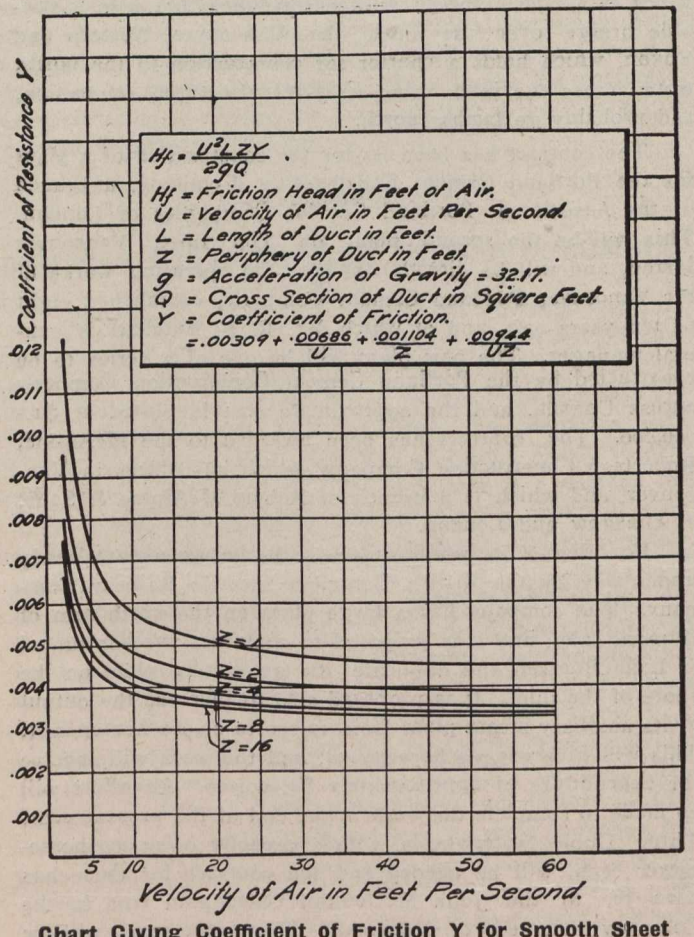


Chart Giving Coefficient of Friction Y for Smooth Sheet Iron Pipes.

by resistance increases as the square of the velocity of flow, it will further appear that the resistance of an orifice varies inversely as the square of the area of the orifice.

When different resistances are passed in series by the current of air, the total resistance of the circuit is the sum of the pneumatic resistances of the several parts arranged in series. For instance, suppose a room to have on one side an inlet orifice 6 in. diameter and on the opposite side an outlet orifice 1 ft. diameter. The resistance of the inlet orifice, according to the above definition, will be 1. The area of the outlet orifice is four times as great as that of the inlet orifice, and the resistance will therefore be ${}^1/_{16}$ and the total resistance encountered in forcing the air into and out of the room will be $1{}^1/_{16}$.

[2] Head of feet of air may be converted into pounds per square foot by reference to Table I., and this to inches of water by multiplying by 12/62.4.

If air flows from one point to another by two different paths simultaneously, the drop in head over each path will be the same. If the resistances of the two paths are R_1 and R_2 respectively, we will have the equations

$$H = R_1 S_1^2$$
$$H = R_2 S_2^2 \text{ and}$$

also if the total flow is S we will have

$$H = R S^2$$

where R is the resistance equivalent to the combined resistances of the two circuits in parallel.

From these three equations we may easily deduce, since $S = S_1 + S_2$, the following:

$$(1 \div \sqrt{R}) = (1 \div \sqrt{R_1}) + (1 \div \sqrt{R_2})$$

Then if we substitute for R, R_1 and R_2 their equivalents, namely

$$\frac{1}{27a^2} \quad \frac{1}{27a_1^2} \text{ and } \frac{1}{27a_2}$$

where a, a_1 and a_2 are the respective areas of the equivalent orifices, we have $a = a_1 + a_2$, or in words, the combined air-passing capacity of orifices or channels in parallel is the same as that of a single channel whose equivalent thin plate orifice is equivalent in area to the sum of the areas of the equivalent thin plate orifices for the separate channels.

We may, therefore, speak of the thin plate orifice equivalent to the resistance of a mine, although the mine may contain many passages in parallel and series. Or we may speak of the equivalent orifice of a duct or a complex ventilating system, or the equivalent orifice corresponding to the grates, the fuel on the grates, the boiler passages and the chimney of a steam boiler plant. Or, if we know the equivalent orifices of the several parts which are arranged in series and in parallel, we can easily calculate the equivalent orifice of the whole.

Shaw's experiments are based on the use of a circular orifice in a thin plate, and a comparison of his formula,

$$H = \frac{1}{27\ a^2} \times S^2,$$

with the formula for falling bodies

$$U^2 = 2g\ H,$$

wherein g = acceleration of gravity and U = velocity in ft. per sec., will show that the coefficient of this thin plate orifice works out as 0.653. That is, only 65.3% as much air is passed through the orifice as would be passed if the whole orifice were occupied by a stream moving with the velocity U theoretically due to the head H. Orifices of different shapes and with different conditions of approach or efflux, have different coefficients. For instance, if the up-stream side be provided with a raised edge the coefficient will be reduced to about 0.5. If the collar is on the discharge side, however, and is extended to form in effect a long pipe, the coefficient will be increased to a value approaching 0.83.

Table I.—Total Weight of Saturated Air in Pounds Per Cubic Foot.

	Dry Bulb Temp., Deg. F.			
	30	40	50	60
Barometer.				
28.5	0.07703	0.07541	0.07381	0.07224
29.0	.07839	.07674	.07512	.07352
29.5	.07974	.07806	.07642	.07479
30.0	.08110	.07939	.07772	.07607
30.5	.08245	.08072	.07902	.07734
31.0	.08381	.08205	.08032	.07682
Additional for each degree wet bulb depression	.000017	.000019	.000022	.000026

	Dry Bulb Temp., Deg. F.			
	70	80	90	100
Barometer.				
28.5	0.07067	0.06909	0.06748	0.06581
29.0	.07267	.07032	.06868	.06700
29.5	.07317	.07155	.06989	.06818
30.0	.07442	.07277	.07109	.06937
30.5	.07568	.07400	.07230	.07055
31.0	.07693	.07523	.07351	.07174
Additional for each degree wet bulb depression	.000031	.000037	.000045	.000055

AN ACT TO CHECK THE SPREAD OF TYPHOID.

The following is the text of a bill now before the Senate, which is of interest to all engineers dealing with sanitary matters:—

1. The Criminal Code is hereby amended by inserting therein, immediately after section 222 thereof, the following sections:

"222a. Every one is guilty of an indictable offence, and liable to one year's imprisonment, who endangers the lives or health of the public by emptying or depositing any excreta, whether solid or liquid, from a typhoid fever patient.

(a) into, or on the banks of, or near to, any lake, pond, well, river, stream or other water, from which, either directly or at any place lower down in the waterflow therefrom, any city, town, or village is supplied with water for drinking or domestic purposes, or,

(b) into, or on the banks of, or near to, any water discharging into such lake, pond, well, river, stream or other water, or,

(c) into any water-closet, drain, ditch, conduit, or sewer so discharging, or,

(d) into any privy or cesspool, or,

(e) by making any other disposition of such excreta, except as hereinafter specified.

"222b. Every one is guilty of an indictable offence, and liable to one year's imprisonment, who,

(a) being a medical or other attendant upon any person, and knowing that person to have typhoid fever, fails or neglects to give notice immediately to the health-officer of, or to the mayor or other head officer of, the municipality in which that person is being attended, or was attended, that the person had typhoid fever; or,

(b) being such health officer, mayor or other head officer, and having received such notice, fails or neglects to make promptly effectual arrangements to have the excreta, both solid and fluid, of such person treated with carbolic acid or such other disinfectant as will effectually destroy all bacilli and germs therein, and to have the said excreta after they have been disinfected, buried in the earth at least three feet below the surface of the ground and at least three hundred yards from any lake, river, pond, stream, drain, ditch, conduit, sewer or other waterway."

2. Section 223 of the Criminal Code is hereby amended by substituting for the words "last preceding section" in the third line thereof, the words "three sections last preceding."

3. In every city, town, or other municipality wherein a case of typhoid fever occurs, or has occurred within one year next before the passing of this Act, this Act shall be published at least twelve times in a daily or weekly newspaper in or near the locality where such case occurred.

Metallurgical Comment

T. R. LOUDON, B.A. Sc.

Correspondence and Discussion Invited

MICROGRAPHIC EXAMINATION OF FAILURES.*

J. S. Glen Primrose, A.C.T.S.

The "Metallographic Examination of Engineering Materials" has been so enormously developed within recent years that it has given experts an extremely valuable insight into the internal structure of most alloys, of which iron and steel are the most important, and shows that in many cases the proximate composition, as revealed by the microscope, is of more importance than the chemical composition. Metallography has emerged from the stage of doubt and uncertainty in which it for a time existed, and has now attained a position of practical importance in no way secondary to physical testing or chemical analysis, so that practically every steel works of note possesses a photo-micrographic equipment, and many engineering shops are following suit. The engineer himself may not have the time available during his training to devote to a study of practical metallography, and, even in practice, be unable to perform a microscopical examination for himself; but he should at least have sufficient knowledge of the rudiments of the art, that he can comprehend the report and illustrations of an expert metallographist, and understand how it is possible to arrive at a fairly accurate idea of the life history of the materials with which he has to work, and also ascertain their fitness for any particular purpose.

The chief advantage of metallography over the ordinary methods of chemical analysis is that it is much more rapidly performed, and can deal with portions of metal much too small for analysis, and, further, it reveals the mode of arrangement of the constituents, whose presence only is detected by the analysis. Unlike the ordinary methods of mechanical testing, it can be carried out without destroying or even injuring the test-piece, which for micrographical purposes need not be detached from the work. The microscopical examination cannot only be done before putting the material into service, but it can also be applied in the case of a failure, and the metal right up to the place of fracture can be inspected

After pointing out the limitations of the art, the author described the most modern methods of work applied in a systematic metallographic examination, as also the latest forms of microscopes and the influence of using different methods of illuminating the carefully prepared and polished specimens or micro-sections. The chief micrographical constituents of iron and steel were copiously illustrated by a series of original micrographs, showing the effect of increasing carbon content, also that of mechanical and heat treatment on the structure, as shown by the various magnifications obtained with the metallurgical microscope.

Investigation of Failures.—The general method adopted in examining a case of failure was stated as first consisting in making a chemical analysis to determine faults due to incorrect composition or segregation of impurities. Static or dynamic tests follow to show up the defects arising from incorrect working of the material; and, as a final word, sections are examined microscopically to discover if wrong heat treatment or fatigue has been put upon the metal. Each method can afford independent evidence, but conclusions drawn from the combined results usually give the true solution.

FIG. 1.—Wrought-iron angle-bar, showing phosphide segregation in ferrite ground mass and black areas of slag. Magnification, 120 diameters.

FIG. 3.—Mild-steel plate, showing irregular arrangement of pearlite in the ferrite ground mass and two circular phosphide segregations. Magnification, 120 diameters.

FIG. 2.—Wrought iron, showing carbide inclusion as a dark band of pearlite in ferrite ground mass and black slag patches. Magnification, 60 diameters.

From the slides shown to illustrate some of the failures investigated by the lecturer photo-micrographs are reproduced on pages 748, 749, and 750. Fig. 1 shows the micrograph made from a portion of a wrought-iron angle-bar, the failure of which caused a serious boiler explosion, attended with fatal results. The actual fracture, which happened to be carefully preserved, showed quite a silky appearance, but a streak about ⅛ in. in from the bend, and parallel to it, exhibited quite a large crystalline structure much whiter than the remainder. The micro-section was taken across this, and shows in the figure quite a marked phosphide segregation running through the ferrite ground mass, and surrounding the elongated slag enclosures. As picric acid was employed in etching, the phosphide showed up highly colored in the actual specimen, although it only appears as a half-tone area in the reproduction. The quality of the metal was not inquired into at the subsequent inquiry, but the analysis give an average value of 0.34 per cent. of phosphorus, which was much too high, even apart from the embrittling manner in which it had segregated as phosphide. Clearly such metal should not have been employed in the position it was.

* Abstract of opening lecture delivered to the Glasgow University Engineering Society.

Another example of brittle wrought iron on investigation showed the fault to be due to the incomplete removal of the carbon, which did not appear unduly high on analysis, but the micro-section (Fig. 2) shows that the rolling had extended it into a flat plate, in which the carbon percentage would approximately be half of 1 per cent., and thus the tubes rolled from this material split, with disastrous results. The micrograph shows the central dark band of pearlite, and on either side the white ground-mass of ferrite with the slag extended longitudinally through it.

thus produced, there are two well-defined phosphide patches in the section, which, although colored in the sample, only show as dark circular stains in the ferrite. The section was taken from a portion of the plate close to the fracture, and the chemical analysis showed 0.14 per cent. of carbon and 0.08 per cent. of phosphorus.

A rail steel of medium-carbon content, which broke under the drop-test, showed the reason for failure very distinctly under the microscope, the micrograph being given in Fig. 4. This shows the much elon-

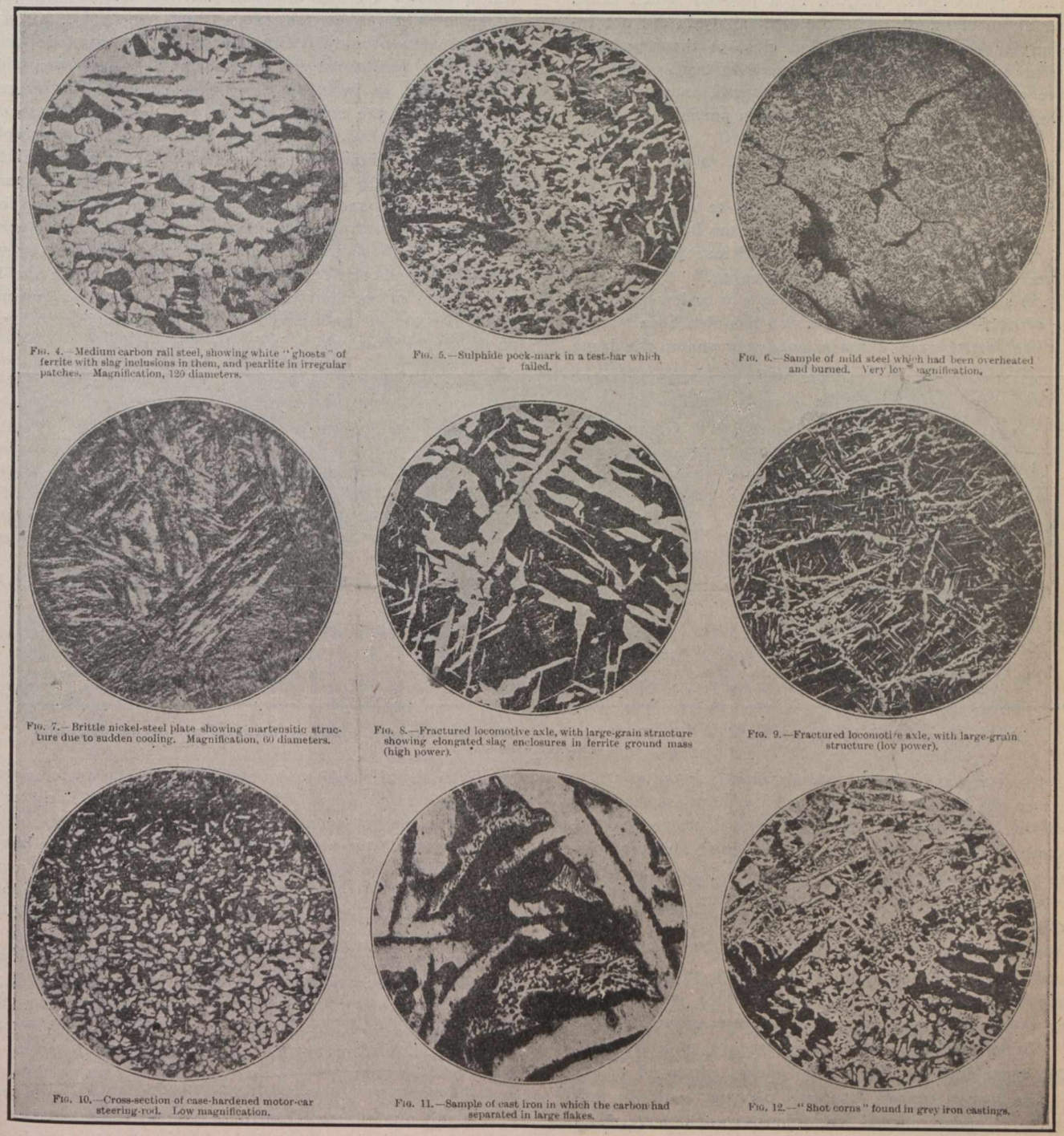


Fig. 4.—Medium carbon rail steel, showing white "ghosts" of ferrite with slag inclusions in them, and pearlite in irregular patches. Magnification, 120 diameters.

Fig. 5.—Sulphide pock-mark in a test-bar which failed.

Fig. 6.—Sample of mild steel which had been overheated and burned. Very low magnification.

Fig. 7.—Brittle nickel-steel plate showing martensitic structure due to sudden cooling. Magnification, 60 diameters.

Fig. 8.—Fractured locomotive axle, with large-grain structure showing elongated slag enclosures in ferrite ground mass (high power).

Fig. 9.—Fractured locomotive axle, with large-grain structure (low power).

Fig. 10.—Cross-section of case-hardened motor-car steering-rod. Low magnification.

Fig. 11.—Sample of cast iron in which the carbon had separated in large flakes.

Fig. 12.—"Shot corns" found in grey iron castings.

The micrograph reproduced in Fig. 3 was taken from a mild steel plate which fractured very badly on bending, although the test-piece had come up to specification tests. The structure shows a very elongated and irregular arrangement of the pearlite through the ferrite ground-mass, indicating that the metal had been finished at too high a temperature, and either not afterwards annealed, or annealed at too high a temperature. In addition to the brittle effect

gated bands of ferrite, free from carbon, and known as "ghosts," in which has been entangled quite a considerable amount of slag. This is seen to be grey in shade and quite distinct from the irregular pearlite areas, which under a higher power were seen to be well laminated (indicating that the metal had been left to cool slowly from an over-heated condition), and not sorbitic in character, as it would be in a properly-finished rail. The

carbon content was slightly low at 0.3 per cent., but the weakness was undoubtedly due to the structure being traversed by the weak ferrite bands, and also to the slag inclusions which increase the tendency for the metal to split along the "ghosts."

Failure is not commonly due to the presence of sulphur in the form of sulphide segregations, but when these occur the metal is found to be not only "red short," but also to develop brittleness when cold, and fail by fracture under even moderate stresses. Fig. 5 shows the micrograph of a sulphide "pock-mark" noticed in a test-bar which failed to come up to standard. The chemical analysis did not indicate any marked segregation, but close to those parts of the bar at which the skin had puckered in testing, the appearance was found to be very much altered, as seen in the the lower part of the micrograph. In this portion both manganese and iron sulphides were recognized, and embedded with these in the ferrite were considerable masses of scoriaceous or slaggy matter.

A very general fault in annealing is to raise the temperature too much, and this gives rise to too large a crystal growth, readily recognizable under the microscope, and even in extreme cases to what is called "burning."

Fig. 6 shows the appearance under a very low power of a piece of over-heated mild steel which has also been "burned." The ferrite ground mass not only shows the large crystal structure and irregular distribution of the pearlite, but heat cracks have made their way into the mass from the edge of the billet and left the characteristic track of oxide film, showing up as a black inclusion. Whilst for over-heating the remedy is proper annealing and rolling or forging, for the defect of "burning" produced in this way there is no remedy, short of remelting the material, if the oxide films have penetrated to any considerable depth.

A somewhat unusual type of brittleness was shown by a consignment of nickel-steel plates, which were unfortunately scrapped before the micrographic examination was made. Along one edge the plates were almost glass-hard, and had considerably damaged the shears employed to cut them. The carbon content was only 0.33 per cent., so that the structure under normal conditions should have been pearlitic; but Fig. 7, under a high power, shows the appearance, which is a strongly martensitic or triangular structure. This brittleness could only have arisen by a drastic quenching, and inquiry elicited the fact that some of the plates, whilst on the cooling bank, had been exposed to the action of a heavy snowfall, which sudden cooling was practically equivalent to quenching. This defect could therefore have been easily rectified by a suitable annealing.

One of the most interesting cases of failure investigated by the author was that of a locomotive axle which fractured while the engine was travelling at express speed, but fortunately without serious result. In the summing up of the inquiry blame was largely thrown upon the design of the built-up axle, and yet the two micrographs reproduced in Figs. 8 and 9 clearly show that the metal was in itself distinctly faulty, even although it has passed specification tests. The chemical analysis gave the carbon content as 0.43 per cent., and the sulphur and phosphorus were well within the limit; but on testing the material for tensile strength it broke at an ultimate stress of 30½ tons per sq. in., and gave an extension of only 6¼ per cent. on the 3-in. test-piece, which was the largest size available. The low-power micrograph (Fig. 9) indicates from the large size of the grain structure that the metal had been left after manufacture in a brittle or overheated condition, possibly due to incomplete mechanical working, or the finishing of this at too high a temperature. The strongly marked lattice-work arrangement of the ferrite around and through the pearlite is characteristic of brittle and untrustworthy material. The higher magnification (Fig. 8) shows a further source of weakness by reason of the presence of elongated slag enclosures in the ferrite ground mass, and both of these defects had evidently given rise to the conditions favorable to developing "fatigue" of the metal from which it finally fractured.

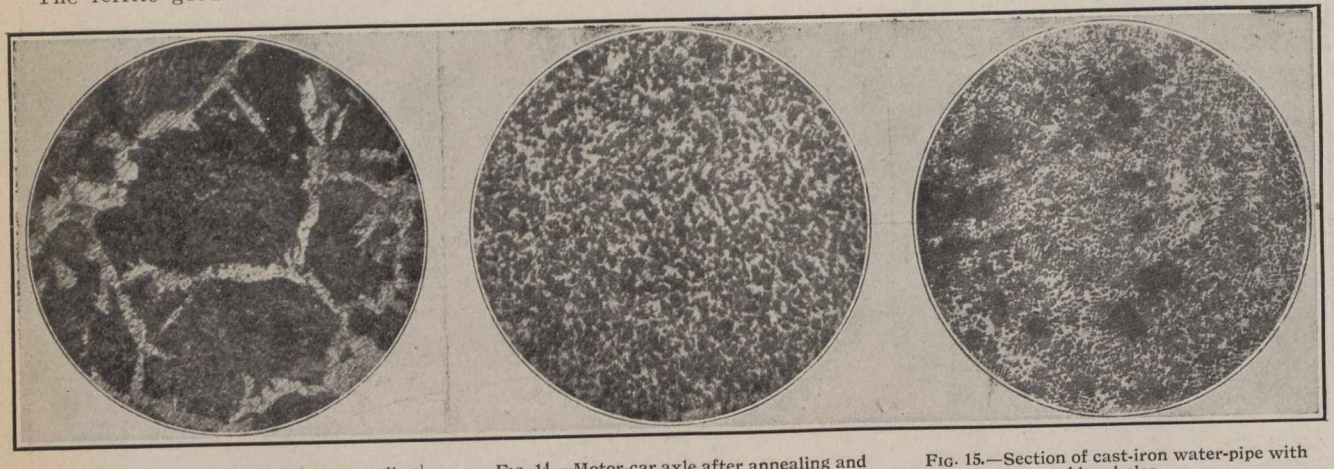


FIG 13.—Motor-car axle before annealing.

FIG. 14.—Motor-car axle after annealing and fairly rapid cooling.

FIG. 15.—Section of cast-iron water-pipe with blow-holes.

Such metal could undoubtedly have been restored to a proper condition by a suitable annealing and fairly rapid cooling before being put into use, and instances were quoted to show how motor-car axles which developed serious brittleness had been heated and oil-quenched to produce the necessary reduction in the grain size and uniform distribution of the pearlite to give exceedingly durable material (Figs. 13 and 14).

The failure of a motor-car steering-rod, due to fracture, was shown to be due to the imperfect case-hardening of the material. Fig. 10 shows the micrograph of a cross-section near the point of fracture, and shows, even at the low magnification, the very sharp line of demarcation between the martensitic structure of the outer edge (shown at the top) and the mild-steel centre containing the ferrite ground-mass with small quantities of pearlite. Evidently a small heat or surface crack had penetrated the hardened skin, which, not being well cemented to the core, had yielded under the stress of a sudden twist.

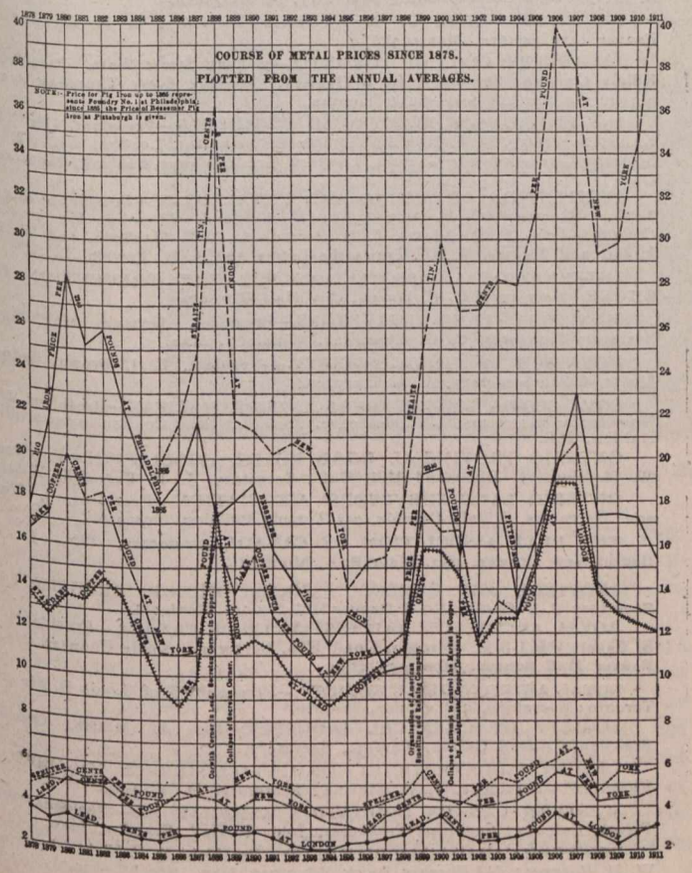
Cast iron is not usually called upon to withstand heavy stress put upon it, but hydraulic castings occasionally fail in a way which may appear mysterious without the aid of the microscope. One peculiar case of the failure of a heavy casting while in service was investigated, the test-bar having given entirely satisfactory results. It had cooled at a much

quicker rate than the metal in the casting, which was rather high in silicon for the thickness employed, with the result, as shown in Fig. 11, that the carbon separated in very large flakes, which were without doubt the cause of fracture. The metal was also weakened by the considerable degree of segregation of the iron phosphide, which appears as the eutectic mass enclosed within the dark pearlite areas.

Sometimes even grey iron castings fail on account of the separation within them, of minute "shot corns" or bullets of a very hard material, often attributed to chilled metal. In nearly every instance of such defects investigated by the author these were shown to be due rather to eutectiferous segregation of iron phosphide. These bullets are often much too small for analysis, but the microscope reveals the characteristic eutectic structure, as shown in Fig. 12, which not only illustrates the peculiar manner in which the pearlite areas are affected, but indicates how the iron phosphide can separate out in lozenge-shaped crystallites when above the eutectic proportion. This makes the portion of metal extremely hard and brittle to shock.

Blow-holes in castings are responsible for many failures, particularly in instances where the metal is desired as hard and close in the grain as possible. Fig. 15 illustrates the micro-structure of a water-pipe which failed badly under pressure, owing to the defective manner of casting, which had evidently produced too sudden a cooling. The ground mass had been converted into the cementite characteristic of a white iron, and the large amount of contraction had led to the formation of unsound patches in the interior of the metal, indicated by the dark holes scattered throughout the pearlite areas.

The lecturer claimed that there were many cases in which the microscopieal examination of metal before use would prove a great service to the engineer, particularly in preventing the use of faulty material unsuited for the purpose to which it was to be put.



ENGINEERING NOTES.

Ottawa, Ont.—The operation of the municipal electric light plant during the year 1911 was the best in the six years during which the plant has been owned by the city. A net profit of $27,716.37 is shown in the annual report. During the year $34,000 was spent on extensions to lines. The cost of constructing the white way, three miles in length, was $21,194. On the new conduit between the power house and the distributing station $38,505 was spent.

* * * *

Fredericton, N.B.—It is reported that Sir Thomas Tait, president of the Fredericton and Grand Lake Coal and Railway Company, has increased his holdings in the New Brunswick coal areas by the purchase of 112 acres of coal property.

* * * *

Montreal, P.Q.—The plans of the Harbor Board include the extension of Alexandra and King Edward Piers, the construction of a new pier to be known as No. 1. Two lift bridges, with railway and roadway accommodation, will be flung across the basin to the Guard Pier, where 1,600 feet of new wharf is to be built, thus materially increasing the accommodation of the port.

The construction of islets or anchorage banks in the Laprairie Basin, to hold the ice until melted in the spring.

The construction of grain elevator No. 2, and jetty at Section 19, with conveyors reaching adjacent piers.

The improvement and extension of the Harbor railway tracks from Victoria Pier to the Racine Wharf above winter water level, so as to be useful both summer and winter.

Completion of Victoria Pier and Market Basin, giving 2,700 lineal feet of high level quays for ocean steamers, with a depth of 35 feet at low water, and 4,000 lineal feet at low level quays for river vessels.

The erection of permanent sheds on the new Victoria high level quays, including equipment.

The lengthening of the Alexandra and King Edward Piers to about 1,200 feet each, and of the Jacques Cartier Pier to 1,100 feet, and a corresponding lengthening of the sheds upon them.

PERSONAL.

Mr. Charles Brandeis, C.E., of Montreal, has been appointed consulting engineer to the Saraguay Electric & Water Company, in place of his previous appointment, as chief engineer.

Messrs. Mitchell, Wilson and Holloway have been selected by Mr. L. E. Cousins to assist in the engineering work of the Harbor Board. These gentlemen were employed in the city engineer's department of Toronto.

Mr. J. P. Gordon has been appointed assistant chief engineer of the Hudson Bay railway. Mr. Gordon has been in the employ of the Hudson Bay railway two years in the capacity of locating engineer. Prior to this connection he held various engineering positions with several roads. His work has been entirely restricted to Western Canada. He held the position of locating engineer with the Great Northern railway in British Columbia for five years. Prior to that he was for about five years resident engineer with the Canadian Northern railway on the Prince Albert, Saskatchewan and Edmonton branches.

ENGINEERS' CLUB OF TORONTO.

The elections of the Engineers' Club resulted in the following gentlemen being appointed directors: Messrs. L. E. Cousins, A. J. Van Nostrand, A. L. McAllister, James McEvoy and George Powell. The election of the new officers will take place in the near future.

The statement prepared at the close of December, 1911, showed a membership of 423, of which there were 2 life members, 317 resident members, 70 non-resident, and 34 associate.

COMING MEETINGS.

CANADIAN FORESTRY ASSOCIATION.—February 7th and 8th, 1912. Forestry Convention Meetings held in the Railway Committee Room, Parliament Buildings, Ottawa. Secretary, Mr. James Lawler, Canadian Bldg., Ottawa.

CANADIAN LUMBERMEN'S ASSOCIATION.—February 6, 7 and 8, 1912. Annual Meeting to be held at the same time and place as the Canadian Forestry Association.

THE ENGINEERS' CLUB OF TORONTO, 90-96 King St. West.—Meeting, Thursday, Feb. 8th, 8 p.m. (in Lecture Room) of Canadian Section of Society of Chemical Industry. Address by Mr. F. N. Speller, Metallurgical Engineer, National Tube Co., Pittsburg, Pa., on "The Manufacture of Soft Steel Tubes in Relation to Corrosion." R. B. Wolsey, Secretary.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Tuesday evening, February 13, at eight-fifteen o'clock, in the Engineering Societies' Building, 29 West 39th St., New York, the American Institute of Mining Engineers co-operating. A paper entitled "Notes on Design and Mechanical Features of the California Gold Dredge" will be presented by Robert E. Cranston, consulting engineer for the Marysville Dredging Co., Marigold, Cal.

THE CLEVELAND ENGINEERING SOCIETY.—Regular Meeting, Tuesday Evening, February 13, 1912, Chamber of Commerce Bldg., Cleveland, O. Address by Mortimer E. Cooley, Dean, Department of Engineering, University of Michigan; Subject: "Public Utilities and Their Relation to the Public." Secretary, F. W. Ballard.

THE ENGINEERS' CLUB OF TORONTO, 90-96 King St. West.—Thursday, Feb. 15th. Dinner at 6-30; Lecture at 8 p.m., in Dining Room. After dinner address by Prof. W. R. Lang, Major Canadian Engineers, "Organization, Administration, Duties and Achievements of the Engineering Forces of the Crown," illustrated with models and lantern slides of Bridges constructed by the Royal Engineers in different parts of the Empire. R. B. Wolsey, Secretary.

CANADIAN NATIONAL ASSOCIATION OF BUILDERS.—The Sixth Annual Convention will be held in Toronto, February 20, 1912.

ONTARIO GOOD ROADS ASSOCIATION.—Annual Convention to be held at Toronto, February 26, 27, 28. Secretary, J. E. Farewell, Whitby.

THE ENGINEERS' CLUB OF TORONTO, 90-96 King St. West.—Thursday, Feb. 29th, 8 p.m. Meeting of Toronto Branch of Canadian Society of Civil Engineers. R. B. Wolsey, Secretary.

THE CANADIAN MINING INSTITUTE.—Annual meeting held in Toronto, March 6th, 7th and 8th, 1912, the American Institute of Mining Engineers co-operating; also important delegates of the Institute of Mining and Metallurgy of Great Britain will be present. Secretary, H. Mortimer-Lamb.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE; Secretary. Professor C. H. McLeod.

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, T. C. Irving; Acting Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary E. Brydone Jack. Meets every first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

MUNICIPAL ASSOCIATIONS.

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready City Clerk, **Fredericton.**

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bec, Lemberg; Secretary, Mr. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

CANADIAN TECHNICAL SOCIETIES.

ALBERTA ASSOCIATION OF ARCHITECTS.—**President, G. M. Lang;** Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Thomas Southworth, Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President. Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. Frank D. Adams, McGill University, Montreal; Secretary. H Mortimer-Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 **Union Station. Meets third Tuesday each month except June, July, August.**

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Killaly Gamble; Secretary, R. B. Wolsey. **Meeting every Thursday evening during the fall and winter months.**

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; **Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.**

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. **Canadian Members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain, and W. H. Miller, and Messrs. W. H. Trewartha-James and J. B. Tyrrell.**

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary, R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C.B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, J. E. Farewell, Whitby.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. Whitson; Secretary, Killaly Gamble, **703 Temple Building, Toronto.**

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5 Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

TENDERS PENDING

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page
Calgary, Alta., bridge	Feb. 10.	Jan. 18.	86
Calgary, Alta., sluice gates	Feb. 29.	Feb. 1.	68
Galt, Ont., Y.M.C.A. building	Feb. 24.	Feb. 1.	59
Hamilton, Ont., works supplies	Feb. 6.	Jan. 25.	59
Lajord, Sask., schoolhouse	Feb. 10.	Jan. 25.	59
Little Lameque, N.B., wharf	Feb. 14.	Jan. 25.	59
Kerrisdale, B.C., valves, hydrants, etc.	Feb. 19.	Feb. 1.	59
Lake Quinze, Que., dams and sluiceways	Feb. 15.	Jan. 25.	59
Lloydminster, Sask., public building	Feb. 7.	Jan. 25	59
Lethbridge, Alta., extension to power house	Feb. 15.	Feb. 1.	59
London, Ont., engines and pumps	Feb. 14.	Feb. 1.	70
Meaford, Ont., construction work on E. Breakwater; dredging	Feb. 26.	Feb. 1.	59
Ottawa, Ont., launches	Feb. 24.	Feb. 1.	59
Ottawa, Ont., contracting machinery	Feb. 26.	Jan. 11.	59
Saskatoon, Sask., subway	Feb. 23.	Jan. 25.	68
Saskatoon, Sask., pavements	Feb. 16.	Jan. 18.	86
Saskatoon, Sask., concrete sidewalks	Feb. 16.	Jan. 18.	86
Swift Current, Sask., theatre	Feb. 16.	Jan. 25.	59
Toronto, Ont., track intersections, etc.	Feb. 20.	Jan. 25.	72
Toronto, Ont., bridges	Mar. 2.	Feb. 1.	59
Upper Salmon River, N.B., pier	Feb. 14.	Jan. 25.	59
Winnipeg, Man., drawings for Parliament Buildings	Mar. 31.	Jan. 25.	70
Winnipeg, Man., pumping machinery	Mar. 1.	Jan. 25.	72
Winnipeg, Man., piers and abutments, Red River bridge	Feb. 14.	Feb. 1.	59
Winnipeg, Man., transformers and accessories	Feb. 8.	Feb. 1.	59

TENDERS.

Calgary, Alta.—Tenders will be received at the office of the Division Engineer, Calgary, until noon of February 18, 1912, for concrete substructures, excavation, etc., for overhead bridges and subway at Edmonton. Full particulars at Chief Engineer's Office, Edmonton; Asst. Engineer's office, Strathcona, and office of N. E. Brooks, Div. Eng., Calgary.

Edmonds, B.C.—Tenders will be received until March 11, 1912, for the supply of about 35 miles of steel pipes, varying in diameter from 3 to 10 inches, for the municipality of Burnaby Water Supply. W. Griffiths, Clerk Municipal Council. (See advt. elsewhere in Can. Eng.)

Moose Jaw, Sask.—Tenders will be received until February 12, 1912, for the erection of the Saskatchewan College and principal's residence, plans and specifications of which may be obtained at the office of R. G. Bunyard, architect, Room 6, Bank of Commerce Chambers, Moose Jaw.

Ottawa, Ont.—Tenders are invited for the construction of a quarantine station at Keremos, B.C., specifications of which may be obtained from Wm. Thompson, V.S., of Keremos, B.C. Tenders to reach Ottawa not later than March 1st, 1912. A. L. Jarvis, Asst. Deputy Minister and Secretary of Agriculture, Ottawa.

Ottawa, Ont.—Tenders will be received by the secretary Board of Control, City Hall, until February 13, 1912, for the supply of broken stone, brick, stone setts, cement, plank and cedar, sand, vitrified clay pipe, asphalt, castings, street sweeper's brooms, hardware, or street sprinkling wagons. Full particulars at office of Newton J. Ker, City Engineer, Ottawa. (See advt. elsewhere in Can. Eng.)

Ottawa, Ont.—Tenders will be received by the secretary of the Water Works Committee, until February 13, 1912, for the supply and delivery of brasswork, special pipe castings, hydrants, cast-iron pipe, lead pipe and pig lead, valves, oils and grease, as the case may be. Full particulars at the office of Newton J. Ker, City Engineer, Ottawa. (See advt. elsewhere in the Can. Eng.)

Ottawa, Ont.—Tenders will be received until February 20, 1912, for the construction of east and west highway approaches to the steel service bridge over the Red River at Lockport, Selkirk County, Man. Plans, specifications, etc., may be obtained at the offices of W. Z. Earle, Esq., Dist. Engineer, 504 Ashdown Block, Winnipeg, Man.; J. G. Sing, Esq., Dist. Engineer, Confederation Life Bldg., Toronto. Ont.; J. L. Michaud, Dist. Engineer, Merchants Bank Bldg., St. James St., Montreal, P.Q.; Postmaster at Lockport, Man., and R. C. Desrochers, Secretary Dept. of Public Works, Ottawa.

Ottawa, Ont.—Tenders for the design and construction of a schooner for Pacific Coast Survey will be received until noon, February 15, 1912. Particulars with the officer in charge, H.M.C. Dockyard, Esquimalt, B.C. G. J. Desbarats, Deputy Minister the Naval Service, Dept. of Naval Service, Ottawa.

Ottawa, Ont.—Tenders for approximately 2,500 feet of 30-inch steel pipe in connection with the West End Drainage System, will be received by the Secretary of the Board of Control, City Hall, Ottawa, until February 15th, 1912, for the supply and laying same in the Ottawa River. Newton J. Ker, City Engineer. (See advt. elsewhere in Can. Eng.)

Toronto, Ont.—It is expected that the Northern Navigation Company will call for tenders in the near future for a 500-foot combined freight and passenger vessel. Mr. James Playfair, Midland, Ont., is president of this company.

Victoria, B.C.—Tenders for the erection and completion of a two-room frame schoolhouse at Port Alberni, in the Alberni Electoral District, B.C., will be received until February 14, 1912, by the Hon. the Minister of Public Works. Plans, etc., at the offices of A. D. Cooper, Secretary of School Board, Port Alberni, B.C.; the government agent, Alberni and Nanaimo; and office of J. E. Griffiths, Public Works Engineer, Dept. of Public Works, Victoria, B.C.

Victoria, B.C.—Bids for the supply of a new motor fire apparatus for the city of Victoria will be called for shortly. The new apparatus will consist of a combination motor hose and chemical wagon, an 80-gallon gas motor chemical and chassis for the present city service truck and engine at headquarters station.

COPIES OF ENGINEER WANTED.

A copy of our issue of March 30th, 1911, No. 13, is required. A month's subscription will be allowed to the party supplying this number.

Copies of the Canadian Engineer of the issue of January 18, 1912, are wanted. By forwarding same to the main office your subscription will be extended over another month.

CONTRACTS AWARDED.

Brantford, Ont.—Messrs. Schultz Bros. Company, Limited, have received the contract for the erection of a two-story schoolhouse on Chestnut Ave. The building will be comprised of basement, 84 x 112 feet, ten rooms, brick with reinforced concrete floors, concrete foundation, steam heating, electric lighting, etc.

Calgary, Alta.—Messrs. Nicholson & Bain, Winnipeg, wholesale commission merchants and brokers, have let a contract in Calgary for the erection of a six-storey solid brick warehouse and office building. It is also the intention of the firm to erect a large warehouse in Edmonton this year.

Carman, Man.—Tenders will be received until noon, February 17th, 1912, for the erection of two bridges over the Boyne River at Carman, Man. Plans and specifications for bridges may be seen at the office of the Manitoba Government Engineer at Winnipeg, Man., or at the office of A. Malcolmson, Secretary-Treasurer, Town of Carman, Man.

Edmonton, Alta.—The contract for the construction of the new municipal library has been let to William Ditz, local contractor, for $24,501.

Montreal, Que.—The contract for the erection of the new immigration buildings at Quebec has been awarded to Messrs. C. E. Deakin & Co., of Montreal. The sheds are to be erected by the government on the Louise Embankment. The new buildings are to be of steel and concrete, two stories high, over 700 feet in length, and will have accommodation sufficient for 1,500.

Montreal, Que.—The Canadian Pacific Railway Company have awarded a contract to Messrs. John S. Metcalf Co., Limited, Montreal and Chicago, for a reinforced concrete storage addition to their elevator at Port McNicholl, Ont. Capacity of additional storage will be 2,000,000 bushels, and estimated cost, together with additions to wharf work to enable travelling marine towers to reach new storage, is approximately $350,000.

New Westminster, B.C.—The contract for the construction of 6,900 feet of jetty at the mouth of the Fraser River has been awarded to Mr. T. F. Sinclair. Mr. Sinclair's tender of $171,000 was the lowest received, the Norton Griffiths Construction Company being second with a bid of $190,000. The other tenders received ranged up to $295,000 for the work.

Niagara Falls, Ont.—The contract for furnishing and installing the heating plant in the city hall has been awarded to J. T. Henderson, of this city, for $1,255. Three bids were received, the highest being $1,292.

Strathcona, Alta.—The Heenan-Frowde Co. have received the contract for the erection of an incinerator, at a cost of $40,200.

Toronto, Ont.—Tenders will be received until February 27th, 1912, for the construction of Toronto Junction Main Sewer, Section No. 4, Bloor St. Tunnel. G. R. Geary (Mayor), Chairman of the Board of Control, City Hall, Toronto. (See adv. elsewhere in the Can. Eng.)

Vancouver, B.C.—The contract for the supply of three large water turbines of 14,000 h.p. each, in connection with the power development of the B. C. Electric Railway, to be placed in a separate generating station on the North Arm of Burrard Inlet, has been awarded to the John McDougall Caledonian Iron Works Company, Limited, of Montreal; and the contract for the electrical generators, each of 9,000 k.w. capacity, has been given to Messrs. Dick, Kerr & Co., of London, England.

Vancouver, B.C.—The Grand Trunk Pacific has placed an order for 10,000,000 feet of lumber, mostly heavy timbers, bridge materials, etc., with the Victoria Lumber Manufacturing Company, of Chemainus, B.C. Lumber to be delivered in Manitoba to be used for construction east of Winnipeg.

NILE BRIDGE CONTRACT.

The tender of a Darlington (England) firm, the Cleveland Bridge and Engineering Company, has been accepted for the construction of a bridge to replace the Pont des Anglais over the branch of the Nile at Cairo known as the Bahr el Aama.

RAILWAYS—STEAM AND ELECTRIC.

Collingwood, Ont.—A report states that the Canadian Pacific Railway are preparing plans for an entry to this port.

Fort William, Ont.—Although there was a profit shown on the operating expenses of the street railway of over $55,000 in 1911, there was actually a loss of about $10,000 on that concern. Mayor Ray stated that the profit made on the street cars would not be sufficient to pay interest and sinking fund by $10,000, and therefore what was apparently a profit of $55,000, was actually a loss of $10,000.

Guelph, Ont.—A report states that the electric road to be built from Toronto to Guelph will go through Acton. Construction is likely to start this spring, but so far the plans of entry into Gelph have not been submitted to the Guelph city council for their approval.

Kingston, Ont.—The Canadian Pacific Railway intends shortly to take over and operate the Kingston and Pembroke Railway, and make extensive improvements.

London, Ont.—The management of the Lake Erie Coal Company have approached the municipal council of London with a view of electrifying the line of the London and Port Stanley Railroad.

Montreal P.Q.—Plans for the alteration of the C.P.R. bridge over Mountain street have been approved by the controllers. In connection with the laying of new tracks it will be necessary to widen the bridge, which already covers in a good part of the street between Dorchester and St. Antoine streets.

Montreal, P.Q.—A report states that the Montreal and Southern Counties Railway Company have under consideration the extension of its lines to Laprairie, Boucherville and Sorel, also having made an arrangement for the electrification and operation of the Montreal & Province Line Railway between St. Lambert and St. Cesaire, intending to extend the line from St. Cesaire to Granby, thereby giving the shortest route between Granby and Montreal.

Nanaimo, B.C.—The city of Nanaimo has given notice of its intention to apply to the legislature for authority to construct a railway from Nanaimo to Brecken, thence to Northfield, to East Wellington, through the Five Acre Lots to Extension, and thence to Nanaimo river bridge.

Ottawa, Ont.—The railway companies of Canada are taking steps to stop the practice of carrying explosives in baggage checked in the usual way and in packages of household furniture shipped as freight.

Port Colborne, Ont.—The Grand Trunk Railway will increase their yard accommodation at Port Colborne, and have leased from the Dominion Government all the government land lying between the Grand Trunk Welland line and Welland street.

Province of New Brunswick.—A third surveying party is to be started on work on the St. John Valley Railway.

LIGHT, HEAT AND POWER.

Montreal, P.Q.—Some weeks ago the Isle Au Heron Development Company filed with the Dominion Government a plan for the development of power at Isle Au Heron, practically opposite the Lachine power site. The drawings submitted show two parallel walls, between which a part of the flow of the river is intended to go and at the end is a concrete dam. The Hon. F. D. Monk announced that nothing, as regards approval of the company's plan or authorization of its undertaking, will be done until the Departmental engineers or the commission on St. Lawrence water power schemes reports fully in the matter.

Montreal, P.Q.—It is stated that the Cedar Rapids Manufacturing & Power Company will call tenders for the dyke and power house without much delay, as it is the desire of the company to begin active operations at the plant in the early spring. Mr. Henry Holgate, C.E., Montreal, is provisional president.

Ottawa, Ont.—A deputation from the Canadian Peat Society, assisted by a committee from the board of trade, will ask the minister of mines to have one or more engineers of his department sent to investigate and report on the

leading peat, gas power installations in Europe. Messrs. G. B. Greene, A. W. Fleck and John McKinley will represent the board.

Ottawa, Ont.—An additional 200 horse-power for the municipal electric plant will be ordered from the Ottawa and Hull Power Company. The order is to date from December 1st last. This will make 3,100 horse-power taken by the city for the plant. The cost is $15 per horse-power, making a total of $46,500.

Prince Rupert, B.C.—The newly formed council have decided to push the hydro-electric work with all possible speed. This work includes the construction of a large concrete dam and the installation of a steel or cast-iron pipe.

Regina, Alta.—The Leader Publishing Company are installing a private power plant and water system in their new building. The company have placed with the British-Canadian Engineering and Supply Company, of Winnipeg, an order for a 100-h.p. Ruston Proctor engine and gas producer plant, together with a 75-k.w. Westinghouse generator. The plant will be utilized at times for pumping water from the well which has been sunk in the basement of the building, and which will furnish a water supply independent of that furnished by the city.

Saskatoon, Sask.—The city commissioners have decided that the wiring for the new lighting standards shall be of armored insulated wire. This will do away with conduits as the wire is buried in a trench. This does away with the difficulty often experienced in handling wires for repair purposes when they are in conduits.

Smith's Falls, Ont.—The Smith's Falls Electric Light and Power Company have installed a new auxiliary steam power plant of the most modern type. The engine is one of the largest of its kind in Canada.

Toronto, Ont.—It is reported that the municipal engineering department will recommend that a water meter be placed in every house and a yearly inspection of mains be made.

Vancouver, B.C.—The engineers at work on the trunk sewers have announced the possibility of tenders being called within the next few days for the construction of work.

GARBAGE, SEWAGE AND WATER.

Brantford, Ont.—During January at the waterworks 86,308,275 gallons of water were pumped as against 75,244,066 gallons in 1911.

Ottawa, Ont.—A sand filtration plant to cost about $2,000,000 has been decided upon by the civic water committee. The municipal engineer, Mr. Ker, has been instructed to make the necessary surveys, etc., and to procure any assistance required. The plant is to be erected on Lemieux Island and the intakes will receive their supply from the river, the present source of supply.

New Westminster, B.C.—The city engineer, Mr. I. W. Blackman, has recommended that a new reservoir be constructed with a storage capacity of 5,000,000 gallons, also the extension of the present reservoir.

Port Colborne, Ont.—The Canadian Union Furnace Co. will put in its own waterworks plant and fire protection. If the town so desires the municipal system can be connected up with the company's system, and in case of a big fire or other necessity the company's supply will be at the disposal of the town.

Toronto, Ont.—The estimates of the property commissioner for 1912 include the following items:—Scavenging, $267,875; pound, $450; street cleaning, $65,774; culvert cleaning, $12,467; asphalt cleaning, $156,420; street watering, $8,006; street flushing, $23,361; road oil, $25,000; stable, $59,592; plant and shop, $32,542; horses, $10,500; crematory, $12,700; water, $237; rental, $1,550; inspectors' salaries, $4,800; total, $681,274.

Town of Edmonds, Burnaby, B.C.—Authority has been given the engineers to substitute six-inch for four-inch water pipes and to complete specifications and call for tenders for a supply of pipe to be laid under the 1912 waterworks by-law.

Toronto, Ont.—The experts advising the city of Toronto upon its water problem suggested in their report that a 25,000,000-gallon steam pump be added to the equipment at the main pumping station. The city engineer will bring the matter before the council.

Toronto, Ont.—The city engineer, Mr. Rust, advised the council to clean out the reservoir annually for at least two or three years, when it is hoped that the use of filtered water will render it unnecessary after that time for some years.

Victoria, B.C.—The municipal council have appointed a committee to investigate certain defects in Smith's Hill reservoir.

Victoria, B.C.—Since the first of the year the city health department has taken over the handling of street sweepings, and in consequence the quantity of refuse handled by the garbage collectors has materially increased, the amount now being daily handled aggregating some 150 loads or well over 100 tons.

Winnipeg, Man.—A committee to investigate the disposal of garbage and sewage may be formed.

BUILDINGS AND INDUSTRIAL WORKS.

Brantford, Ont.—The directors of the Brantford Roofing Company have decided to increase the plant during the coming year. At the annual meeting the directors recommended the increase of the machinery to double its present capacity, the installing of an entire new system and the addition of two new stills capable of turning out from 1,200 to 1,500 additional rolls of roofing daily.

Burnaby, B.C.—The construction of a wharf on the North Arm of the Fraser and the erection of a new stone crushing plant at an approximate cost of $12,000, are a part of the plans of the municipality of Burnaby for the year 1912.

Calgary, Alta.—The Dominion Government have decided to erect a new customs building. The building will be five stories in height and will extend the full size of the lot, 175 x 160 feet. The cost will be at least $300,000. A government architect will plan the building.

Calgary, Alta.—Announcement is made that Wood, Vallance & Adams, of Hamilton, Ont., wholesale hardware, have decided to locate a branch in this city. The firm will erect a four-storey building.

Galt, Ont.—A syndicate of Toronto and Galt financiers have formed a brick manufacturing company. The output will be 40,000 per day.

Kingston, Ont.—It is reported that the Grand Trunk Railway propose building a new passenger station in conjunction with proposed new freight sheds on the site of the hay market.

Kingston, Ont.—Proposed additions to the Canadian Locomotive Works are planned. Additional stories will be built to the present buildings, and a couple of new buildings will be started. The company contemplates spending $1,000,000 in improvements.

London, Ont.—The following is the statistical building report for the city:—

	No. of Permits.	Estimated Value.
January, 1911	27	$ 7,030.00
January, 1912	13	18,717.00

Moose Jaw, Sask.—The Prairie Oil Company, Winnipeg, Messrs. F. H. Rees & Company and Benjamin Olsen are negotiating with the municipal council regarding the erection of factories, etc.

Montreal, P.Q.—The Westmount Methodist Church will probably erect a new building at the corner of Roslyn Avenue and Sherbrooke Street. The Rev. W. E. Baker, pastor.

Niagara Falls, Ont.—The Urschel Bates Valve Bag Company of Toledo, Ohio, with branch factories in nearly all of the large cities in the United States, will install a branch at this point. The new factory will occupy what is known as the old mill property. Messrs. Hartman and Motler are representing the company.

Saskatoon, Sask.—Mr. Meyer J. Sturm, of Chicago, Ill., has been requested by the City Council to prepare plans for the new civic hospital.

St. John, N.B.—There is a probability that a pig-iron industry may be established at this point. A mining company at present is shipping ore to points in the United States. The increased bounties, at present engaging the attention of the government, will, it is claimed, enable them to smelt the iron at a profit in Canada. The question which is now engaging their attention is whether it would be cheaper to erect blast furnaces at the mines where the shipping facilities would be limited or bring it to this port.

Tilbury, Ont.—The Dominion Canners have issued instructions to the local management to proceed with the erection of a big addition to the local plant. The addition will be 180 by 40 feet.

Tod Inlet, B.C.—A report states that a local syndicate has completed all preliminaries toward the erection of a tourist hotel on Tod Inlet. Mr. Thos. Hooper, Victoria, B.C., architect, is drawing plans for the structure, which will have upwards of two hundred rooms.

Toronto, Ont.—The Confederation Life Association has secured a permit to build a one-story brick and steel addition to their Victoria street building, to cost $10,000.

Victoria, B.C.—Mr. H. S. Griffiths, architect, is preparing plans for an eight-story office building for the Dominion Trust Company, which will be erected on the corner of Fort and Douglas Streets.

Winnipeg, Man.—The T. Eaton Company has decided to square the present building and make a complete nine-floor structure with a frontage of 266 feet on Portage Avenue by 315 feet on Donald Street. There will also be installed five new passenger elevators and several freight elevators, two of the latter being so designed that they will carry either the delivery vans or loaded drays to the furniture floors where the loading and unloading will be done. Mr. H. McGee, vice-president, is considering estimates, etc.

Welland, Ont.—The plans of the Dominion Canning Company's plant to be erected in Fonthill, near Welland, have been issued. The main building will be three stories high, and will be used for canning tomatoes and fruit. It is expected that another large building will be put up in which corn and peas will be canned.

Winnipeg, Man.—An effort is being put forth by the members of the Anglican Church to build a cathedral near the centre of the city. It is the intention to have all the details sufficiently advanced to submit to the next meeting of the Synod in June.

BRIDGES, ROADS AND PAVEMENTS.

Kerrisdale, Point Grey, B.C.—This municipality is seeking government aid in the construction of a bridge across the deep ravine leading to the university site. It is estimated the bridge will cost in the neighborhood of $120,000.

Nelson, B.C.—A delegation waited upon the provincial government for the purpose of urging that body to construct a bridge across the Kootenay River.

Province of Ontario.—Experiments in treating clay roads with a solution of tannic acid will be conducted by Mr. W. A. McLean, provincial engineer of highways, during the coming spring and summer. This treatment will give a hardened surface to clay, rendering it tough and rubbery.

Welland County, Ont.—A report states that the good roads bill has received the official approval of the government, and will now be acted upon by the council.

York County, Ont.—Forty miles of macadam highway are to be constructed in this county. Mr. Ed. James, engineer. Tender will be found in this week's issue.

York County, Ont.—The York Highway Commission has deputed Messrs. J. J. Ward and George Henry to Ottawa with delegations from the Good Roads' Association, to wait on the Government on February 8, to ask for federal aid in the improvement of roads.

FIRES.

Halifax, N.S.—The Woodside plant of the Acadia Sugar Refining Company was totally destroyed by fire with a loss of over a million dollars.

Woodstock, Ont.—Fire damaged the Queen's and Victoria Hotels and stables to the extent of $20,000.

CURRENT NEWS.

St. John, N.B.—The Dominion Government are considering the contract for the harbor improvements at St. John, involving an expenditure of about nine million dollars. A company headed by Norton Griffiths, M.P. (Britain), is the lowest bidder in the tenders received by the late government.

Niagara Peninsula, Ont.—A report states an item for the construction of the new Welland Canal will be brought down in the House of Commons at an early date. The amount to be set aside for this work is to be $30,000,000.

Calgary, Alta.—Within the next few weeks Calgary will have one thousand new telephones in operation, and by the month of July, two thousand more will be available to customers.

Maritime Provinces.—A convention of delegates from every agricultural society, and every board of trade, the warden from each county, mayors, editors of newspapers, representatives from all farmers' and dairymen's associations, the Fruit Growers' Association, and representatives from the transportation companies, will be held in Fredericton at an early date, to discuss various means of increasing the trade of these provinces.

Winnipeg, Man.—Competitive plans for a new city hall for the city of Winnipeg will be called for shortly by the board of control.

Ottawa, Ont.—The municipal auditor is of the opinion that a purchasing agent be appointed for civic works.

LIVERPOOL DOCK EXTENSION.

The Mersey Docks and Harbor Board has decided upon a dock extension scheme, which will include a deep-water approach to accommodate vessels of 1,100 feet. The improvements, it is estimated will cost $15,000,000.

SOME RAILROAD CONSTRUCTION NOTES.

Probably the longest branch line, the Regina-Colonsay branch, of the Canadian Pacific Railway constructed last year was opened for traffic in November. The distance is 152 miles. From Regina to Colonsay it is 133 miles, while from Valeport, where the smaller branch leaves the large branch, to Bulyea, it is 19 miles. Another branch, from Outlook to Kerrobert, Saskatchewan, over 100 miles, is being constructed, and another from Weyburn and Macklin to Lethbridge. This line when completed will open a new route from Portland, Oregon, to St. Paul, Minneapolis and Chicago. From Swift Current, two branches of the Canadian Pacific Railway are being built and two branches from Wilkie.

The Canadian Northern Railway Company has spent over a million and a half dollars in improving its line between Regina and Prince Albert, a distance of about 250 miles. This line was originally known as the Qu'Appelle, Long Lake and Saskatchewan railroad, and was controlled by English capitalists and operated for many years by the Canadian Pacific Railway upon a lease which was taken over by Sir William Mackenzie when it expired in 1906.

In construction work on the Canadian Northern Railway 16,686 men are engaged. This road west of Port Arthur is operating at the present time 4,000 miles of railway. In addition, there is a line running from Fort Frances to Virginia, Minn., 98.9 miles long, controlled by the Canadian Northern. To the end of September last year 985 miles of track had been laid out of a total of 1,982 miles of new construction. It was expected that an additional 100 miles of track would be laid before the end of the year.

The Georgian Bay and Seaboard Railway of the Canadian Pacific Railway, from Victoria Harbor to Bethany Junction, Ont., was built during the year. Victoria Harbor is situated at the southerly end of the Georgian Bay, and Bethany Junction 14 miles west of Peterboro', on the present main line of the Canadian Pacific Railway, between Montreal and Toronto The length of the new line is 88 miles, 12 miles of which, from Victoria Harbor easterly to Coldwater, were completed in 1909. Work was started on the balance during the summer of 1910, and the line was opened for traffic late last year. The important towns passed through are Orillia and Lindsay. Extensive terminals are being constructed at Victoria Harbor, the yard tracks amounting in all to about 13 miles. A grain elevator has been constructed having a capacity of 2,000,000 bushels, accommodation being provided for five additional units of similar capacity.

TRADE ENQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ending January 22nd, 1912:—

A London firm of universal electrical providers and manufacturers who manufacture all classes of electrical fixtures, especially for the Canadian market, are desirous of getting into touch with actual importers in the Dominion.

A Derbyshire firm who supply large quantities of pulpstones to the Canadian market through United States agents, are anxious to get into direct communication with importers in Canada.

A London firm manufacturing a patent glass jar for preserving fruit and vegetables desire to get into touch with Canadian canners and others likely to be interested.

A firm in the English Midlands manufacturing cast-iron articles of all kinds covered with a porcelain enamel, and willing to conform to Canadian requirements, wish to hear from importers in the Dominion.

A Lancashire firm desire to find a market in Canada for Static transformers; also electric lifting tackle, such as hoist blocks, runways, light cranes, crabs, winches, etc.; and are prepared to appoint reliable agents in each province and each important business centre.

A Vancouver correspondent wishes to obtain United King goods, and construction material.

A Canadian firm of importers desire to secure the Canadian sales agency for specialties in paper manufactures such as D'Oyleys and table decorations.

A Toronto firm of grocery brokers desire to form a connection with a reliable London firm in a position to ship Ceylon and Indian teas in bulk; they are also in the market for supplies of cocoa beans and cocoa butter.

A Vancouver firm desire the agency of a United Kingdom manufacturer of cotton, cashmere, and woolen hosiery.

From the branch for City Trade Inquiries, 73 Basinghall Street, E.C.:—

A Yorkshire firm of baby carriage, toy, and steel folder manufacturers, operating several factories, desire a first-class representative in Montreal, having offices and showrooms, and possessing an established connection among stores, furnishers, etc.

A Yorkshire company manufacturing all types of steam boilers, chemical works, plant, tanks, pans, stills, heaters, etc., wish to extend their business to Canada.

A Liverpool company would be glad to receive offers from Canadian curers of dried codfish suitable for export to tropical countries.

A Montreal engineer is prepared to represent United Kingdom manufacturers of railway supplies and machinery. such as are used in connection with locomotives and rolling stock, and in railway shops.

THE BOARD OF RAILWAY COMMISSIONERS FOR CANADA.

Order No. 15819.

In the matter of the application of the Sanitaris, Limited, of Arnprior, in the Province of Ontario, for an Order directing Railway Companies to furnish, during cold weather, heated cars for the carriage of mineral water, ginger ale, and other bottled beverages, in quantities aggregating not less than carload lots, from one shipper to one or more consignees and destinations: File 18855.

Upon the hearing of the application on the 4th January last, and hearing what was alleged on behalf of the Railway Companies and the Applicant, and judgment being withheld for further information;

And upon its now appearing that Railway Companies had in practice systems of carrying way freight in heated cars; and upon the complaint of the Sudbury Brewing and Malting Company that such systems had been abandoned; and upon its appearing that at a meeting of the Canadian Freight Association, held on November 23rd, 1911, it is alleged in a circular sent to the said Brewing and Malting Company by the local freight agent of the Canadian Pacific Railway Company at Sudbury, that it was resolved that shipments in less than carload lots in heated cars should be discontinued; and its appearing that no notice of the withdrawal of such privilege had been given to shippers, and such withdrawal has worked hardship—

It is ordered that all railway companies subject to the jurisdiction of the Parliament of Canada shall forthwith reestablish the system or systems in practice by them of carrying less than carload lots in heated cars during the winter of 1910-1911; and shall forthwith grant to all shippers the rights and privileges of such shipping facilities in respect to such traffic as were in force upon their various lines during the said winter, until further Order, or until the reasonableness of the withdrawal of such facilities can be passed upon by the Board.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

15815—January 19—Extending until 1st March, 1912, time for execution of Commissions and for transmission to Secretary of Board at Ottawa in connection with examination of witnesses in Dawson Board of Trade vs. White Pass & Yukon Railway in connection with Order 15719, January 2nd 1912.

15816—January 17—Authorizing G.T.P.B.L.Co. to construct spur for Yellowhead Pass Coal & Coke Co., Ltd., Alberta; from its Mountain Park Coal Branch.

15817—January 18—Approving location of C.N.O.Ry. through Twps. of Springer, Field, Badgerow, Gibbons, and Crerar, District of Nipissing, mileage 366 to 386 from Montreal.

15818—January 18—Anuthorizing town of Leamington to cross with street right-of-way of M.C.R. (Leamington & St. Clair Branch).

15819—January 18—General Order re less than carload freight to be carried in heated cars, etc.

15820—January 20—Amending Order 15741, January 3rd, 1912, that "Applicant Company install cover plates their tracks pass through the sidewalk," C.P.R. spur Swift Canadian Co., Winnipeg, Man.

15821 January 19—Approving by-law of Maine Central Railroad Co., authorizing W. K. Sanderson, G.F.A., H. D. Waldron, G.F.A., and F. S. Davis, Chief of Tariff Bureau, to issue tariffs.

15822—January 18—Authorizing International Bridge and Terminal Co. to construct its bridge and railway across Church St., Fort Frances, Ont. Crossing to be protected by gates.

15823—January 19—Authorizing C.P.R. to construct its Lacombe Easterly Branch of C. & E. Ry.), across 10 highways, and divert same, to close up portions of diversions, mileage 129.47 to 139.22, Alberta.

15824—January 20—Authorizing Vancouver, Victoria & Eastern Ry. (G.N.R.) to construct portion of tram track on Front St., Vancouver, B.C.

15825—January 19—Approving location of G.T.P. Railway station at Fitzhugh, a divisional point in Alberta.

15826—January 22—Approving location of C.N.O.R. station grounds at Portland, Ont.

15827—January 20—Authorizing C.N.O.R. to cross public road on Lot 8, between Cons. 2 and 3, Twp. of Dorion, Dist. Thunder Bay, Ont.

15828—January 23—Authorizing Twp. of Brooke, Ont., to construct McDougall Drain under tracks of Canada Southern Rly. Co., (M.C.R.)

15829—January 23—Approving location of C.N.O.R. station grounds at Dwyer Hill, Ontario.

15830—January 24—Extending until 15th February, 1912, time for erection of gates by G.T.R. at John Street, Toronto, Ontario.

15831—January 24—Extending until June 30th, 1912, time for construction of subway over Elizabeth St., Toronto Junction, Ontario.

15832—January 24—Authorizing city of Strathcona to construct a level crossing over track of C. & E. Railway, (C.P.R.), at Third Ave., North.

15833—January 24—Authorizing C.P.R. to divert highway between sections 9 and 4, at Naples Station, mileage 85.3, Napinka, S.D.

15834-35-36—January 24—Dismissing applications of city of Strathcona, Alta., for level crossings over C. & E., (C.P.R.), at 2nd Ave., North, 2nd Ave., South, and 3rd Ave., South.

15837—January 25—Approving proposed addition of C.P.R. existing bridge and change of grade across Mountain St., Montreal.

15838—January 24—Authorizing G.T.R. to reconstruct swing bridge over Rideau Canal at Ottawa.

15839—January 24—Relieving G.T.R. from further protection at Adelaide Street, at Mount Bridges, Ontario.

15840—January 24—Authorizing Government of Province of B.C. to construct highway crossing over Shuswap and Okanagan Railway (C.P.R.), one mile north of Okanagan Landing.

15841-42—January 23—Authorizing C.N.O.R. to cross public road in Lot 8, between Cons. 1 and G., Twp. of Medora, Dist. of Muskoka, and across Jane Street, Twp. of York, County of York, Ont., by means of bridge carrying highway over railway.

15843—January 23—Extending until 9th April, 1912, time for installation of bell by C.P.R. two and one-half miles east of St. Basile, County of Portneuf, Quebec.