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The Canadian Engineer

WEEKLY

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The Canadian Engineer

ESTABLISHED 1893.

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CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR

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TORONTO, CANADA, AUGUST 7th, 1908.

CONTENTS OF THIS ISSUE.

THE HIGHWAY AND THE AUTOMOBILE.

The automobile on a Canadian country road in summer impresses one forcibly and in a most unpleasant manner with the unsuitability of our roads for such traffic. The highway engineer has not been able to keep pace with the mechanical engineer, the result being that the clients of both are heavy losers.

The automobile industry suffers in two ways. The very few highways suitable for such traffic limit its use and the dust nuisance destroys the running gear, thus increasing the cost and again limiting its use.

The rapid deterioration of the gravel or macadam road under self-propelled carriages, while a loss to the municipality, is also one cause of friction between the motor tourist and ratepayer along such travelled roads.

The automobile is here to stay, and we may as well recognize this fact and be prepared to increase its usefulness. Not only have we self-propelled carriages for passengers, but the volume of freight transported by motor vehicles increases daily.

In cities the matter of suitable road material is not a difficult question. The tax-rate is sufficiently high to provide for pavements of asphalt, tar-macadam, wood or granite block. None of these are perceptibly injured by motor-vehicles, even those equipped with non-skidding devices. A road built for heavy urban traffic is quite sufficient for good motoring, but a road sufficient for rural districts might be quite unsuitable.

With public sentiment still opposed to the automobile travelling on rural highways it is hopeless to expect council to grant money to overcome the dust nuisance, no matter how inexpensive the device suggested. When the day does come for improvement the first attempts will doubtless be made with some coating material.

In some sections of the United States a top dressing of coal oil has been used. This allayed the dust, but soon wore off. Heavy bituminous material was then tried, and with much better success. Farther than this experiments on country roads have not been tried.

The next step will doubtless be tar-macadam roads. Already many residential streets in our cities are paved with this mixture of broken stone tar and pitch. Where the stone is crushed granite and the road well rolled when put down good results will be secured, even when the road is subjected to the destructive skidding devices of touring machines.

Under the present system of township road control very little progress will be made in road improvement. Country roads would be an advance, but State-controlled roads under the direction of a central board would give a system of roads uniform in construction and complete in location giving the maximum of service. This should be our aim, even if it does appear visionary. Only under such a system could leading roads suitable for motor traffic be built.

SOME FIGURES FROM A STRIKE.

On July 1st the union plasterers were locked out. They were receiving fifty cents an hour for an eight-hour day. They were offered forty cents an hour, and upon refusing to accept this offer work was closed down.

The plasterers have been idle twenty working days, or at a total loss of eighty dollars per man. It has been estimated that there were three hundred and fifty men idle, which would mean a loss of $28,000 to members of the Plasterers' Union.

Besides the plasterers some two hundred and thirty helpers were thrown out of employment, which meant a loss of $2.60 per man per day, or a total loss to the helpers of $12,558. Directly the wage bill for July was decreased by $40,558, and indirectly very much more. Other trades were idle, because their work was dependent upon the plasterers. The carpenter, the painter and the lather each suffered with his fellow.

The difficulty has been settled, and the men return to work having gained their point. They lost eighty dollars to gain eighty cents a day, or in one hundred working days they will have made good their loss. By what happens in November one will be better able to judge whether they have won out in the struggle.

BRITISH COLUMBIA SHIPPING.

During 1907 British Columbia's shipping industry added more tonnage than during any of the five previous years, and was only surpassed on two previous years: in 1898, when 12,228 tons were added, and 1901, when 7,728 tons were added. The following table gives the growth for the last six years:—

	No. of Vessels.	Net Tonnage.
1902	36	2,550
1903	56	3,494
1904	48	2,362
1905	51	3,536
1906	82	2,774
1907	97	7,115

British Columbia now stands second in the Dominion in list of vessels registered and third in tonnage added.

EDITORIAL NOTES.

Canada has not yet completed her railway system. The railway subsidies granted by the Dominion Parliament this month provide for aid to almost four thousand miles of road. The re-votes include twenty-six roads, representing 1,678 miles, and new subsidies were granted to forty-four roads, aggregating 2,150 miles. To this must be added the bond guarantee in Western Canada, covering 609 miles more, and anticipating the expenditure of $8,000,000. The re-votes amount to over $5,000,000 and new subsidies to $6,000,000.

* * * *

In this issue we conclude the series of articles on "Sewerage and Sewage Disposal," by Mr. T. Aird Murray. The questions Mr. Murray has discussed are of interest to all engineers, and the lucid manner in which he has presented the subject has made the articles of great value. In connection with the series Mr. Murray writes:—

"By means of this treatise it is my endeavor to bring the whole question of town drainage and the purification of sewage in a terse and concrete manner before those authorities, engineers and others to whom the subject is a new one. It is not pretended that the information given is by any means conclusive. There are many variations and features which can be found described in more pretentious works on the subject. I am indebted for much information on American sewage disposal to Messrs. Rafter and Baker in their extensive work on 'Sewage Disposal in the United States.'

"The principal information which I give is based on an experience of over twenty years' connection with this work in Great Britain, and I recognize that certain precautions will have to be taken in a country such as Canada to guard against severe frost.

"I shall be glad to give any further information at any time and answer enquiries arising out of these pages upon receipt of a letter addressed to the offices of the 'Canadian Engineer.'"

SOME THINGS A POWER USER SHOULD KNOW ABOUT COAL.*

E. C. Bailey.
Arthur D. Little Laboratory.

The majority of manufacturers are dependent upon the combustion of coal for the operation of their mill. The man who is responsible for the continuous and economic operation of the plant should know: (a) Where he can always get coal when he needs it. (b) Where he can get coal of such character and quality that his plant will not be crippled for lack of steam. (c) What coal is the most economical for him to burn. (d) How to convert a large percentage of the heat energy of the coal into useful work.

(a) It is an exceptional circumstance when a manufacturer does not have many kinds of coal offered him at competitive prices. But at times of strikes or delays in transportation he is sometimes compelled to seek coal and pay whatever price is asked. In placing a contract this point should be kept in mind, and whenever the difference in price is not too great, preference should be given to the company that is most able to keep you supplied with coal at such exceptional times. If you expect fair treatment from the coal company you must treat it fairly by living up to your part of the contract, whether the price falls or rises during the continuance of the contract.

When plants are at any great distance from the mines it becomes necessary to store a considerable quantity of coal. This involves additional expense due to the extra handling, value of storage space, and loss of coal, both mechanically and chemically. The loss due to oxidation or weathering of coal not only reduces the calorific value of the coal, but as the temperature of the pile rises, the oxidation becomes more rapid until the ignition temperature is reached, and much additional labor and expense is necessary to prevent the burning of the coal and often the destruction of other property. There are many theories as to the cause of spontaneous combustion in coal piles, and several remedies have been tried with more or less success. Storing coal under water seems to be the only method of absolute prevention. Sulphur is generally referred to as the cause of spontaneous combustion; but each per cent. of sulphur, if burned completely and if no heat radiate from the pile during the slow combustion, would raise the temperature of the pile only 200 degrees Fahrenheit. Many cases of spontaneous combustion occur in piles of coal that contain less than one per cent. of sulphur, and analyses of coal from heated piles show that only a small percentage of the sulphur has been oxidized. Some heat must be radiated from the pile, and a temperature considerably above 200 degrees Fahrenheit is necessarily reached. Should the sulphur exist in the form of pyrites, and both the iron and sulphur oxidize, the heat generated would not be great enough to cause the temperature of the pile to rise as high as 550 to 600 degrees, which temperatures have been reached before the coal really ignited. Excessive moisture may play some part in causing spontaneous combustion, but exceptions to this are many. The height to which the coal is piled is generally considered a very important factor, but frequently the hottest part of a pile twenty feet deep is within three feet of the surface. In one case a pile of coal ten feet deep took fire about six feet below the surface, and in another part of the same pile the coal was thirty-five feet deep with no sign whatever of heating. Some coals store better than others, the reason for which seems to depend upon its physical structure rather than the chemical composition.

* Read at the National Association of Cotton Manufacturers, Boston.

It seems that the rate of circulation of air through a coal pile has more to do with this question than any other condition outside of the character of the coal. The heating is mostly very irregular throughout a pile, as there are usually spots where the temperature is much higher than in the surrounding space. For this reason the usual method of taking temperature measurements in a pile by letting a thermometer down a set of pipes scattered throughout the pile is very unsatisfactory, as the hottest spot that will soon cause trouble may be missed entirely. The question, What is the safe limit for the temperature of a coal pile? is frequently asked, and it is rather difficult to answer, for a coal pile may heat up to a pretty high degree, then cool down without being moved. But if there is enough heat generated to raise the temperature of the coa l pile to 212 degrees Fahrenheit, the moisture being evaporated at or before this temperature is reached leaves only the dry coal, which has a comparatively low specific heat, to be heated. The heating takes place much faster and the rate of oxidation also increases with the rise in temperature. The carbon in the coal evidently oxidizes to a considerable extent, as large percentages of carbon dioxide have been found in coal piles at comparatively low temperatures.

(b) Many plants are so limited in boiler capacity, have such poor draft, or some kind of grate or stoker that it is possible for their boiler-room force to keep steam with only certain kinds of coal. While this is not an ideal state of affairs, it is a condition that exists in a large percentage of the power plants in this country, and unless a man knows what coal will develop the required boiler horse-power in his plant he may have the costly experience of shutting down a part or all of his mill. There is a great deal of difference in the rate of combustion of different coals. The percentage of volatile matter, coking properties, amount and nature of ash are the principal factors upon which depends this characteristic in various coals. It is not always the better or higher priced coals that give the best satisfaction under such conditions, for a cheaper coal might give more satisfactory results than are being obtained with the highest priced coal on the market, but the risk of experimenting has seemed too great for the management to consider stepping out of the well-beaten path.

(c) All minerals or raw material are bought because they contain some one ingredient or property that may by a certain treatment or operation be enhanced in value or utilized by the manufacturer in such a way as to cause him to make a profit from the principal product of his factory. It is seldom that any mineral or raw material does not contain some impurity or inert matter that may involve additional expense for its riddance or by a certain process may be converted into a by-product, and thus become a secondary source of profit. Coal varies more in character and quality than any other mineral produced. In character it is found in all successive stages between lignite and anthracite. Each different kind is more applicable for one purpose than another. In selecting a coal for making illuminating gas the yield of gas, measured in "candle feet," is of primary importance, while the coke and tar are by-products, and sulphur is the impurity that causes additional expense. For making coke the purity, structure and yield of coke are the properties to be considered, and the gas, tar and ammonia may be utilized as by-products. In buying steam coal the amount of heat that may be developed from it is the measure of its value to you. There is no by-product that may be utilized, except that in some cases the sale of ashes might be considered in this connection, but their removal is generally an additional expense. Two coals at the same price and containing the same number of heat units may not be equally desirable. The difference in volatile matter might cause the lower to prove more satisfactory under certain conditions of smoke restriction, while the higher volatile coal would probably be more applicable in a plant with fluctuating load. The amount and nature of ash in regard to the formation of clinker often needs to be considered.

The liability of spontaneous combustion of one coal more than another may make it advisable to pay several cents per ton more for one coal containing no more heat units than the other.

The following table shows the analyses and results of evaporative tests of some of the better coals together with their price f.o.b. cars at the plant of an inland New England mill. The relative values have been calculated by taking coal A as a basis and determining what will be the cost of the equivalent amount of coal required to produce the same number of heat units as coal A produces for $4.60 per ton. For example, should you buy coal F at $4.40 per ton, your coal bill would amount to the same as if you had bought coal A and paid $4.92 per ton for it, but as you can get coal A for $4.60 you would save 32 cents per ton by taking coal A instead of coal F at the given prices.

In this case it appears that neither the best nor the lowest priced coal would be the cheapest to buy.

Coal	Moisture.	Volatile.	Fixed Carbon.	Ash.	Sulphur.	B. t. u.	Lbs. water evaporated from and at 212°F.	Price f.o.b. plant.	Relative Cost per ton with Coal A as basis. By B. t. u.	By evaporation.
A	1.25	17.94	73.15	7.66	2.07	14354	9.93	$4.60	$4.60	$4.60
B	1.43	17.59	71.58	9.40	1.09	14032	9.73	4.55	4.65	4.64
C	1.17	30.51	61.01	7.31	0.99	14251	9.79	4.65	4.69	4.71
D	1.36	16.42	71.35	10.87	1.77	13811	9.60	4.58	4.76	4.74
E	1.75	19.58	71.95	6.72	0.82	14533	10.03	4.86	4.80	4.79
F	3.72	21.06	66.90	8.32	1.36	12834	8.80	4.40	4.92	4.96
G	1.74	31.16	53.68	13.42	2.93	12833	8.67	4.60	5.14	5.27

In this table the coals are arranged in order of cost for equal amounts of heat generated and equal evaporation, but in selecting a coal for any particular plant it might be policy to select a coal that would cost a little more money in order to obtain some particular advantage that a certain coal might have over another. Comparing coals A and B, coal A appears to be better in every way except that it contains about one per cent. more sulphur than does B. For steam purposes the sulphur is of little importance below two per cent. at least, so that coal A would probably be selected on account of its being five cents per ton cheaper on a heat unit basis, and there would also be less ash to handle. In case a plant had limited draft and boiler capacity a coal like C might be selected in preference to B, or even A, with a difference of nine cents per ton in favor of coal A. Should the prevention of smoke be an item of considerable importance, coal D would probably be purchased at an additional expense of seven cents per ton as compared with coal C. Of the two coals D and E there is a difference of only four cents per ton, and that would scarcely pay for the additional cost of handling ashes, the possibility of not being able to carry the load without the use of more boilers, and other expenses that are greater with a poorer coal.

While coal E is the best all round coal, it would not pay to purchase it when coal A could be obtained for 20 cents per ton cheaper on a heat unit basis, and 19 cents per ton cheaper on an evaporation basis.

Coals F and G are both much inferior to the others, and their purchase would not be considered when any of the other coals were available at the given prices. Judging from the ash and sulphur alone, it would seem that coal F would be better than either B or D, but a certain characteristic appears in this coal that makes it different from any of the others. It is "crop" or "red" coal coming from a part of the seam near the outcrop, and has become saturated with the surface water that has been percolating through it for hundreds of years. The moisture is much higher than in any of the other coals, and it contains a still larger percentage of combined water that is not driven off by the mere drying of the coal. If a man were depending upon the ash determination alone he would never detect that he was receiving an inferior quality of coal; in comparison with coal A he would be paying 20 cents per ton less for the coal, yet he would have to burn so much more of it to develop the same horse-power that he would actually be losing 32 cents per ton, or $16,000 per year on a 50,000 ton contract.

Coal G is high in ash and sulphur and correspondingly low in B. t. u., so that it would be a very expensive fuel to burn at the price quoted, and in comparison with the other coal you would not consider it. Yet there are thousands of tons of it being burned, and the manufacturer seems to be willing to pay the price.

In the preceding table the equivalent evaporation in pounds of water from and at 212 degrees Fehrenheit is given as determined in carefully conducted boiler tests on the same boiler. They represent the average of two or more tests under as nearly identical conditions as it is possible to maintain, thus accounting for the closeness of their comparison with the B. t. u. determination. Duplicate boiler tests on the same coal frequently vary five to ten per cent., even though the method of firing and the rate of combustion have changed as little as possible. The chemical analysis and calorimetric determination will represent the value of coal within one per cent., providing the samples are properly taken. The plea for evaporative tests because they are practical is counterbalanced by their failure to burn the coal under equally comparable conditions in two or more cases. A fireman must become accustomed to different coals and find wherein they must be handled differently in the firebox in order to obtain the best evaporation from each. The laboratory tests are generally considered as theoretical and unreliable. But theory and practice always agree when they both represent the facts.

After the most economical coal has been selected, it remains for the manufacturer to see that such coal is delivered. Throughout the year the coal company may send coal of different quality from other mines, or the quality of the coal from the same mine may change, due to impurities encountered in the seam or lack of preparation at the mine. The coal operator may know the change in quality, as many of them follow up their product by chemical analysis and inspection, much more closely than does the purchaser, but it is the manufacturer's place to know what he is getting and prove to the coal company that the coal has changed and that he is not receiving the coal he is entitled to by the contract. The results of an evaporative test mean but little to anyone except the man who conducts them, and apply only to the one plant and set of conditions under which they were made, while the analysis of coal is now on such a standard basis that the results are comparable whether the sample is taken at the mines, en route, or at the destination. There are many analyses published and given out by a large number of coal companies that represent selected samples of the coal from certain parts of the seam that are absolutely valueless as representing the quality of coal actually loaded at their tipple. Such a policy is shortsighted, and is fortunately disappearing, for the consumer is going to find out for himself when the coal reaches his plant, and the comparison of results is generally to the discredit of the coal company. But the person who has suffered the most from this practice is the coal man who does give representative figures, for he is judged by the consumer as also giving fancy results, and allowance is wrongly made for shrinkage. The present day tendency is to buy coal on a B. t. u. basis, adjusting the price for the coal delivered in accordance with its quality. The advisability of carrying this into effect depends upon the tonnage, method of delivery, and difficulty in otherwise obtaining a uniform product. The fact that a coal company knows their coal is being systematically analyzed is generally sufficient to ensure the delivery of coal of uniform quality.

In addition to knowing what is the most economical coal to buy, the manufacturer must know:—

(d) How to convert a large percentage of the heat energy of the coal into useful work. The efficiency of a boiler plant depends primarily upon the completeness of combustion of the fuel and completeness of absorption of the generated heat by the water or steam in the economizer, boiler or superheater. It is impossible to generate into available form all of the heat energy of the coal. Some coal and carbon are lost with the ashes, while combustible gases and carbon in the form of smoke usually escape unburned to a greater or less extent. The loss due to incomplete combustion depends largely upon the design of the grate, furnace, and combustion chamber, as well as the proportionate rate and method of supplying coal and air to the furnace.

There are so many kinds of mechanical stokers, special furnace designs, fuel-saving devices and smoke preventers on the market that the manufacturer is at a loss to know which one would give the best results in his plant or whether it would pay at all to change from the old hand-fired stationary grate. Many people install a certain appliance because it has given satisfaction in some plant known to them. They do not stop to consider that their conditions may be different, they may have a more fluctuating load, it may not do equally well with the coal they want to burn, or they may not have men of the necessary intelligence or experience in their boiler-room to successfully operate the appliance. A mechanical stoker that does very satisfactory work when one kind of coal is being burned may fail when fed with another coal. The fault does not lie in the stoker, but in the judgment of the man who tried to burn a certain coal on it under certain conditions. A man, hand-firing a stationary grate also frequently fails to keep steam with one coal when he could with another. It may or may not be the fault of the fireman, but such difficulty is usually due to his unfamiliarity with the coal, and he tries to fire it in the same manner he has been accustomed to firing the coal he has previously used. If two firemen, one having always burned a good coal that formed practically no clinker, and the other a coal which clinkered badly, should both receive the same kind of coal of medium quality, one might fail to keep steam, and the other would consider that it was of very good quality. In many cases it would pay to make changes in the boiler plant or add more boilers so that the most economical coal could be burned regardless of its quality, as well as to secure as nearly complete combustion as possible.

The question of smoke prevention must receive more consideration from the manufacturer in the future than it has in the past. While it may not be possible or economical to prevent the last traces of smoke, yet there are many stacks in different parts of the country that issue so little smoke that they are not at all objectionable. In most cases where other than anthracite coal is being burned the prevention of smoke has been accomplished by means of furnace design and the method of firing.

After combustion has taken place the heat of the coal appears in the form of sensible heat in the gases leaving the furnace or combustion chamber. The important problem is to cool the gases as much as possible with a minimum of boiler heating surface. In order to accomplish this the heating surface should be kept clean, inside and out. Too much emphasis cannot be put on this point. Combustion is more complete with considerable excess air, but this excess air passing through the furnace reduces the temperature of the gases approaching the boiler and the temperature of the escaping gases remains about the same, so that a larger percentage of the developed heat is lost up the stack. This condition might be compared with a steam engine running with low initial pressure and exhausting against a high back pressure. The amount of air excess is regulated by the intensity of draft and condition of the bed of fuel. Few firemen have ever had the opportunity of learning what was the best thickness of fire or intensity of draft under the conditions existing in their boiler plant when burning a certain kind of coal. Many people think the stronger the draft the better, but there is opportunity to save thousands of dollars every year in many plants by merely reducing the draft or better regulation of it. The installation of a damper regulator is not always the remedy, for they often cause more loss than occurred when hand-regulated dampers were used.

The analysis of the flue gases is the best criterion for regulating the conditions of a furnace so as to obtain nearly complete combustion with a minimum of air excess. The perfecting of automatic gas indicators and recorders will do very much toward increasing the boiler-room efficiency.

No one kind of boilers or heat-absorbing apparatus will give equal satisfaction in all plants. This depends upon location of plant, kind of water, uniformity of load, kind of coal, etc., and must be determined in each individual case.

It may seem unnecessary to investigate so thoroughly what would be the most economical fuel, how it can best be burned, and how the largest percentage of the heat can be converted into useful work, but the money saved by doing so, even in the smaller plants, amounts to a surprising sum in the course of a year. The manufacturer who is too busy enlarging his mill and increasing his output to give corresponding attention to his boiler-room usually regrets the mistake when all his labor is standing idle for lack of power or the coal bill becomes a disproportionate percentage of his cost of operation.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Copies of these orders may be secured from the Canadian Engineer for a small fee.

5029—July 16—Ordering and directing the G.T.R. to refund to the Montreal Lumber Company, Limited, at Ottawa, the sum of $332.07, being total amount of overcharge by G.T.R. on lumber between Brule Lake and Ottawa.

5030, 5031, 5032—July 16—Authorizing the Bell Tel.Co. to erect, place and maintain its wires over the tracks of the G.T.R. and M.C.R.R. at Essex (M.C.R.R.), at Branchton station and Woodstock station (G.T.R.).

5033—July 17—Authorizing the C.P.R. to open for traffic its double track from Raleigh to Tache, a distance of 13.0 miles, being mileage 15.1 to mileage 28.1 from Ignace.

5034—July 17—Authorizing the V. V. & E. Ry. & N. Co. to construct a portion of a branch line from a point on the west limit of Huntingdon town site, B.C., through the said town site to the International Boundary Line.

5035—July 14—Authorizing the Ontario Power Company to carry its transmission wires across the tracks of the G.T.R. near the town of Welland, Ont.

5036—July 17—Authorizing the C.P.R. to construct a branch line to the premises of the Cochrane Brickyards Co., Cochrane, Alta.

5037—July 14—Dismissing the application of the town of Napanee for an Order directing the G.T.R. and B. of Q. Ry. to provide proper protection at Centre Street, known as Selby Road and Thomas Street in the town of Napanee, Ont.

5038—July 14—Confirming Interim Order No. 4985, dated the 8th July, 1908, directing the C.P.R. to stop its trains at the home semaphore at the St. Jerome diamond, and ordering the C.N.Q. Ry. to construct a platform from the point at which its trains stop to the diamond, and to supply proper and safe conveniences for the transfer of passengers at the point in question to the C.N.Q. Railway's passenger trains.

5039—July 17—Authorizing the Victoria Terminal Railway & Ferry Company to construct a bridge over the Nicomekl River, B.C.

5040—July 17—Authorizing the Victoria Terminal Railway & Ferry Company to construct a bridge over the Serpentine River, B.C.

5041—July 14—Authorizing the C.P.R. to take additional lands adjoining its railway in the Township of Albion, County of Peel, Ont.

5042—July 21—Granting leave to the Bell Telephone Company to erect, place, and maintain its wires across the tracks of the C.N.R. at St. Charles Borromee Street, Joliette, P.Q.

5043—July 21—Granting leave to the Oro Telephone Company to erect, place, and maintain its wires across the track of the G.T.R. at road crossing quarter of a mile west of road between Concessions 1 and 2, Township Oro, Province Ont.

5044—July 21—Granting leave to the Oro Telephone Company to erect, place, and maintain its wires across the track of the G.T.R. at public road crossing 5th Concession, Township Oro, Ont.

5045—July 21—Authorizing Joseph Contant, Fabien Contant & Mederic Contant, of the Parish of L'Epiphanie, Farmers, and A. A. Granger, of Montreal, P.Q., to carry a highway across the tracks of the C.P.R. on Lot No. 260 of Parish of L'Epiphanie.

5046—July 21—Authorizing the Temiscouata Railway Company to construct a bridge at mileage 5 over public road at Green River, P.Q.

5047—July 21—Authorizing the C.P.R. to construct, maintain, and operate an additional track on the portion of the lane in Block No. 67, Calgary, Alta.

5048—July 21—Permitting the C.P.R. to open for the carriage of traffic portion of its double track from Garwood to Kenora, mileage 140.5 to mileage 145.5 from Ignace, Ont., a distance of five miles; from Vermilion to Gilbert, mileage 89.8 to mileage 97.9 from Ignace, Ont., a distance of 8.1 miles, and from Buda to Dexter,mileage 40.4 to mileage 54.0 from Fort William, Ont., a distance of 13.6 miles.

5049—July 21—Authorizing the Corporation of the town of Palmerston to lay water mains under the tracks of the G.T.R., where the same Main Street, James Street and William Street, Palmerston, Ont.

5050—July 22—Authorizing the Temiscouata Railway Company to construct a bridge at mileage 60 over Fole River, P.Q.

5051—July 22—Authorizing the Temiscouata Railway Company to construct a bridge at mileage 5, over Green River, P.Q.

5052—July 22—Permitting J. H. Wilcox, of Onondaga, Ont., to lay gas pipe under the tracks of the G.T.R. at Onondaga Station, Ont.

5053—July 21—Granting leave to the McKillop, Logan & Hibbert Telephone Company to erect, place, and maintain twenty of its telephone wires across the tracks of the G.T.R at Main Street, Dublin, Ont.

5054—July 21—Granting leave to the Welland County Telephone Company to erect, place, and maintain wires under the tracks of the M.C.R.R. at public crossing between Lots 10 and 11, Township of Bertie, Ont.

5055—July 21—Granting leave to John L. Benn, of Long Lake, Ont., to erect, place, and maintain telephone wires across the tracks of the K. & P.R. at Tyrons' Crossing, two miles south of Sharbot Lake, Ont.

5056—July 21—Granting leave to J. L. Benn, of Long Lake, Ont., to erect, place, and maintain telephone wires across the tracks of the K. & P.R. at Hinchinbrooke, Ont.

5057—July 22—Authorizing the C.P.R. to make change on the line of railway of its Bulyea branch near Bulyea, Sask.

5058—July 21—Granting leave to the Welland County Telephone Company to erect, place, and maintain its wires under the tracks of the M.C.R.R. at Black Creek, Ont.

5059—July 21—Granting leave to J. L. Benn, of Long Lake, Ont., to erect, place, and maintain telephone wires across the tracks of the K. & P.R. at a quarter mile north of Godfrey Station, Ont.

5060—July 21—Granting leave to J. L. Benn, of Long Lake, Ont., to erect, place, and maintain wires across the tracks if the K. & P.R. one mile north of Verona, Ont.

5061—July 21—Granting leave to J. L. Benn, of Long Lake, Ont., to erect, place, and maintain wires across the tracks of the K. & P.R. at Sharbot Lake Station, Ont.

5062—July 21—Granting leave to the Hamilton Cataract Power, Light & Traction Company, to erect, place, and maintain its electric power transmission lines, 2,400 volt, two-phase, four wire circuit, across lands and tracks of the G.T.R. to premises of Berlin Machine and Tool Company Works, Limited, on Lot 6, Concession 1, Township of Barton, Province of Ont.

5063—July 21—Authorizing the G.T.P.R. to construct a bridge east of Portage la Prairie, Man.

5064—July 21—Authorizing the G.T.P.R. to construct a bridge west of Portage la Prairie, Man.

5065—July 21—Authorizing the G.T.P.R. to construct a bridge over the North Saskatchewan River.

5066—July 21—Authorizing the G.T.P.R. to construct a bridge over the South Saskatchewan River, near Saskatoon, Sask.

CORRESPONDENCE.

[This department is a meeting-place for ideas. If you have any suggestions as to new methods or successful methods, let us hear from you. You may not be accustomed to write for publication, but do not hesitate. It is ideas we want. Your suggestion will help another. Ed.]

SYMBOLS FOR PHYSICAL QUANTITIES.

Sir,—It is very desirable to have a notation for the representation of physical quantities in scientific books and periodicals, which shall be the same in all languages.

The subject is under the consideration of the International Electrotechnical Commission with a view to international agreement, and committees in the different countries (in England under the chairmanship of Lord Rayleigh, O.M.) are discussing this particular subject. They are dealing more especially with symbols for electrical and magnetic quantities but the system might with advantage be extended to embrace all important quantities in physical science, especially as the subject is receiving the attention of most technical societies with a view to some action being taken in the matter.

There are, however, two great difficulties which arise when we try to fix upon a standard notation.

The first is the difficulty of persuading a number of writers and readers who have become accustomed to a certain symbol for a certain quantity to change it in favor of an equally large number of writers and readers who have become accustomed to another symbol. For instance, in France and Germany, the letter "I" commonly represents the strength of an electric current, while in England and America "C" is more commonly used.

In the second place, there are not enough letters in the two or three alphabets at our disposal to give a distinct symbol to each quantity, without resorting to the combination of more than one letter to form a single symbol. There is a great objection to this combination of letters, because the use of sub-script letters and numbers is required for distinguishing between particular quantities of the same general kind. If, for instance, C represents current, Ca might conveniently represent armature current, and C1 the current in circuit No. 1. It would, therefore, not be good to take Ca to represent capacity, or any other quantity other than an electric current.

There is, moreover, an objection to using letters at all to represent quantities in a universal notation, because, unless initial letters are used, there is no connection in the mind between the letter and the quantity, and the symbol is difficult to remember. We cannot always use initials, because the initial letters differ in different languages. For instance, in England "R" commonly stands for resistance, while in Germany it is more convenient to use "W" for widerstand. Moreover, the same initial occurs for a great number of different quantities. For instance, "R" might stand for Resistance, Reluctance, Reactance, Radius, etc.

One way of avoiding the above difficulties would be to create a number of new symbols which could be printed by means of type, like ordinary letters, and which would represent each physical quantity in a distinctive manner.

The question, however, arises as to whether a number of entirely new symbols would be acceptable to writers, readers and printers alike, and the sub-committee on symbols appointed by the British section of the commission, has requested the writer to place his views publicly before the profession, with a view of obtaining suggestions and criticisms as to the feasibility of such a scheme from as wide a circle as possible.

In choosing a symbol, we would try to make a very simple picture of something that reminds us of the quantity in question. For instance, | might represent temperature. If we were told that this simple outline of a thermometer represents temperature, we would have no difficulty in remembering it. Similarly / might represent Force, and the various "Forces" might be derived from it; for instance, ϟ electromotive force, (conventional representation of lightning); and ∩ magneto-motive force.

It is not my purpose here to say what would actually be the best form of symbol for each quantity, but it is not a difficult matter to devise very simple characters which can be written quickly, easily and with sufficient accuracy, and which can at the same time assist the memory to connect them with the quantity for which they stand.

What would the printers say to the new type? The author has taken up this matter with a very large publishing firm, and is assured by their chief expert that 200 or 300 new type would be a small matter to a modern printer, who is already accustomed to deal with many hundreds of different founts, each of which contains from 30 to 120 different symbols. He estimates that a printer in a large way of business has at his command as many as 60,000 distinct type, differing from each other either in letter, size, body or face. The addition of 200 or 300 more would be a drop in the ocean. The size of the new type could be standardized for most purposes, and it would only be in some special case that another size would be called for.

The setting up of the formulæ with the standard size of type would be simpler than with the present system, in which sub-script letters are often unnecessarily introduced. One symbol under the present system sometimes consists of 4 or 5 letters.

If it be admitted that the introduction of new symbols is advisable, the question arises what shall the new symbols represent exactly? Shall the sign | (temp.) represent Temperature in any units, or shall it represent the number of degrees of temperature, measured by some scale agreed upon, and embodied in the definition of the symbol. If the system of units employed be not prescribed, fewer symbols would be required, and the general writer who now says vaguely "Let T equal the temperature," would find the symbol sufficient for his purpose. But from the reader's point of view, there is much to say in favor of a symbol which will embody in its definition a standard system of units. Any formula expressed in such symbols would be completely self-contained, and would be an exact statement of a physical fact. Until the units employed in any formula are known, the formula expresses only half its meaning. Perhaps some slight addition to the symbol, or even to the whole formula, might be used to indicate that the standard system of units is employed. Without that addition, the symbol would have a general meaning. For instance, | might equal Temperature, while | might indicate the degrees centigrade above the absolute zero. The name of the type might be the name of the physical units which it represents; for instance, for ϟ we might read "volts."

If writers, printers and readers, who have any definite views as to the best method of devising a system of symbols would communicate with the technical press, or with the author, they might assist in solving the many difficulties which arise in connection with this matter.

Yours truly,

MILES WALKER.

Leicester Road, Hale, Altrincham.

ENGINEERING MAXIMS.

Sir,—Thinking some of your readers would appreciate some thoughts on engineering on a lighter vein I send you these:—

To the engineer who makes a mystery of engineering; engineering is a mystery.

When you send a man out in the morning to stand by a picket, try and remember before night that he is there.

To be afraid of criticism, is to know there is something to fear.

Diplomacy is the art of telling a lie, when you might as well tell the truth.

Before giving advice, find out the kind of advice you are being paid to give.

Controllers and aldermen are inspired engineers, not merely trained.

When an alderman addresses an engineer, he should commence. "Although not exactly an engineer myself." This means that his knowledge is of a broad, unwarped character.

When a mayor receives a suggestion from an engineer, he should say, "Of course you are quite right; but, I have the whole mass of citizens to consider." This is non-committal.

The training of a city engineer should consist of, "a study of aldermen."

When clients are scarce, take in premium pupils.

When out of employment, talk about the posts you are busy refusing.

When out of employment, don't talk about the important post you once held, people wonder why you left.

While standing on your professional dignity, endeavor to keep your balance.

Don't be friendly with the contractor in public.

If a chief engineer does not understand his work, he can get a good man at $25 a week to do it for him.

A chief engineer should not do work himself, he might be blamed for it.

Don't give an assistant orders in writing, the fool might carry them out.

An assistant should remember he is more able than his chief.

An assistant has had a university training, the chief probably only built universities.

If a contractor says, "How shall I do this?" Reply, "Now my good man, you know exactly how to do it. Suppose you were in my position what would you naturally advise?" Then say, "Any man with common sense would do exactly as you say." This inspires mutual confidence.

When a contractor says, "I have never had a wrong word with an engineer," it is his first contract.

When a contractor says, "My work never requires testing," take him at his word and have it redone properly.

The fundamental basis of engineering is "I guess!"

Yours, Cynicus.

Toronto, August 1st, 1908.

WEIGHT OF TRACTION ENGINES.

Sir,—In designing rural highway bridges, the heaviest loading we have to allow for is that put upon the structures by the traction engines and road locomotives.

The wheel loads and other dimensions of these engines I find hard to secure and would be pleased if you could secure these for me.

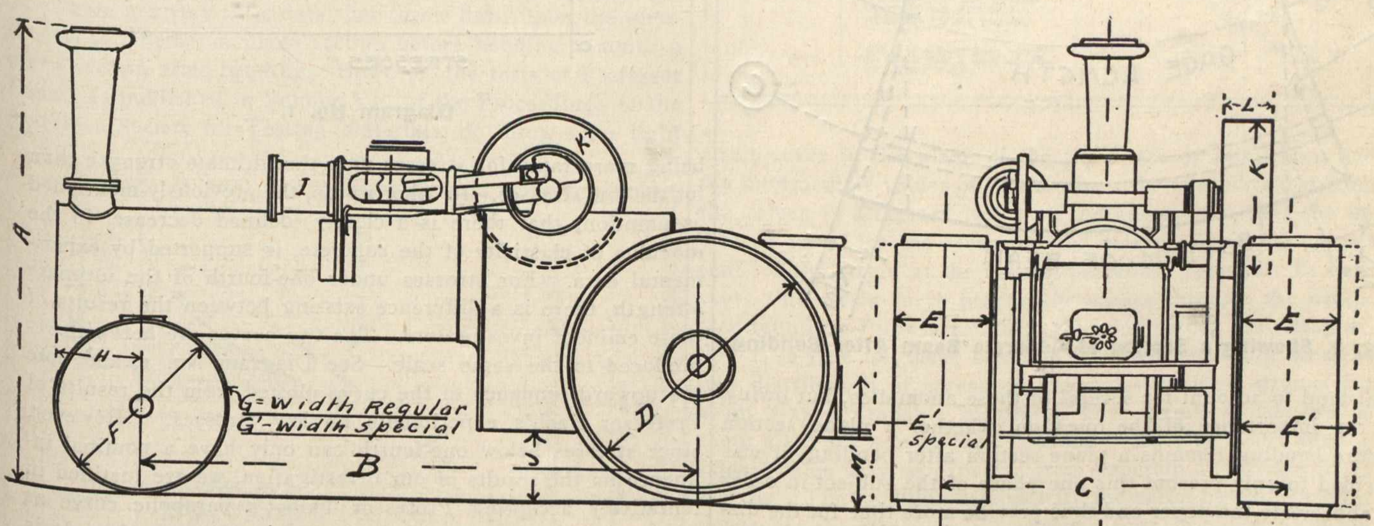
Yours,

Willowdale, Ont.

[Herewith you will find a diagram and table, furnished by the J. I. Case Company, Racine, Wis., which will give all information necessary to calculate moments and shears.

Column headed weight total gives total weight of engine, weight rear, gives weight on hind wheel; weight front, gives weight on front wheel of engine.

In this connection we might say that in general all traction engines with axle at rear of fire box, two-thirds of the weight is on the rear axle and on engines having stub axles bolted to the sides of the fire-box, three-quarters or more of the total weight is on the rear wheels.—Ed.].



Horse-power.	A	B	C	D	E	F	G	H	I	J	K	L	M	E' Special.	G' Special.	Weight Front.	Weight Rear	Weight Total.
9	8'-8 13-16"	8'-1½"	5'-6⅝"	4'-5"	14"	38"	8"	20½"	7¼" x 10"	13½"	36"	9½"	25½"	16"	"	3,564	7,236	10,800
12	9'-7 9-16"	9'-5¼"	5'-11⅜"	5'-0"	16"	42"	8"	20½"	8¼" x 10"	14⅝"	40"	10½"	29"	24"	10"	4,165	8,455	12,620
15	9'-8¼"	10'-6"	6'-1⅛"	5'-0"	18"	42"	10"	20½"	9" x 10"	14⅜"	40"	12"	29"	24"	12"	4,623	9,387	14,010
														24"				
20	9'-11 3-16"	11'-1⅝"	6'-6⅛"	5'-6"	20"	44"	10"	22"	10" x 10"	17⅜"	40"	12"	32"	36"	14"	5,067	10,288	15,355
25	10'-0¾"	11'-10½"	7'-4 1-16"	5'-6"	24"	44"	12"	22"	11" x 11"	17⅛"	40"	12"	32"	36"	16"	6,666	13,334	20,000
32	10'-5"	12'-2⅛"	7'-0¾"	7'-0"	36"	53"	14"	32"	12" x 12"	21⅜"	43½"	16"	21¾"	48"	18"	10,000	22,000	32,000
Road Loco.	12'-0"	13'-4⅜"	7'-11"	8'-0"	36"	53"	14"	36"	14" x 14"		50"	16"				14,667	29,333	44,[illegible]

FORMULAE FOR REINFORCED CONCRETE IN FLEXURE IN THE LIGHT OF EXPERIMENTAL DATA.*

William Fry Scott, Structural Engineer, Toronto.

Proposition 1.—A plane section before bending becomes after bending a curved section through which an imaginary plane passes and touches three principal parallel lines in the curved section, viz.,—a line in the plane of the top fibres of the concrete; a line in the plane of the centre of gravity of the areas of the steel reinforcement; and a line in the plane of the neutral axis. (In plain beams of wood, steel or concrete, the curved section may possibly take the form of the dotted line "D" in Figure 1 on the tension side and the imaginary section would then touch the plane of the bottom fibres of the concrete instead of "C").

Formulae based upon correct theoretical assumptions point out theoretical values that are supported by experimental data. This is not the case with the formulae now used for reinforced concrete in flexure because there are anomalies existing between theory and practice. It was the writer's original intention to present the records of experimental data

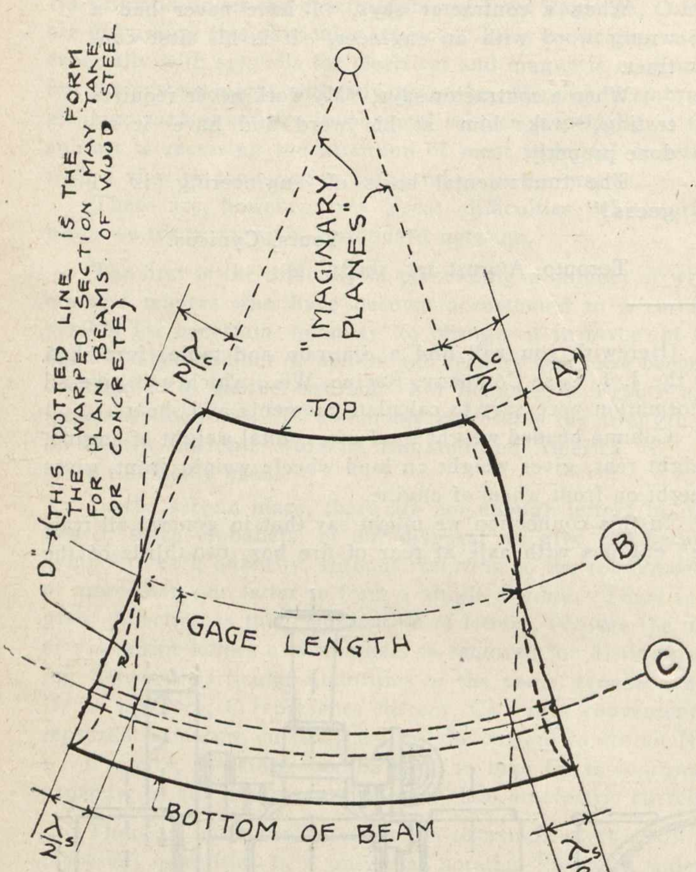


Fig. 1, Showing a Section of Concrete Beam After Bending.

that tend to account for several of these anomalies, but owing to the importance of the question, whether a plane section be'ore bending remains a plane section after bending, it was decided to only present this one phase of the subject in order to abbreviate the paper and thus provide more time for the discussion of it by the members of this Convention. All other facts in connection with this subject are therefore omitted and will probably be given at some future date to some of the technical papers for publication.

There are two theories upon which these formulae are based. In one, the theory of **Straight Line** stress distribution, it is assumed that the modulus of elasticity of the concrete in compression is constant throughout the working limits of stress, and that a plane section before bending remains a plane section after bending; in the other, the **Parabolic** theory of stress distribution, it is assumed that there is a clearly defined decrease in the modulus of elasticity of the concrete, and also, as in the first case, that a plane section before bending remains a plane section after bending. A number of other assumptions are also made, but this paper will be limited to the consideration of the foregoing.

In considering the modulus of elasticity of concrete in compression, it was found that the curves plotted from the results of the experiments conducted under the direction of Professor Bach of Stuttgart University, and those conducted under the direction of Professor Talbot, of the University of Illinois, practically coincided within the working limits of stress,—that is, for stresses from one-fourth of the ultimate strength to the ultimate strength of the concrete in compression, a range which practically covers the field of experimental investigation.

In Bulletin No. 14 of the University of Illinois Engineering Experiment Station, Professor Talbot has this to say on the question of the stress-strain relation:—"Concrete does not possess the property of proportionality of stress and deformation for wide ranges of stress as does steel; in other words, the deformation produced by a load is not proportional to the compressive stress. . . . . Various curves have been proposed to represent the stress-deformation relation but the parabola is the most satisfactory general representation. Frequently the parabola expresses the relation almost exactly." In the light of these facts which are practically supported by the experiments of Professor Bach, we are led to believe that the curve of the modulus of elasticity of concrete in compression follows the law of the parabola—the rate of decrease

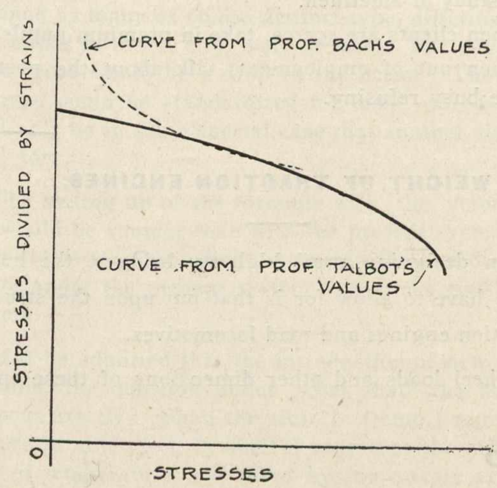


Diagram No. 1.

being more rapid for stresses near the ultimate strength than for the low stresses. In other words, the previously-mentioned assumption, that there is a clearly defined decrease in the modulus of elasticity of the concrete, is supported by experimental data. (For stresses under one-fourth of the ultimate strength, there is a difference existing between the results of these eminent investigators. The two curves are herewith reproduced to the same scale.—See Diagram No. 1, and note the upward tendency of the curve plotted from the results of Professor Bach's experiments on low stresses. However, since stresses below one-fourth can only have a nominal influence on the results of our investigation, we are justified in tentatively accepting Professor Talbot's parabolic curve as given, i.e., from zero stress to the ultimate strength). It is not proposed to accept this curve as representing the actual values of the modulus of elasticity, but rather, as representing the nature of the change that takes place in the modulus of every specimen of concrete in compression as the stress uniformly increases from low stresses to the ultimate stren . In other words, we are concerned, in this discussion, with the law underlying the stress-strain relation, rather than the actual stress-strain records. In accordance with this assumption, the curve in Diagram No. 2 has been made to conform to the curve suggested by Professor Talbot, as representing the changes in the stress-strain relation throughout the whole range of compressive stresses. The abscissas in Diagram No. 2 represent the stresses in percentages of the total stress that

*Read before the American Society for Testing Materials.

would probably take place at the instant preceding rupture, and the ordinates represent the strains in percentages of the total maximum strain at the same instant.

In the light of this curve it is conceivable that the parabolic theory of stress distribution may possibly be sufficient. It is also conceivable that this may not be the case. For instance, suppose we assume that a plane section before bending becomes after bending a curved section through which an imaginary plane passes and touches three principal parallel lines in the curved section, viz., a line in the plane of the

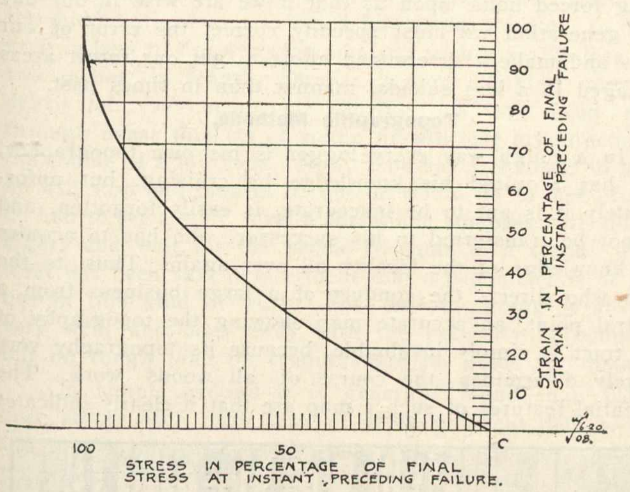
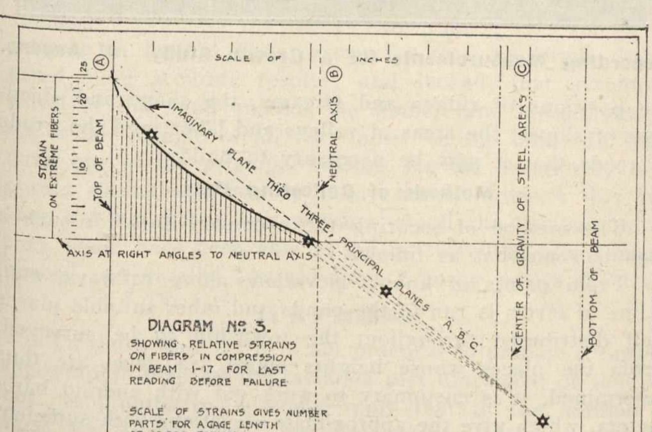


Diagram No. 2, Stress-Strain Curve For Concrete in Compression.

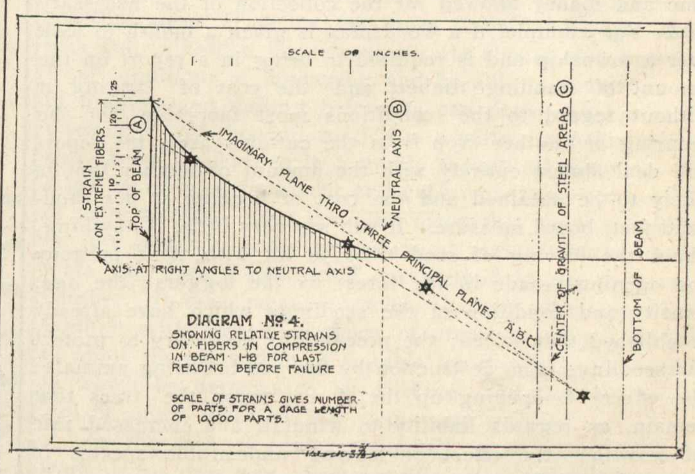
top fibres of the concrete; a line in the plane of the centre of gravity of the areas of the steel reinforcement; and a line in the plane of the neutral axis. If this latter assumption be true the distribution of stress on the cross section will vary according to the strains indicated by this curved section. Further assume that the fibres in this curved section are strained so as to give a distribution of stress on the cross-section that follows the straight line law. We will thus have two curves to represent the boundaries within which experimental values of strains may be expected to fall. Both assumptions may be wrong but an investigation of them along these lines will bring us nearer the truth than we could arrive if we were to accept either one without further investigation.

There are very little data that throw light upon the question as to whether a plane section before bending remains a plane section after bending. However, the tests of Professor Lanza, as published in Volume VI., of the Proceedings of the American Society for Testing Materials, do throw some light



upon the subject. In these tests "the strains were measured at four points in the depth of the beam on each side. The points at which strains were measured were respectively 1 inch and 5 inches above and below the centre of the depth of the beam; those 5 in. above and below the centre being determined on a gauged length of 27 in., and those 1 in. above and below the centre being determined on a gauged length of 12 in." These test beams had a cross-section of 8 x 12 inches and 11-foot span. They were supported at the ends and loaded transversely, the load being applied in each case at two points each 22 inches from the middle of the span. The concrete had the proportion of 1 : 3 : 6 measured by volume These proportions being such as would theoretically, a little more than fill the voids in each case. The quantity of water used varied from 6 to 7½ per cent. The reinforcing rods extended longitudinally throughout the length of the beams and the centres of their cross-sections at the ends were two inches from the bottom with a sag of from ⅛ to 3-16 of an inch at the middle of the span. They were tested at the ages of 2 month and 14 months, but the beams tested at 14 months were chosen as likely to give a more perfect stress-strain relation. It was not considered necessary to present an analysis of more than two of these beams. Beam 1-17 was reinforced with four ¾-inch twisted bars, and beam 1-18 with plain bars of the same size.

A separate diagram has been drawn for each of these beams. The abscissas represent the position of the fibres throughout the depth of the beam, the ordinates represent the positive and negative strains on these fibres. The four stars indicate the strains given by Professor Lanza for the last reading preceding the breaking of the beam. (The strains for the last reading are cited by the writer because they represent a stage in the stress-strain relation that always produces the greatest difference between theoretical expectations and experimental data). In the case of beam 1-18 the position of the neutral axis is taken to be indicated by the projection of the line passing through the two lower stars, whilst for beam 1-17 it was assumed to be on the line bisecting the angle 3-1-2. A plane through these lines at right angles to the sides has been assumed to intersect the true



strain-curve in the plane of the top fibres of this beam, and the intermediate values of this strain-curve were obtained from the values in Diagram No. 2 on the assumption that the indicated value for the strain on the extreme fibre was 90 per cent. of the strain at the instant preceding rupture. In both cases this strain-curve practically passes through the ordinates found by Professor Lanza, thus indicating that Proposition 1, is true for these beams. It also indicates a straight line distribution of stress on the cross-sections, giving for beam 1-17 a probable maximum fibre stress at rupture of about 4,100 per square inch, and for beam 1-18 about 3,600—values which may be expected from concrete at the age of 14 months. The modulus of elasticity indicated by these strain-curves for the stress on the extreme fibre is about 1,500,000 per square inch for beam 1-17 and 1,350,000 for beam 1-18.

In the light of these investigations and other evidences in experimental data, it is assumed by the writer that in general a plane section before bending bcomes a curved section after bending; (See Figure No. 1). And that the stress on any fibre varies directly as the distance from the neutral axis. This is also assumed to be true for wood, steel or concrete.

A word in regard to the use of extensometers: They have usually been attached on the sides of the beams with the lower screw fixed in the plane of the steel reinforcement and the top screw from 8 to 32 per cent. of the distance between the top of the beam and the neutral axis from the top of the beam, thus causing an error in the strain indications for the extreme fibres. Correct results could be obtained by supporting the extensometers on the top and attaching them on the sides of the beam in the plane of the steel. Another set of extensometers might be attached to the sides with the lower screws in the plane of the steel and the others midway between the theoretical position of the neutral axis and the top of the beam.

[It will be noticed that in the above article Mr. Scott gives Professor Talbot credit for being the first to state that curve representing the stress-strain relation follows closely the parabola.—Ed.]

FOREST SURVEY METHODS.*

By A. H. D. Ross, M.A., M.F., Faculty of Forestry, University of Toronto.

A complete Forest Survey includes (1)A more or less accurate plane and topographic survey of the tract under examination; (2) A careful estimate of the amount of timber upon it; (3) A determination of the rate at which the timber is growing, and (4) A study of the conditions of light, moisture, soil and other factors which influence both the present and the future condition of the forest crop.

Degree of Accuracy Required.

The accuracy of the methods employed to bring together information of this sort will, of necessity, be determined by (1) The use that is to be made of it, and (2) The time and money allowed for the collection of the necessary data. For example, if a woodsman is given a month to look over a township and is required to bring in a report on the amount of standing timber, and the cost of logging it without regard to the conditions most favorable for the securing of another crop from the cut-over area, his report will deal almost entirely with the amount of lumber that is likely to be obtained and the cost of logging it per thousand feet, board measure. It will say very little, if anything, about the leaving of seed trees to fill with their progeny the openings made in the forest by the loggers; the age, density and condition of the seedlings which have already established themselves; the precautions necessary to protect the seedlings from destruction by fire and browsing animals; the effect of opening up the forest upon the trees that remain, as regards liability to windfall and increased rate of growth; the effect of leaving undesirable species in possession of the soil; and other matters that must be considered when it is proposed to prevent the destruction of our rapidly diminishing forested areas.

If, however, it is proposed to diminish the possible revenue that may be obtained by the present destructive methods of lumbering, and to so manage the woodlands that they will always regulate the flow of water in the streams and yield a perpetual supply of timber, it will be necessary to establish permanent roads for the removal of forest products and the protection of the growing stock from fire. It will also be necessary to know exactly the amount of growing stock, and the rate at which it is increasing, so that it may not be removed at a faster rate than it is being replaced. To lay out roads to the best advantage, whether for destructive lumbering or for the purpose of deriving a sustained yield, it is necessary to have exact information regarding the topography of the tract, and before it is possible to put it under proper management it is necessary to know its sylvicultural condition. Thus it appears that the forest engineer who would make a complete survey of a tract of timber must be familiar with the methods of plane and topographic surveying, so that he may properly mark the boundaries of his timberland and prepare an accurate map showing the size and location of the various ridges, gullies, swamps, lakes, streams and other topographical features that will determine the location and character of the necessary roads, dams, bridges, etc. He must also be able to estimate the amount of standing timber and know how to make accurate studies of its rate of growth. Without this information he would not know how much timber it would be safe to remove at each cutting, without diminishing the value of the property.

From this it will be seen that the essential difference between a forester and an old-time lumberman is that one makes provision for the production of future crops, the other does not. Heretofore, it has not been considered necessary to make such provision, but the truth is rapidly being forced home upon us that if we are wise in our day and generation we must speedily correct the error of our ways and make a determined effort to get our forest areas managed in a less suicidal manner than in times past.

Topographic Methods.

In a rough way every logger is his own topographer, and has acquired his knowledge by cruising, but unfortunately it is apt to be inaccurate, is easily forgotten, and cannot be transferred to his successor, who has to acquire his knowledge of the locality all over again. Thus, to the man who directs the conduct of a large business from a central point, an accurate map showing the topography of the tract is simply invaluable, because its topography very largely determines the course of all woods work. The essential features of such a map are that it clearly indicates the positions of ridges and streams, the shape and steepness of slopes, the areas of valleys and lakes, and the grade of roads that it may be necessary to build.

Recording Measurements for a Growth Study of Aspens.

Methods of Collecting Data.

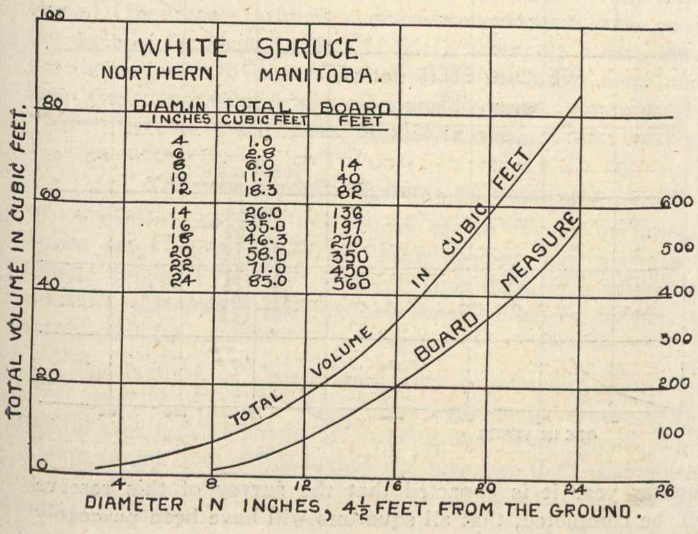
The method of securing the necessary data for such a map is somewhat as follows:—

From points of known elevation, along railways, etc., a line of levels is run to the ponds and other suitable places well distributed throughout the township to be surveyed. From the places whose heights above sea level are thus determined, it is customary to work out with aneroid barometers, which give the approximate elevations with sufficient accuracy for all kinds of woods work. In determining the grades of roads which it may be desirable to build, it is found that any Abney clinometer is much lighter, quicker and almost as serviceable as a land level. Usually the land is blocked out into mile squares, and easily found marks are made every quarter of a mile. These marks serve as starting points for the examination of the interior of any given "forty" (see Estimation of Timber on Forty Acre Squares), and enable the cruisers to locate themselves quite accurately on a line by pacing. With practice, measurements by pacing can be made much more accurately than would be supposed. Steps taken to get round obstacles are

* Part of an address delivered at Montreal.

not counted, and on strong slopes discount is made. On very steep ground, indeed, steps taken are not a guide to distance, and judgment has to be resorted to in order to fill in the count. The count tells us when a line is approached, and enables us to pick it up with certainty, though it may be blind. But this means location may be made with considerable accuracy along the whole line. Having traversed the lines of a lot, noted the crossings of brooks and divides, taken the heights of essential points and noted and sketched whatever topography can be seen, we may then start from the middle of one side to run a line across the lot. In doing so it is best to use a pocket compass with a needle less than two inches in length, because a man climbing over the debris left, by cutting or shoving his way, head down through dense thickets of young fir will lose his direction in the course of a few rods. Now, if he has a compass in hand, he will stop and look at it, but he would do so less often if he had to set a staff, level a three-inch compass with folding sights and wait for the needle to come to a stand. From what has been said it is evident that a pedometer is of little use in this kind of work. For smooth going it answers very well, and does away with the necessity of counting, but on rough land its readings are no guide for distance.

On simple ground it is generally found that pacing once across each forty acre lot gives sufficient data to map the topography with sufficient accuracy for all ordinary purposes. Elsewhere there may be roads and streams to locate and divides that should be carefully put in. Here the compass and pacing method is still used, tying to the lines as often as may be. Travel in parallel straight lines is better, however, provided it is sufficient for the immediate



purpose in hand. The reasons for this are, first, that it gives more accurate results; and second, that systematic travel of this kind enables the timber land topographer to see a fair sample of all the timber on the land. In times past, one of the principal reasons for the notoriously inaccurate estimates given by many timber cruisers was that they did not get a fair average of all the timber, which they would have been able to get by travelling along evenly spaced and parallel straight lines running across the tract.

Is it Practical?

To those who say it is not practical to prepare a reliable topographic map by the methods just described, or that the cost is prohibitive, I would reply that in the autumn of 1896, Mr. Austin Cary, a practical timber cruiser, a graduate of the Yale Forest School and now Professor of Forestry at Harvard University, prepared such a map of Township 3, Range 5, in Franklin County, Maine. This township is six miles square, heavily timbered with spruce, and was gone over from four camps in a little over six weeks' time. Two weeks were then required in the office to work up the data collected in the field and prepare the map, which proved so valuable to the firm of Hollingsworth & Whitney, of Waterville, Maine, that other concerns were led to desire similar maps. The result was that, during the next few years, Mr Cary's services were greatly in demand for work of this nature, and that he has prepared maps of this description for 200,000 acres of timber lands. Most of them are drawn to a scale of four inches to the mile, and have 50-foot contour lines representing the topography. As some woodsmen cannot easily read such maps, it was found advisable, in a few cases, to prepare cardboard or veneer models, which represent the land in miniature and show its main features just as clearly as if the men were on the land.

Taking the stumpage price of spruce at $3.50 per M., and assuming that a township, containing thirty-six square miles, will average 5,000 board feet per acre, it is seen that we are dealing with a property worth $403,200 in its present wild state, and easily worth $500,000 by the time it can be got under proper management. From this it will be seen that an outlay of less than $2 for every $1,000 worth of property, or four cents per acre, will secure to the owners a first-class map of the topography of the entire township, which will enable them to sit in the office and discuss plans or let contracts with the same clearness as to details as if the men were on the land.

The Estimation of Timber.

Where the supply of timber is both plentiful and cheap, timber cruisers or "timber lookers" are generally employed to make ocular estimates of the contents of stands, but where it commands a better price it is now customary to constantly check the judgment of the estimators by means of measurements on sample areas properly distributed over the whole tract.

At the outset it should be clearly understood that ability to estimate the merchantable contents of a stand of timber can be acquired only through practice and experience in the woods. The estimator must be able to recognize the external signs of defect and have some knowledge of the loss due to hidden imperfections. He should also know the local conditions of lumbering and be able to judge the cost of logging and milling before he can place a value on the stumpage. All this information is a matter of field training, and cannot be learned in a purely theoretical manner. It is a matter of good judgment and experience, and not a matter of mere method. This does not mean that there should not be any method in the procedure of making such an estimate, nor does it mean that one method is just as good as another. It does mean, however, that an estimator who is familiar with several methods of cruising is in a position to apply the method most suitable for the particular locality in which he happens to be working, and that his returns will be much more reliable than mere guesses.

In the case of ocular estimates, each cruiser does his work in his own way. Some multiply the **estimated** number of trees by the contents of the **average tree,** making due allowance for defects; others count the trees and multiply by the **estimated** contents of average trees, allowing for defects; and still others estimate the contents of each tree separately, making deductions for unsoundness and other imperfections. In the case of irregular hardwood stands, this latter is the only reliable method of estimating, because many of the older trees are almost worthless for saw timber, and would not pay for the cost of removing them.

The more defective the trees are, the more preferable is the judgment of estimators who have had long experience in the mill and in the woods to the methods of mere measuring. In sound timber, however, the method of measuring the trees on a known percentage of the total area is much preferable to the ocular estimate of a timber cruiser—no matter how experienced. Furthermore, a cruiser may be able to estimate pretty closely in the locality in which he has had long experience, and in a new region find himself very much "at sea." Possibly this fact explains the origin of the term "cruiser." Be that as it may, the cruiser finds it necessary to establish a new standard which will enable him to estimate correctly the contents of stands in the new region in which he finds himself. The quickest and surest way to establish such a standard is by a careful selection and exact measurement of representative trees in the stand. Having established his new standard of reference he is then in a position to correctly estimate the volume of the timber in the new locality in which he finds himself. When the timber is fairly uniform in size and evenly distributed over the tract it may suffice to estimate the yield of a few sample acres, find their average and multiply by the total acreage. Usually, however, the timber is not uniform, and it is necessary to estimate the lower slopes of a mountain separately from the upper, the north slopes separately from the south, and the water-sheds, swamps and other special types separately also. To meet this difficulty, the plan of estimating the timber on sample areas aggregating a given percentage of the whole tract has been devised. If properly distributed they give a very close average for the timber on the whole tract.

Sample Plot Methods.

Many methods have been devised for the proper location and rapid laying out of sample plots. Usually they are laid out in the form of circles, squares or rectangular strips, and in area generally vary from one-quarter of an acre to a whole acre. A quarter acre circle has a radius of 19.62 yards, and an acre circle a radius of 39.24 yards. In the form of a square, each edge of the acre is 69.57 yards, and of the quarter acre 34.78 yards.

In open stands of timber one of the quick methods is to travel in parallel lines a quarter of a mile apart and stop every quarter of a mile to lay out an acre (with a radius of 39 yards or a side of 69 yards), and estimate the timber upon it. This would give us 16 sample acres equally spaced over each square mile, and, therefore, represents one-fortieth, or 2½ per cent., of its area. With a little practice the estimator soon learns to judge whether a tree is within 39 yards or not of the centre of the circle where he sands. Another plan is to place a flag at the centre and walk through the timber within 39 yards of it, making the estimate by eye, by counting trees, or by measuring. Returning to the flag he can then pick up his compass direction, pace a quarter of a mile, and estimate the next acre. In dense stands it is not easy to see all trees within 39 yards, and it is preferable to use either half-acre or quarter-acre circles instead, with radii of 24.75 yards and 19.62 yards, respectively. For rough estimating it is customary to use circular plots, but for more accurate work square plots are preferable, because they are generally laid out more carefully. They may be laid out by either pacing or measuring their sides and turning the corners with a magnetic compass or a cross-staff head.

The Estimation of Forty Acre Squares.

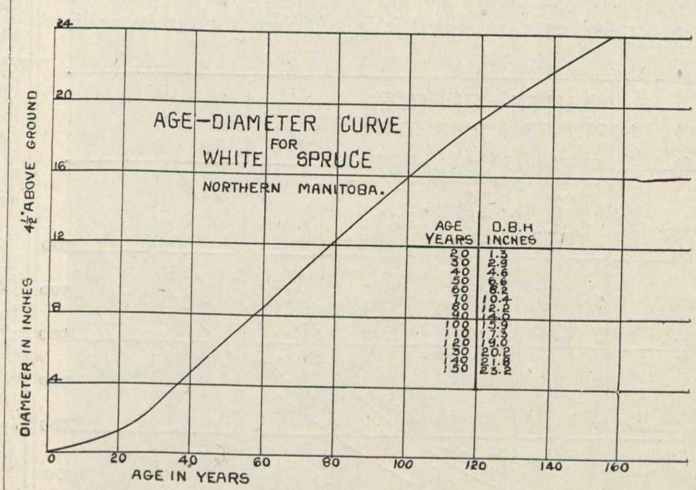
In fairly even aged timber growing on land comparatively easy to travel, it is often a good plan to block out forty acre squares here and there and estimate all the timber on each "forty." Each edge of a "forty" is 440 yards long, and it is advisable to blaze the boundaries so the estimators will know when they come to them. For convenience in estimating, the large square is usually divided into 16 smaller squares of 2½ acres each, and, therefore, with edges 110 yards long. Starting at any given corner of the "forty," say the south-east, a flag is placed at the centre of the first small square, each edge of which will then be 55 yards from the flag, and can be easily located by eye measurement or by pacing. The estimator then goes through the timber on the square, records his estimate, returns to his flag, and goes on to the remaining squares in the order indicated by the diagram.

Having determined the amount of merchantable timber, it is a good plan to prepare on transparent tracing cloth a map showing its location and the character of the growth. Such a map can be laid over the one showing the topographical features of the tract, and thus show at a glance the relations between the two. Furthermore, we may represent on the tracing cloth the extent and location of each year's cutting, and thus have a complete record of the work done from the beginning.

The Dominion Forest Survey, or Strip Method.

When it is necessary to get an accurate estimate of the amount of timber on a very large tract of land, and also to obtain a clear notion of its topography for mapping purposes, the most satisfactory method is to run parallel strips across it every quarter of a mile. Strips ¼ of a mile apart and 4 rods wide cover 5 per cent of the tract. If only 2½ per cent. is required, they may be placed half a mile apart, or else made only two rods wide. The advantages of the strip method are: (1) It gives data which enable us to show the topography of the region; (2) It enables us to map the distribution of the different forest types; (3) It gives a good average of all the timber on the tract, and (4), when combined with studies in volume, it enables us to predict the growth per acre per year in cubic feet, cords, board feet, or any other desired unit of measurement.

During the last three years this method has been used by the Dominion Forest Survey parties sent out to the Forest Reserves in Manitoba for the purpose of getting accurate information regarding the topography, distribution of forest types, kind, location, amount and condition of the standing timber, to make studies of the rate at which it is growing, to study the amount and character of the reproduction, note the effect of the forests upon stream flow, devise means for protecting them against fire and timber thieves, and other matters necessary to know if they are to be put under proper management and preserved from absolute destruction. During the past summer I had charge of a party of twelve men collecting information of this sort in some of the unsurveyed townships along the eastern side of the Riding Mountain Reserve, in north-western Manitoba. This reserve contains over a million acres nearly half of which have been burned over in recent years. The timber remaining consists of aspen, "balm," or balsam poplar, white and black spruce, Jack pine, some larch or "tamrack," patches of scrub oak, and, along the streams, some green ash, "Manitoba maple" or box elder, elm, etc. In



another year it is expected that the survey of this reserve will be completed, that all squatters will have been peaceably removed, that an efficient system of fire ranging will be in force, and that at least part of the reserve will be put under management designed to make it a constant producer of wood crops.

How Measurements are Obtained.

In running out the strips a magnetic compass is used to keep them parallel, and the distances are measured either by pacing or by dragging a light "chain" four rods, or 66 feet, in length. The ordinary "link" chain used by land surveyors is seldom used for this work because it is constantly getting tangled up in the undergrowth and fallen branches, and thus delays the progress of the party. A light, well-tempered steel tape slips easily along the ground, and is, therefore, very much preferable. The great advantage of chaining over pacing is that we do away with the necessity of counting paces and get a much more exact measurement of distances. Each party usually consists of four men, viz.: A compass-man, who keeps the direction, drags the tape and keeps the silvicultural notes; two calipermen—one on each side—to measure the diameters of all trees within two rods of the tape; and a tallyman to record diameters, to keep a record of distances chained, and to note changes in elevation and other data required to sketch in the topography of the country traversed. The calipermen measure the diameters of the trees at "breast height," or 4½ feet above the ground. The reasons for this are:

(1) It is a convenient height at which a measurement can be rapidly made; (2) It avoids the "flare" or "root swelling" found in most merchantable timber; (3) The volume of the tree is a function of the diameter at this height. In large timber the diameters are returned in two-inch classes, but in small timber by inch classes.

Care must be taken to see that the caliper men do not measure dead or defective trees, that they don't get too far from the "chain" or make the strip too narrow, that all measurements are made at right angles to the stems of the trees, and that they keep the calipers up to "breast height." Towards the end of the day they are apt to drop them, and thus raise the estimate for the volume of the stand. When there is a dense stand of small timber or it is difficult to get through the undergrowth, it is advisable to make the strips only two rods wide, thus giving each caliper-man a strip of timber only a rod wide to look after. In turns they call to the tallyman first the species, and then the diameters. If the strips are four rods, or a chain wide, the party only needs to go 10 chains to complete a strip whose area is one acre, but if the strips are only two rods wide, they must go 20 chains The compass-man keeps count of the number of chains, and at the end of every 10th or 20th chain, depending upon the width of the strips, calls out "Acre." Wherever the forest type changes, the silvicultural notes are written up on the back of the sheet and a new one is taken. The tally on the face of each sheet shows what distance the party has gone, and consequently the number of acres and fraction of an acre measured before the type changed. In open stands of timber, such as longleaf pine, where the going is easy, a party of four men may do as much as 60 acres in a day, but if they have to fight their way through a dense undergrowth, they may not be able to do more than 14 or 15 acres. If a fifth man can be secured to direct the work of the other four and keep the topographical and silvicultural notes, the progress of the party is much more rapid and the accuracy of the work is increased.

The Relation of Diameter to Volume.

A careful study of the shapes of the trunks of forest-grown trees shows: (1) That each species has a characteristic shape or "form," and (2) That there is a tolerably constant relationship existing between its diameter at breast height and its volume.

The method of determining this relationship for any given species is to select a large number of sound trees having the typical shape of forest-grown trees whose diameters range from a few inches up, measure their diameters at breast height to the nearest tenth of an inch, fell them, cut them into 10 foot lengths, until a diameter of three or four inches is reached and measure to the nearest tenth of an inch the average diameters at the ends of the logs, first outside the bark and then inside the bark. From the measurements thus obtained we then compute, to the nearest hundredth part of a cubic foot, the total volume of each log, of the stump and of the unused top; also the volume of the wood inside the bark for the different sections of the tree. The object of making two sets of measurements and calculations is to find what percentage the solid wood inside the bark is of the total volume. Several mathematical formulæ have been devised for the computation of these volumes, but are of too technical a nature to be dealt with in such a paper as this. Having found the volumes of all the trees analyzed, the next step is to plot, on cross-section paper, the breast high diameter of each tree as a horizontal distance and its volume as a vertical distance. From the points thus located we can then draw a curve showing the relationship that exists between the volume of an average tree and its diameter at breast height. The accompanying diagram shows such a curve based upon the analysis of 66 aspens measured last summer in the Riding Mountain Forest Reserve. Some of the technically trained foresters present will probably object to my basing Diameter-Volume curves upon the analysis of so few trees. The explanation is that we have only made a start in the work of studying growth of these species. Next year more stem analyses will be made, which, with those already obtained, will give a fair average for aspen, balm, white spruce and Jack pine.

To find the number of cubic feet of wood per acre for any given species, we first find out from the tally sheets how many trees of each diameter class there are per acre, multiply by the volumes indicated by the Diameter-Volume Curve of the species under consideration, and add together the products. In the case of trees less than a foot in diameter it is found that a standard cord of stacked wood contains only about 90 cubic feet of solid wood; hence, if our figures indicate 1,080 cubic feet of wood per acre, we say that there are twelve cords to the acre. Where the trees are large enough for saw-timber we may scale the logs down to any given diameter, by whatever Log Rule is in use in the district, and then construct a curve showing the relationship between the breast high diameters of the trees and their merchantable contents in board feet. Our next diagram shows a curve of this nature, which naturally falls away below the total volume curve. (1) Because of the volume lost in the tops not large enough to make sawlogs; (2) The volume of the stumps; (3) The volume of the bark (about 15 per cent. for spruce), and (4) The loss due to sawdust, slabs, edgings, and trimmings.

Growth Studies.

The ultimate object of nearly all studies of growth is to predict the number of cubic feet of wood per acre per year that will be added to the growing stock. Studies of this sort are of too complicated a nature to be dealt with in a paper of this kind, but, perhaps, I may be permitted to state that they depend upon a knowledge of the volume of the stand during the different periods of its growth from youth to maturity. During the last three years the Dominion Forest Service has been collecting data for studies of this nature, but, as yet, no attempt has been made to work up the material. This is due partly to the fact that during the winter months the men with the training necessary to do work of this nature were required to do the office work connected with the distribution of planting material in the Prairie Provinces, and partly to their leaving the service almost as soon as the data collected in the field were available for growth studies. It is hoped, however, that all the material collected will soon be worked up and put in such a shape that we will know definitely what the annual rate of increase is in the present wild, fire-scarred timber of our Western Forest Reserves. Not until we have full and definite information regarding the location, the amount, the sylvicultural condition and the annual rate of growth of the more important species will we be in a position to devise satisfactory rules and regulation of these reserves, and to keep them in perpetual forest for an ever-increasing population.

The Enormous Cost of Planting.

If you draw the attention of the "man in the street" to our rapidly diminishing supplies of timber, he will, in nine cases out of ten, say: "Yes; that's so. Why, the Government ought to go to work and plant up the open spots." Let us examine the practicability of such a scheme. With a large and well-equipped nursery for the growing of forest tree seedlings, and with labor at $2 per day, it is possible to reduce the cost of planting, five feet apart each way, to between $7 and $8 per acre. For sake of argument, let us assume that it can be done for $5 per acre, or $3,200 per square mile At this rate the planting of a township only six miles square would require the enormous expenditure of $115,200. The "man in the street" will do some pretty hard thinking before he will consent to pay his share of the cost of such an undertaking, yet he will read in his morning paper that thirty townships, or more than a thousand square miles of woodlands in northern Alberta, Saskatchewan or Manitoba have been destroyed by fire, and scarcely give the matter a passing thought.

Need for Protection.

Would it not be very much more to the purpose to take time by the forelock and use the money required to plant up a single township for the maintenance of an efficient fire ranging system, similar to the one already established in Ontario? To my mind, the problem pressing hardest upon the Dominion Forest Service for solution is the protection of the Western woodlands from fire. The new railways being built through them, and the settlement that will quickly follow will be a constant source of danger, but if fire rangers who feel the responsibility of their positions, and with the necessary diligence, firmness and tact to faithfully perform their duties and secure the co-operation of the settlers and the railway companies, can be found and retained in the service, a great deal may be done to save invaluable forested areas from ruthless destruction.

More Reserves Needed.

As far as I understand the situation, the second great problem pressing for solution is, to secure definite information regarding the location, kind, condition, and amount of timber which **should** be placed in forest reserves before it is encroached upon, and either partially or wholly destroyed by axe and fire.

Need for Forest Surveys.

The third great problem will naturally be to gradually place all the reserves under management designed to make them perpetual producers of wood crops, improve their condition, and make them regulate the flow of water in our streams for irrigation and industrial purposes. Before they **can be** placed under such management, however, it will be necessary to study their condition; i.e., to make regular Forest Surveys. In conducting these surveys it will be impossible to lay down cast iron rules, because of the widely varying conditions. The important thing is to thoroughly understand the different methods of making such surveys, and to know which one gives the best solution of the particular problem presented.

Qualifications Necessary for a Forest Engineer.

Thus it appears that the Forest Engineer is constantly called upon to deal with problems of a decidedly practical nature. He is not a mere botanist, let loose to air his knowledge at the expense of others; neither is he a fire ranger, a lumberman, a sportsman, an arboriculturist, a dendrologist, a silviculturist, or a political economist. He must understand **all** these phases of the questions he is constantly called upon to deal with—many of them of tremendous magnitude and far-reaching importance. His profession touches life at many points, and it would be decidedly unsafe to follow his recommendations if they were not based upon a careful consideration of the factors likely to affect the general result. From this I think it should be plain that the academic training of a forest engineer should be so designed that it will give him a clear view of the whole field of Forestry Science, and thus enable him to get a proper conception of the relationships of things that at first sight do not seem to be related—even in the remotest degree. Without this conception he will be decidedly unpractical; with it, he will be thoroughly practical, in the larger and better sense of the term. Regarding his field training, there is only one way to acquire it, namely, by experience in the woods. No amount of reading or theorizing can give him this experience. It must be learned at first hand, but there can scarcely be any doubt that the man who goes into the woods with the broad general outlook that a thorough academic training in the science of Forestry gives him, will acquire this kind of knowledge very quickly, and, what is of more importance, know how to apply it in cases where the man without similar training would utterly fail, and thus prove himself thoroughly unpractical.

Such, then, is the argument in favor of placing technically trained men in charge of all important surveys made for the purpose of studying the condition of our Forest Reserves, so that we may know how to manage them intelligently, improve their condition, and make them produce wood crops for all time.

THE COST OF PREVENTING BOILER SCALE.

Some time since Mr. Arthur D. Little, Chemist, of Boston, was called upon to study the conditions in a considerable number of boiler plants with a view of standardizing the methods of preventing boiler scale and reducing the expense therefor. The following general abstract of his report will doubtless prove helpful to boiler owners and operators.

In a majority of the plants Mr. Little found soda ash and kerosene in use either alone or in combination with each other, while in several others a sumac compound was employed. The price of the latter was 10 cents per pound; its approximate composition being:—

	Per cent.
Water	28
Insoluble matter	9
Sodium carbonate	43
Sodium phosphate	13
Organic matter (tannin)	7

Another plant was using a special compound costing only 2¾ cents per pound with an approximate composition of:—

	Per cent.
Alkali	14
Insoluble matter	5
Water and organic matter	81

Still another plant was using a compound at 6 cents per pound composed of:—

	Per cent.
Water	10
Soda ash	53
Common salt	33
Organic matter	4

It was found that all the mills in the combination which used special compounds were expending nearly $1,300 per year for boiler compounds. Those which were using only soda ash and kerosene were expending very much less per horse-power although practically the same water supply was provided.

The method of applying the soda ash was investigated and it was found that in the case of a number of mills there was a mistaken idea of the use of a boiler compound. The methods employed in these mills, while differing somewhat in details, were to add the soda ash once a week and clean the boiler. The true method was shown to be to add the soda ash in small quantity and continuously, and then keep the boiler in a condition so that by frequent blowing off it is kept clean.

It was shown by Mr. Little that a considerable saving could be made and a better result secured not only by reducing the cost of the compounds themselves, but by keeping the boilers in first-class condition and preventing the formation of scale, thereby reducing the amount of coal required to produce the desired amount of steam.

CEMENT PRODUCTION IN 1907.

According to the United States Geographical Survey, the total production of all kinds of hydraulic cement in the United States in 1907 calendar year was 52,230,342 barrels, valued at $55,903,851 and classified as:—

Portland	48,785,390	$53,992,551
Natural rock	2,887,700	1,467,302
Puzzolan	537,252	443,998
Totals	52,230,342	$55,903,851
Production in 1906	51,000,445	55,302,277
Increase in 1907	1,229,897	601,574

Evidently prices for cement were not quite as good in 1907 as in 1906.

A statistical report of Canada's mineral output, covering the whole Dominion, shows that the total value of the output was about $86,182,000 for the last year, the largest output the Canadian mining industry has yet attained, being an increase of over seven millions, as compared with 1906. There was an increase of $2,669,000 in silver, $4,828,000 in coal, $758,000 in copper, $586,000 in nickel, $258,000 in pig iron from Canadian ore, and $285,000 from petroleum. A decrease of $2,405,000 in Yukon gold, and $556,000 in lead production occurred.

BREAK IN THE CORNWALL CANAL.

James Milden, B.Sc.*

The Cornwall Canal extends past the Long Sault Rapids, is eleven miles long and has six locks. The total fall in the length of the canal is 48 feet. The depth of water on sill is 14 feet, and breadth of canal at water surface is 164 feet.

At Cornwall, near the entrance to the canal, the New York and Ottawa Railway crosses the river and the canal at nearly right angles on a bridge made up of 368-ft. Pratt trusses, a series of plate girders spans across an island and 840-ft. cantilever over the north channel with a 240-ft. draw-span across the canal. On June 23rd, 1908, a leak occurred in the river bank of the canal close to the bearing pier of the draw bridge, and soon developed into a break 30 feet deep and 165 feet wide. The water in its rush to the river undermined the pivot pier of the bridge, overturning it together with the draw-span, completely wrecking both. This pier was 47 feet high, 25 feet in diameter, and its base was 9 ft. above the bed of the St. Lawrence River, and 2 feet below the level of the canal bed. The wrecked draw-bridge was a circular drum bearing one 240 feet long, 17 feet wide, and 28 feet deep, the tension members being of eye bars and compression double latticed channels. The railway people with engines capable of lifting 80 and 5 tons respectively, are rapidly getting rid of the debris.

The leak in the canal was first noticed by an employee and was located about 50 feet west of the pier. It rapidly increased in size so that within three-quarters of an hour it reached almost its present bad state. The draw span which was open for canal navigation then was seen to quiver and fall, the upturned pier being sheared into 3 parts. The water in the mile and quarter stretch between locks was lowered at the first alarm, but owing to leaking valves a considerable flow of water fell over the break until the third day causing a further excavation from the centre of the canal 60 feet wide, 9 feet deep.

From an examination of the walls of this excavation, the upturned pier and surroundings, the pier probably rested upon but a thin layer of hard-pan. The walls of the excavation show distinctly different strata, first a layer of hard-pan, the softer sandy clay, then almost clear clay beneath, while the eastern side of the break shows the presence of a quick sand.

Mr. J. L. Weller, Superintending Engineer of the Welland Canal, and formerly an engineer on the Cornwall Canal, was given charge of the reconstruction.

His first operation was to divert the water from the break. This was done by digging a trench to the lower lock and building a loose rock dam along the north part of the canal, the material being gathered from the bank. Thirty team of horses divided into two shifts of 10 hours each made slow but steady progress with the rocky, sandy clay excavation. The construction of the crib went forward without delay of any kind. As the lower courses of the dam were being built two frame trestle bridges for the purpose of unloading stone on the uuper part of the dam were constructed. About 50 men with shifts of 8 hours were employed in carrying stone while 150 men a shift were engaged in the carpentering.

Probably the most interesting feature of the repair, when one considers the canal's width and the width rquired for a temporary channel, is the making of a by-pass water course the excavated material of which will not be used in the break and causing also the removal of 120 feet trestle work. Considering 55 feet an ample temporary channel; 20 feet the minimum width for a dam, we still have 20 feet of the bottom to use, but one must allow that not only would a part of the debris which they are still removing have to be separated, etc., but the danger of collapse would be greatly increased, partly owing to increased height of dam unless excavation were filled up, but owing to the treacherous nature of the soil. It is claimed, however, that in so far as the debris is concerned that where they formerly spent hours in separating one joint, by the electric burning process, one can be burned out in five or ten minutes.

The 400-foot crib made up of 12-inch by 12-inch, or 12-inch by 10-inch timbers, has the following dimensions from west to east, 39 feet, with a total length of 364.1 feet. The cross-pieces were notched and holes were bored for a ⅞-inch spike or bolt in five places, two in the ends, one in the centre. All the crib work was filled with stone from stone fences, or where obtainable. On the inside face of the dam, 3-inch T. & G. plank were first hand-driven in the soil and then well spiked to the dam. As a further precaution to stop leakage a well-oiled canvas was then placed over the plank and extended about 10 feet in front of dam bank and was well covered with puddled clay. Below the canvas a 3-foot trench was dug all around the dam. The dam was well protected in the rear; not only was a sloping wall of concrete 10 feet high, 2½ on bottom, 1½ on top,, built all around the walls of the excavation, (below the bed of the canal), and the dam braced against it, but 12-inch by 12-inch posts, were also used braced

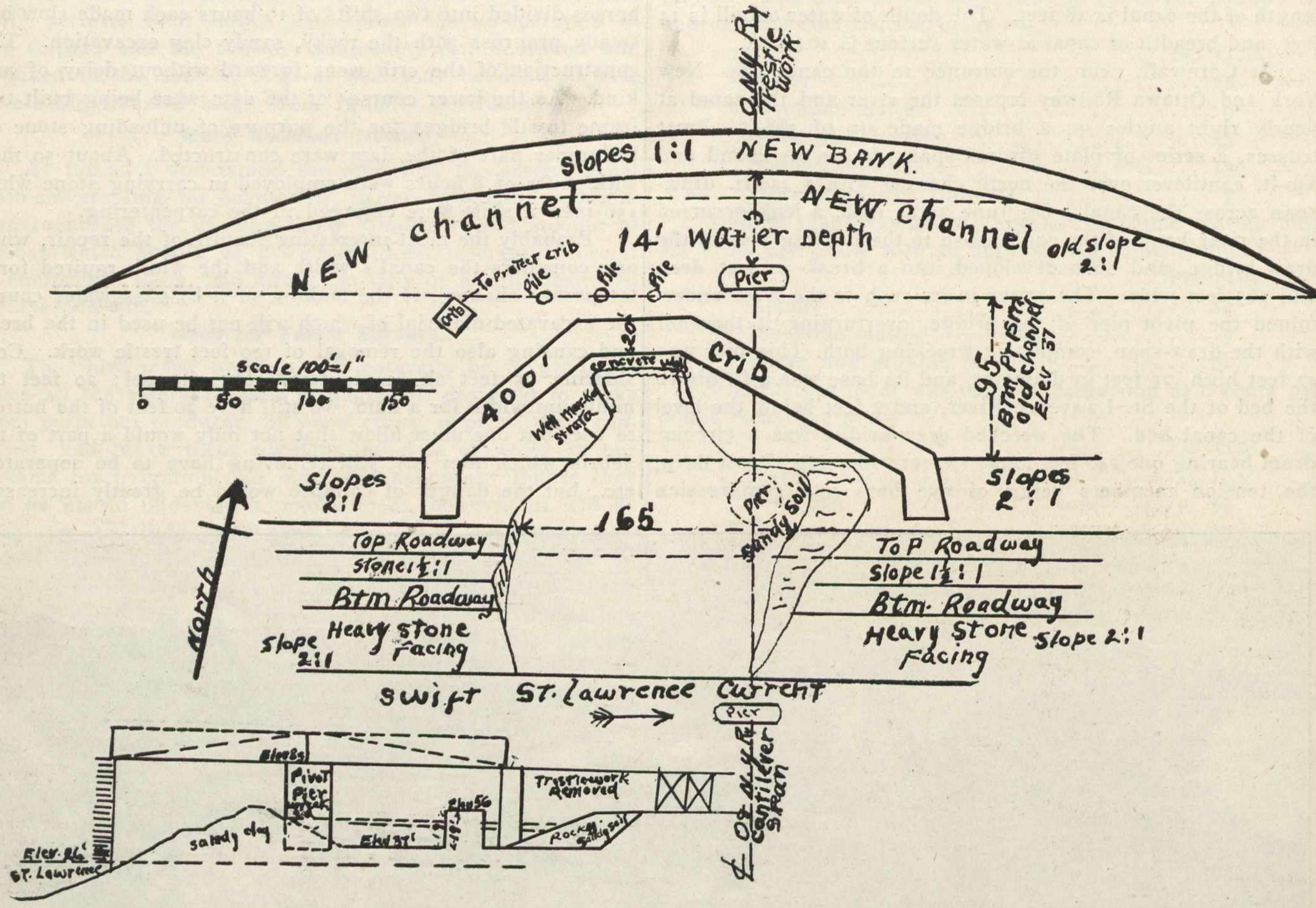
View of Repairs to Cornwall Canal.—View Looking West, July 4th, Eleven Days After Break.

*Consulting Engineer, Cornwall, Ont.

against the wall at convenient points resting on concrete footing.

As it is expected to be some time before the break will be permanently fixed the New York Central people intend to utilize a bridge which they have somewhere on their system

The last serious break in the Cornwall Canal previous to this one was in 1888, when about 250 feet of the south bank, near Moulinette, went out. The break occurred on October 12th, and it was November 15th before the canal was re-opened for navigation. The only other serious break was in



Plan of Crib Placed Across Break in Canal Bank Showing Location of Piers and New Channel.

and swing it on the remaining canal pier and build trestle work for the balance of the distance. It is quite probable that the break itself will be filled with concrete and well protected. The Dominion Government have placed $150,000 in the estimates for the work.

1851. The canal was then of smaller dimensions, and the work of repairing the damage was not so formidable. Traffic was resumed in eight days.

This break occurred on June 23rd, and on July 10th vessels were passing through the canal as usual.

ENGINEERING SOCIETIES.

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

CANADIAN STREET RAILWAY ASSOCIATION.—President, E. A. Evans, Quebec; secretary, Acton Burrows, 157 Bay Street, Toronto.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, J. F. Demers, M.D., Levis, Que.; secretary, F. Page Wilson, Toronto.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, J. Galbraith; Secretary, Prof. C. H. McLeod. Meetings will be held at Society Rooms each Thursday until May 1st, 1908.

QUEBEC BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Chairman, E. A. Hoare; Secretary, P. E. Parent, P.O. Box 115, Quebec. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—96 King Street West, Toronto. Chairman, C. H. Mitchell; Secretary, T. C. Irving, Jr. Traders Bank Building.

MANITOBA BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Chairman, H. N. Ruttan; Secretary, E. Brydone Jack. Meets first and third Friday of each month, October to April, in University of Manitoba.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, J. G. Sing; secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

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

CANADIAN MINING INSTITUTE.—413 Dorchester Street West, Montreal. President, W. G. Miller, Toronto; secretary, H. Mortimer-Lamb, Montreal.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. H. Winfield; Secretary, S. Fenn, Bedford Row, Halifax, N.S.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, TORONTO BRANCH.—W. G. Chace, Secretary, Confederation Life Building, Toronto.

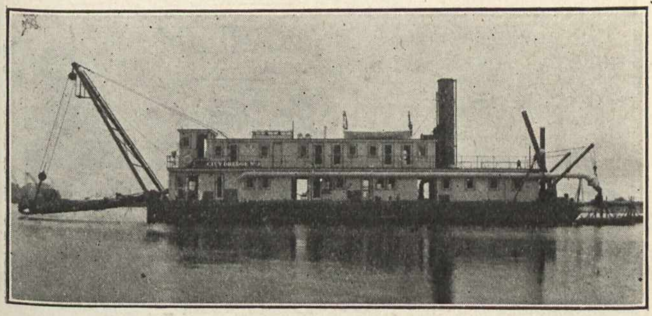
AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—29 West 39th Street, New York. President, H. L. Holman; secretary, Calvin W. Rice.

Clark & Monds, consulting and structural engineers, 36 Toronto Street, Toronto, have been granted a permit to erect a building in Riverdale, to be constructed on the mushroom system of reinforced concrete.

HYDRAULIC DREDGE.

The city of Toronto had recently delivered to them a new dredge by the Polson Iron Works of Toronto, the contract price for which was $60,000, an additional $15,000 being spent on delivery pipe and pontoons.

This dredge is a hydraulic dredge 15 inches in diameter, and is capable of excavating any ordinary material, such as sand, clay, gravel, earth or mud, to a depth of 18 feet, and to make a cut 100 feet wide and deliver the same 1,200 feet from the dredge, either over the water by steel pipes carried on pontoons, or over the land by the same pipes carried on tressels or blocking, as the situation may require. The nominal capacity of the dredge is 250 cubic yards solid matter per hour, but this will vary more or less, depending on the conditions and kind of material the dredge may be operating in. The hull is made entirely of steel with the exception of the deck, which is laid with Douglas fir planking 4 inches



City Dredge No. 3.

wide. The length of the hull is 110 feet by 30 feet beam, and has a moulded depth of 7 feet 8 inches at the side. Openings have been left in the deck to suit the different machines, and the machinery has been so arranged and placed that the boat trims on an even keel.

The main engines are of the triple expansion marine type, having cylinders 8¼-inch, 13½-inch and 22-inch diameter x 16-inch stroke. They are capable of developing 240 I.H.P. when turning up 250 revolutions per minute with 160 pounds steam pressure on the boiler. Usually, however, the engines are throttled to run slower, as under ordinary working conditions full power is not required. The engines are direct connected with the main pump, which is of the centrifugal type, having an enclosed cast steel runner and a heavy cast iron shell. The blades of the runner and the heads of the pump are protected from the scour of the material passing through by renewable steel wearing plates, and the shell with a cast iron lining made in sections.

The suction pipe extends from the pump to the bow of the hull. Part of the way it is under the deck. At the bow it rises above and connects to a ball and socket point. This admits of the suction pipe, which extends beyond this point 35 feet to be raised out of the water or to be lowered any depth up to the capacity of the dredge. The movable section of the suction pipe is carried by 12-inch channels, which are hinged onto the hull, and also carry the mouthpiece and the bearings for the shaft which drives the cutter head. To the mouthpiece the gear for raising and lowering is attached, being suspended from a steel A-frame. The cutter is of the rotary type and is a steel casting 4 feet 6 inches diameter by 3 feet 6 inches long, having 5 cutter arms cast solid with the hub. The arms have renewable steel plates riveted onto the cutting faces and thereafter ends are braced and strengthened by being bolted to a solid forged machinery steel ring. The cutter is specially designed for easy cutting of the material to be dredged, and having ample clearance spaces to avoid clogging.

The forward hoisting engine has cylinders 8-inch diameter x 12-inch stroke, and is placed on the main deck near the bow. This engine operates the hoisting drum placed in the centre of the hull for raising and lowering the suction pipe two swinging drums placed one at each side. It also drives the cutter head. The whole of these operations are controlled from the pilot house by means of a set of handling levers, which operate the friction drives and brake straps, and by these means the operator has under his immediate control the amount of feed or depth of cut he may wish to take. He can also communicate with the engine room by means of a gong or speaking tube. There is also a vacuum gauge connected to the suction pipe which serves as an index to regulate the feed.

At the after end are placed two wooden spuds. One is a fixed spud, capable of being raised and lowered, and on which the dredge swings when in operation. The other is a walking spud for feeding the dredge forward into the cut. The spuds are raised and lowered by means of a double friction drum-hoisting engine operated by levers on the main deck. The walking spud is operated by a 12-inch diameter x 30-inch stroke steam cylinder, specially designed, for forcing the dredge forward into the cut. The other auxiliaries consist of independent air pump and jet condenser, one feed and one pony pump, duplex outside packed type, piped to be interchangeable for any service that might be required. The pumps were supplied by the Smart-Turner Machine Company, Limited, of Hamilton. One sanitary pump, fitted with automatic regulator, a complete electric light plant, furnished by the Canadian Westinghouse Company, Limited, including two searchlights. Steam is supplied for all machinery by a Clyde boiler 10 feet diameter x 12 feet long, inside dimensions, having two corrugated furnaces, and fitted with the latest type of highclass fittings, and built to pass the Canadian Steamboat Act for a working pressure of 160 pounds per square inch.

There is also an auxiliary boiler, vertical type, to supply steam to the heating system during cold weather, early in the spring and late in the fall. This boiler is also used to supply steam to the pony pump when the main boiler is being washed out and cleaned.

The quarters for the officers and crew are very complete and commodious, including an office for the Captain, bathroom, also general smoking and reading room. There are also two hand-derrick cranes, each having a lifting capacity of five tons. They are used for handling the discharge pipes and pontoons. Two hand-capstons are provided for warping purposes, also a life boat swung on davits, shipshape fashion.

All of the hydraulic dredges belonging to the city of Toronto are operated in the same manner. The dredge having been placed in position ready for work, two anchors are placed, one either side of the bow, and ropes lead from these to the swinging drums. The fixed spud is then lowered, which anchors the after end of the hull and the walking spud is raised clear of the bottom. The suction pipe is lowered into the water and the pump is primed and the main engine is speeded up and pumps water only. The cutter head is started by throwing the friction lever in gear, and is then lowered to the proper depth and swung round the spud as a centre, the radius from the spud to the outer end of the cutter being about 130 feet. The swinging motion being accomplished by the swinging drums, and are operated by the operator in the pilot house. The vacuum on the suction pipe which is registered on the gauge in front of the operator serves as an index for regulating the amount of cut. The discharge from the dredge is at the after end, and on the end of the pipe is a ball and socket joint to which the pipes carried on the pontoons are attached, carrying the material to any point that may be required. When the dredge has been swung across the full width of cut it is proposed to take, it is then forced forward bodily into fresh material by means of the walking spud and cylinder for operating it.

The accompanying photograph illustrates the dredge in actual working conditions.

The contract for the engines for the new power plant of the Bigelow Carpet Co, Clinton, Mass., has just been awarded through the office of Chas. T Main, engineer, Boston, to the Providence Engineering Works, Providence, R.I. It includes a 400 horse-power non-condensing and a 1,000 horse-power compound condensing engine, both of the horizontal type. The awarding of the contract for the attached generators has been delayed . The complete units will be of 300 and 750 k.w. capacity, respectively.

AVOIDABLE DANGERS IN REINFORCED CONCRETE MILL CONSTRUCTION.

In a recent discussion of the possible dangers incident to the use of reinforced concrete in mill construction, Mr. Leonard C. Wason, president of the Aberthaw Construction Co., of Boston, was led to speak from his experience. He at once showed that practically all of the possible dangers are avoidable; that they are entailed by incorrect design or poor workmanship, and that there is nothing inherently dangerous in the use of reinforced concrete. So far as strength and structural features go it has few limitations, discrimination in use being controlled principally by its adaptability. Recognizing the common impression that almost anybody can mix and place concrete, Mr. Wason emphasized the vital importance of employing skilled men. First. Because the reinforcement might otherwise be improperly placed, perhaps too high in the beams and girders or in the top of the floor slabs, thereby introducing serious sources of weakness. To the ignorant laborer such misplacement would mean nothing; in fact, it being a not uncommon practice to spread the concrete out over the forms and lay out the bars on top. Under such conditions the laborer is more apt to spread the concrete thick than thin, because if very thin the stone in the concrete interferes in the spreading. Second. Because of the errors which may arise through the selection of the wrong size of bars for reinforcement. In is a simple matter for a man to overlook the difference of an eighth of an inch in diameter, which in small bars may make a difference of 50 per cent. or more in the strength. Sometimes the wrong number of bars may be used.

Third. Because an unskilled or careless foreman may erroneously read his plans. Sometimes he may set the bars at right angles to the correct position. In columns the bars are usually placed near the surface to avoid flexure; but it is easier to place the concrete if they are nearer the middle. If nearer the middle, however, the flexure is not taken care of, and the tie between the floor and column is not so rigid.

Mr. Wason referred to some of the failures of reinforced concrete which have been reported, and stated that, although usually sworn to as caused by the drawing of the form work toc soon, the fact is usually that the failure really has been due to improper setting of the steel and to careless placing of the concrete. In a failure which occurred in Philadelphia about two years ago sawdust and shavings were found in the columns, where they had fallen before the concrete was placed. The effect was to reduce the cross sectional area of the columns by fully 50 per cent.

The difference in strength between tamped and untamped concrete was shown to be 30 per cent., due largely to the fact that under the latter conditions it does not flow around the reinforcement. As a consequence voids are formed. It was also pointed out that when the concrete is mixed dry it does not properly grip the bars. Mr. Wason asserted that it has been pretty conclusively proven by disinterested engineers, who have carefully examined such failures, that they were due to carelessness on the part of the contractor and his workmen, and that none of them were due to incorrect principles of design. In a word, the danger lies in hidden defects, which, once covered from sight, are revealed only by disaster.

The Northumberland Paper & Electric Company, Campbellford, have ordered a Duplex Pump from The Smart-Turner Machine Company, Limited, Hamilton.

There seems to be in Regina considerable opposition concerning the advisability of proceeding with the trunk sewerage and waterworks schemes. The city has a debenture debt of $1,576,135. Its assessment roll for the year 1907 is $11,147,571. It is not desired to cast any reflection whatever upon Saskatchewan's progressive capital, but the city must reflect as to whether now is the time to institute large municipal schemes. Politics and municipal quibbling may play a role at any time, but common sense is a good match for them.

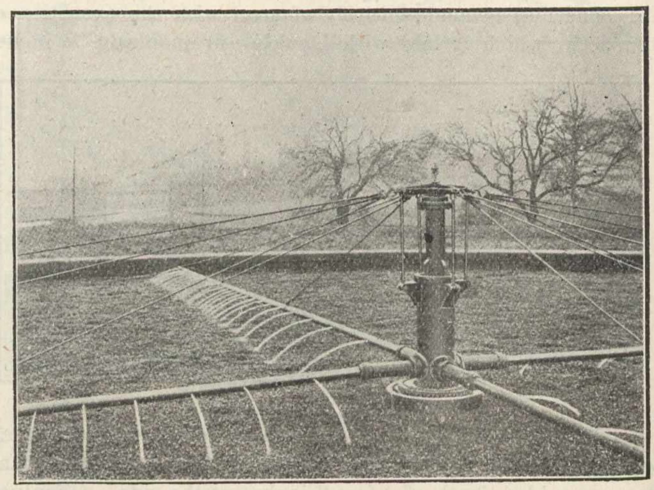
SEWERAGE AND SEWAGE DISPOSAL.

T. Aird Murray, C.E.

An up-to-date "Bacteriological Treatment" System.

Naturally, it took a considerable time before large cities could see their way to accept a new system of sewage disposal. A system so directly opposite in its principles to the chemical method of treatment, generally in vogue.

At many towns large sums of money had been laid out on systems which at the time were practically guaranteed to be final solution of the problem. People began to lose confidence and ask "when is this going to end?" For a time all theories of sewage disposal were received in a spirit of scepticism. Especially in Great Britain is it difficult to install



Sprinkler at Work, Bradford, England.

any plant of an experimental character. There, before a municipality can obtain the consent of the Local Government Board to borrow money on the security of the rates, a perfected scheme on paper, showing every detail, must be submitted to this central authority. This authority is naturally conservative in its institution and practice, and one of its duties is to guard against, local municipalities throwing money away on what may result in profitless experiments.

We, therefore, find that the bacteriological system for a long period was confined to small efforts, made by those who were able either to carry out works by aid of their own funds, or out of current rate, without a loan consent being required.

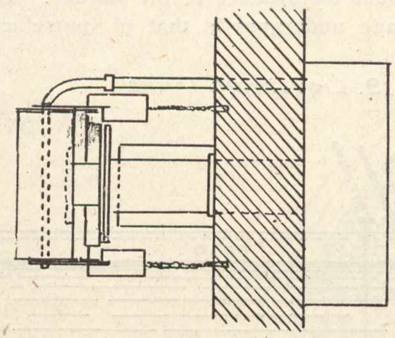
This phase of the problem has now, however, passed. We find the Local Government Boad on every hand encouraging the adoption of this, the most modern system. Large towns in England and Europe have either adopted the bacteriological system, or they are in the process of adoption. Leeds, Manchester, Sheffield, Bradford, and scores of other large towns, with even complex sewage discharges, owing to manufacturing waste, have carried out valuable experiments, and are now asking or have obtained powers for the installation of complete systems.

Processes.

Bacterial sewage disposal may be divided into two systems; (a) "The Contact System;" and (b) "The Continuous System."

By the contact system, the liquid sewage is fed into rectangular tanks containing filtering media. A series of these tanks being adopted, each tank is filled in turn to the point of saturation with sewage. Allowed to remain quiescent for a period of time, and then drawn off. This period is regulated so as to give the nitrifying organisms, growing on the surface of the media, sufficient time to attack and destroy the organic matter in the sewage. These tanks can be on the simple or multiple system. In the first the tank is undivided, in the second each tank is sub-divided, and the sewage syphoned from one division to the other, coming into contact with a finer grade of media in each division. The great advantage of the multiple contact system lies in the fact that several contacts are obtained in the depth of a single contact bed, and practically on the same area. Constructional cost is thus reduced considerably when there is insufficient fall and great purification is required. The whole apparatus for working beds of the above character can be obtained of automatic construction by makers who make a specialty of such plant.

By the continuous system, the liquid sewage is not held back in contact for any quiescent period in the filter. It is supplied (uniformly) to the surface of the filter in small



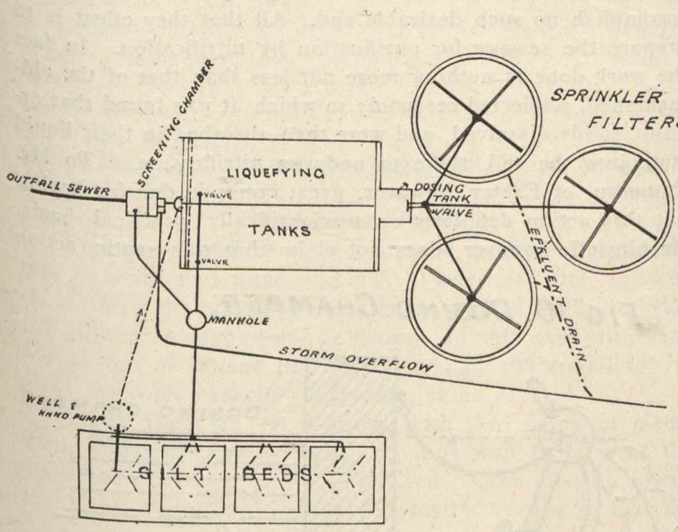
PLAN

AUTOMATIC MEASURING VALVE

doses or discharges, and allowed to percolate slowly from one particle of media to the other by its own gravity, there never being a sufficiently large discharge allowed, which would cause any hydraulic head or weight of sewage in the filter. This system, both from practice and observation, the author claims as the best; although in dealing with certain forms of strong sewage, especially in manufacturing districts, he has found that a combination of both the contact and continuous systems are at times advisable.

The purpose of this article is, however, to describe in more detail a continuous filtration plant dealing with the

FIG. 4. BACTERIAL DISPOSAL SYSTEM.



PLA

domestic sewage of a small town on the most economical lines consistent with obtaining satisfaction.

A System for 2,000 Inhabitants.

We will deal with a town of 2,000 inhabitants with a supposed daily water consumption of 60 gallons per head; giving 120,000 gallons of sewage in dry weather every 24 hours. The system will be capable of taking this amount diluted to five times during rain periods, any overplus being treated as storm water.

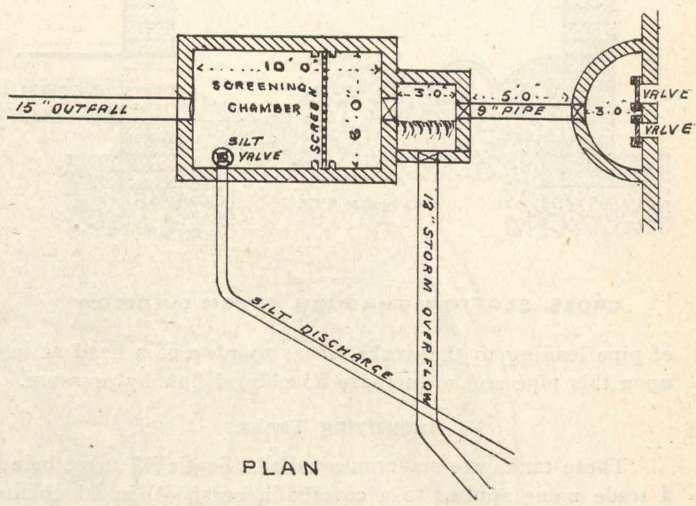
The system may be divided as follows:—

1. Outfall sewer.
2. Screening chamber.
3. Storm overflow.
4. Duplicate liquefying tanks.
5. Dosing chamber.
6. Continuous filters.
7. Effluent.
8. Silt beds, (Fig. 4 shows general arrangement).

Outfall Sewer.

We will take it that the sewage is carried to a plot of land by means of an outfall sewer capable of taking not only the dry weather flow but also storm water dilution. The size of this sewer is, of course, a sewerage question depending upon the amount of surface water taken. If not more than

FIG. 5. SCREENING CHAMBER.



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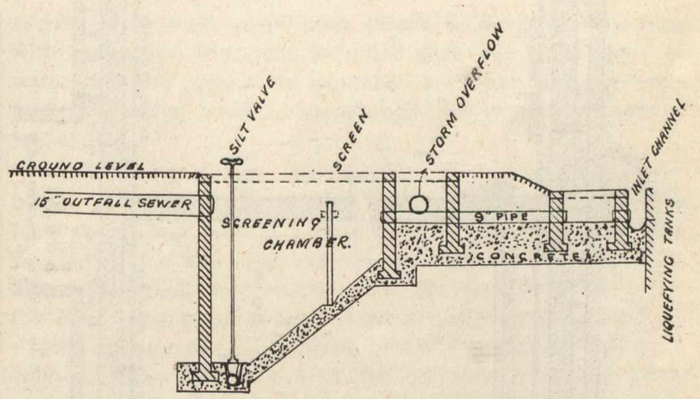
from ten times the dry weather flow, it will probably be represented by a 15-inch pipe at a gradient of not less than 1 in 500 capable of discharging running half full 530 gallons per minute. This sewer should enter the land at its highest level, and the land should at least present a fall of about 10 feet 6 inches for working purposes from inlet of sewage to outlet effluent.

Screening Chamber.

Figures 5 and 6 show plan and section of screening chamber with storm overflow arrangement attached. In this chamber 10′ 0″ × 6′ 0″ × 8′ 0″ deep, a wrought-iron screen is placed of ⅜-inch mesh. The purpose being to keep back such solids as tin cans, scrubbing brushes, etc., which are

FIG. 6. SCREENING CHAMBER



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not easily digested by bacteria, but are often the accompaniment of domestic sewage. There is no standard size for this chamber; but in no case should it be larger than necessary, as it is desirous to produce a boiling or swirling action in the sewage, thus helping to break up the solids into finer particles.

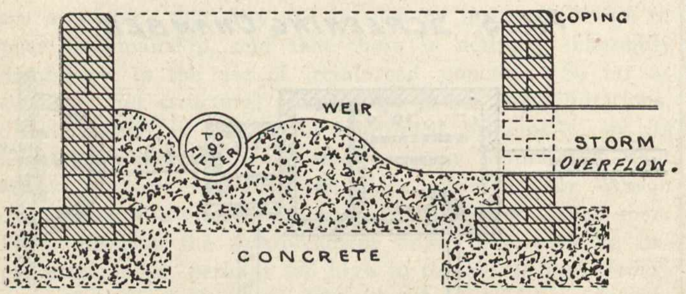
Storm Overflow.

The storm overflow immediately following the screening apparatus is a simple but reliable arrangement, by which only five times the dry weather flow is allowed to enter the works. The overplus passing over a concrete weir, (see Fig 7), and into a separate sewer either direct to the stream or for partial treatment in a rough stone filter if necessary.

The pipe leading to the works is shown 9-inch diameter, and must only be capable of taking 600,000 gallons in 24 hours, or 416 gallons per minute, it must therefore have a gradient of not less than 1 in 290.

The size of the overflow pipe and gradient must be arranged to take the whole of the overplus, and the length of the weir with a hydraulic depth of ½-inch, also represent this amount. The top of the sill being kept ½-inch below the top

FIG. 7 STORM-OVERFLOW



CROSS SECTION THROUGH STORM OVERFLOW

of pipe leading to the works, so as to prevent a head acting upon this pipe and so increase its natural flow by pressure.

Liquefying Tanks.

These tanks are sometimes called "Septic" Tanks, being a trade name applied to a covered-in cesspool, in which the solid sewage is allowed to precipitate by natural methods without the aid of any precipitant. These tanks are very necessary to a bacterial disposal system, as they serve to break up and liquefy the solids and so make the work of the filters much easier and prevent them from choking. Experiments of treating new sewage by direct filtration have not been a success. It is not only the question of the organic solids, but also of mineral solids, such as the sand silt from the tear and wear of roadways, pathways and stone work. These mineral solids always form a proportion of the sewage matter, and settling tanks of some nature are necessary in

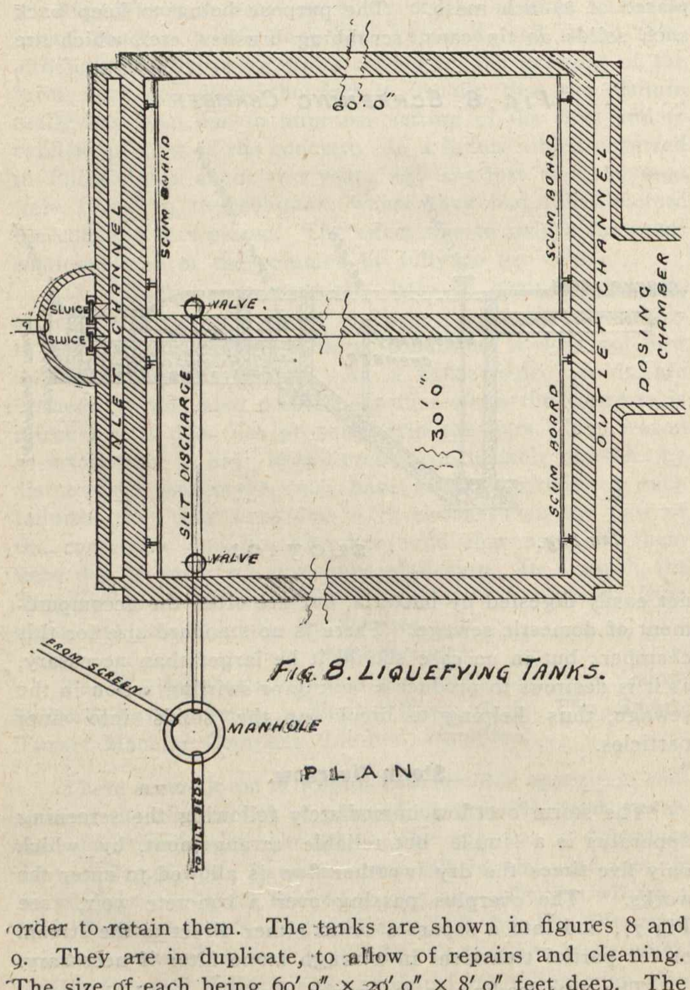


FIG. 8. LIQUEFYING TANKS.

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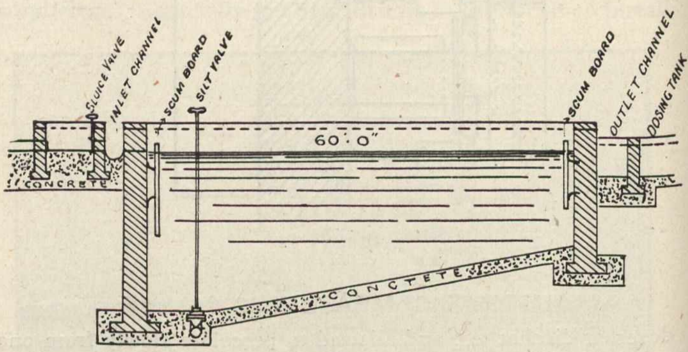
order to retain them. The tanks are shown in figures 8 and 9. They are in duplicate, to allow of repairs and cleaning. The size of each being 60′ 0″ × 20′ 0″ × 8′ 0″ feet deep. The two being capable of holding 120,000 gallons of sewage or 24 hours' dry weather flow.

The sewage enters over a weir, the full breadth of the tank, in the form of a thin film. It then meets with a scum plate fixed about 3 inches from the weir, this stands about 6 inches above the water-level and dips about 2 feet into the body of the tank. It serves the double purpose of preventing any disturbance of the surface of the tank, while the sewage entering at a level above the bottom of the tank, the lower layers of precipitated matter are also undisturbed. The method of outlet is arranged in precisely similar lines.

The main principal in these tanks, is to prevent as far as possible any undue disturbance of the sewage. The process which the sewage undergoes is that of putrefaction. All

FIG. 9. LIQUEFYING TANKS



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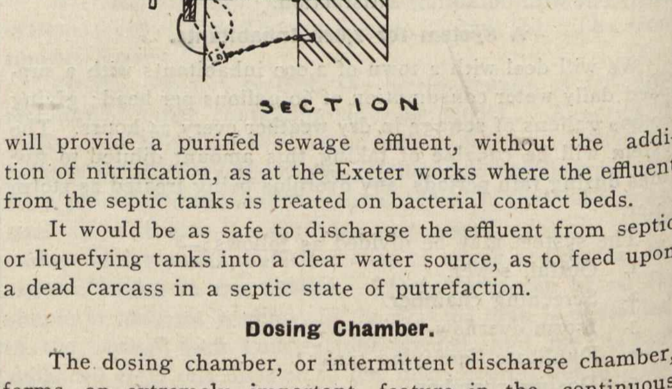
putrefaction is of a septic nature, that is it is brought about by the aid of bacteria in their effort to break up effete organic compounds. Consequently we gain from these tanks a more liquefied form of sewage. But it must be borne in mind, that no nitrification has taken place. And the effluent from these tanks is still sewage, though presenting a more desirable appearance than when it first entered.

An opinion exists in some quarters that such tanks provide all that is necessary for sewage purification. They accomplish no such desirable end. All that they effect is to prepare the sewage for purification by nitrification. In fact the work done is nothing more nor less than that of the old-fashioned, neglected cesspool; in which it was found that organic solids dissolved, and were then absorbed in their liquid state into the soil, there to undergo nitrification. To Mr. Cameron, of Exeter, however, great credit is due for having put this action definitely on a scientifically practical basis. He himself, however, does not claim that this septic action

FIG. 10. DOSING CHAMBER.



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will provide a purified sewage effluent, without the addition of nitrification, as at the Exeter works where the effluent from the septic tanks is treated on bacterial contact beds.

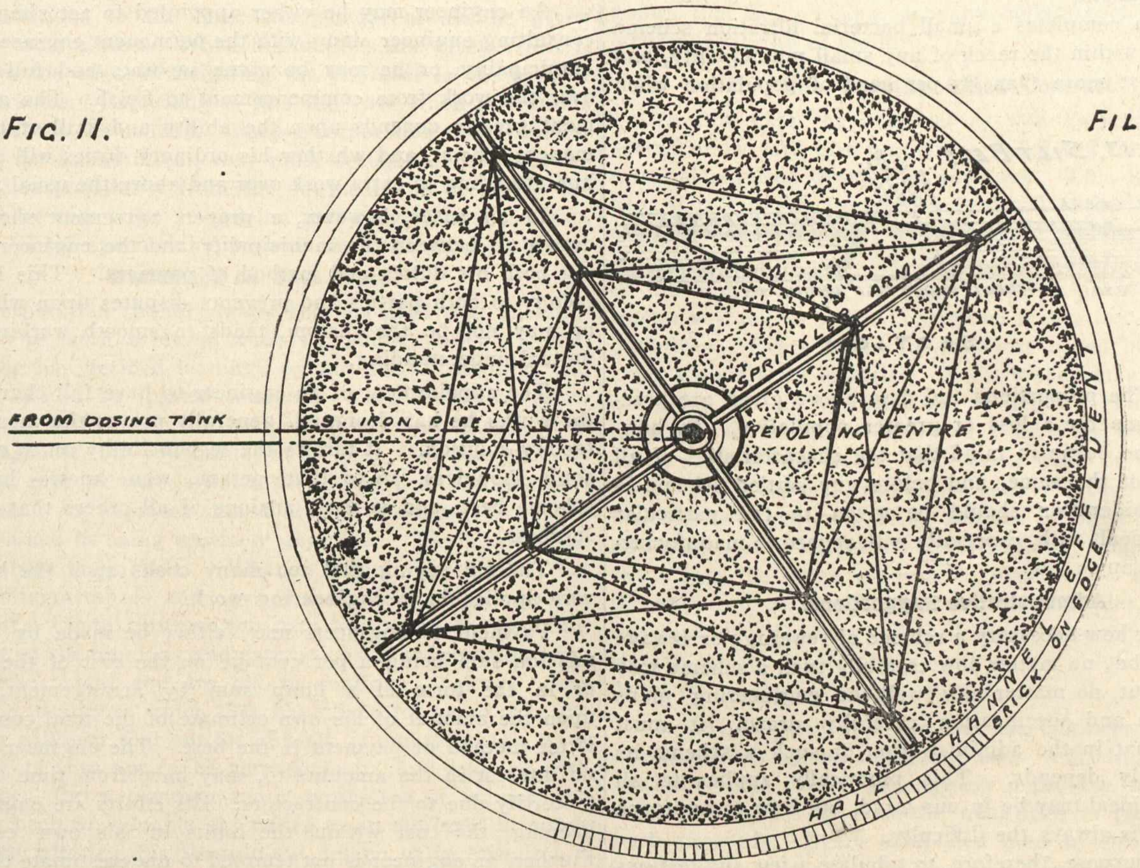
It would be as safe to discharge the effluent from septic or liquefying tanks into a clear water source, as to feed upon a dead carcass in a septic state of putrefaction.

Dosing Chamber.

The dosing chamber, or intermittent discharge chamber, forms an extremely important feature in the continuous bacterial system, on its capacity largely depends the success of the filter.

The capacity is entirely based upon the super area of filtering media to be dosed; and should not represent more than 2 gallons per super yard of filtering area. In other words, should not exceed a ½-inch of rain fall over the surface. Fig. 10 shows a simple form of measuring value by means of which the discharge can be regulated.* The size of the tank shown, 28′ 0″ × 14′ 0″ × 1′ 6″, together with the outlet channel from liquefying tank 30′ ×2′ 0″ × 1′ 6″ will give a capacity of 678 gallons, capable of dosing the area of filtering media required.

FIG. 11. FILTER



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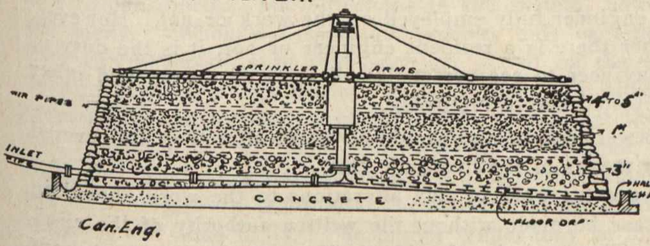
Continuous Filters.

Figures 11 and 12 show plan and section of the usual type of continuous filter supplied. Their total filter capacity should bear the proportion of a cubic yard of media to every 168 gallons of sewage per 24 hours. In this case with 120,000 gallons of sewage per day divided by 168 equalling 715 gives the cubic capacity required in cubic yards.

Three filters 36 feet diameter with 7′ 6″ depth of media would equal 846 cubic yards. As it is well to be over the mark, these are the sizes here advised. The filtering media should be of any hard indissoluble matter graded so that the top layer may consist of cubes from 4 to 5 inches, the centre layer of finer material of about 1-inch cubes, while the lower or draining layer should be of about 3-inch cubes. The author has found these grades of media to give splendid results with domestic sewage. The floor of the filter should be underdrained with ordinary tile sub-soil pipes made on the concrete base; special drain pipes can be obtained for this purpose at a slightly greater expense than ordinary tiles.

FIG. 12. FILTER.



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Pipes are provided radiating from the centre of each bed to the outside, giving free access of oxygen to the body of the media. The circumference walls may be built of honey-combed hit and miss brickwork. If economy is desired, then by means of rough rubble walls, built up with large cubes of the filtering media itself. As many open air spaces in the walls as possible should be provided consistent with strength. It should be noted that the walls have no water pressure upon them whatever, and have merely to support the media, which is practically self-supporting once it has settled.

The method of distributing the sewage, is by means of automatic sprinklers. The sewage is discharged from the dosing tank by means of iron pipe arms fitted with valves, so that any filter may be put out of use on occasion. The dosing tank outlet being above the level of the sprinkler, the head of sewage is exerted on a turbine centre, through which it passes and is carried into perforated arms, which revolving, spray the sewage in fine particles over the whole surface of the filter bed in an even manner. The outlet channel surrounding the filter at the base receives the nitrified effluent.

Effluent.

The effluent from the above may either be discharged direct into a stream, or if desired used for irrigation purposes. Such an effluent will be incapable of causing any nuisance or undergoing further putrefaction. But if it is desired to obtain absolute purity from a biological point of view, that is to make it immediately safe to mix with a drinking water supply; it should be further treated by means of fine sand filters, as are in vogue for water supply filtration.

Silt Beds.

There is still the silt from the screening chamber and liquefying tanks to be dealt with. This consisting principally of mineral, indissoluble matter will be necessarily mixed with a proportion of organic matter.

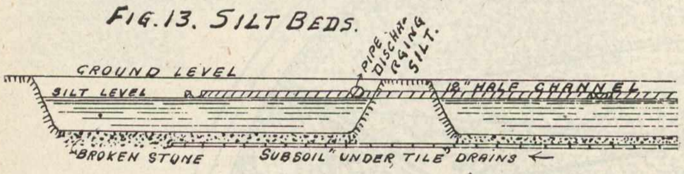
The general plan and section, Fig. 13, shows silt beds simply dug out of the ground with a layer of broken stone

*Messrs. Mather & Potts' patent, Manchester, England.

for the foundations and under drains. The silt sludge is discharged by means of hand valves to a channel running alongside the beds, and is turned into the beds in turn by means of hand penstocks, where it is allowed to drain and dry. The dried sludge being dug out and dug into land as tillage. The amount of sludge made is extremely small by this process and gives little or no trouble. The liquid draining from the sludge should be led back to a well, and from thence pumped by a small hand pump back to the liquefying tanks for treatment.

This then completes a small bacterial filtration scheme which is well within the reach of any small municipality, and should not cost more than $5 per head of population when

FIG. 13. SILT BEDS.



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completed. The proportions and data above given are practically the same for a less or greater population. It, however, should be borne in mind that the characteristics of all sewage are not the same, and before any settled scheme is adopted, consideration should be given to the particular sewage to be dealt with, especially with regard to manufacturing wastes, if any.

Administrative Suggestions.

No matter how necessary a scheme of sewerage or sewage disposal may be, no matter how carefully such a scheme may be thought out, no matter how well the engineering plans may be made and specification carefully drawn, it must be granted that in the administration of such a scheme its success greatly depends. This practically applies to all affairs. The ideal may be in our mind, but how to approach it in practice is always the difficulty.

It is our purpose, therefore, to tabulate a few suggestions which may be of use to communities who have matters of public works in contemplation.

Obtaining a By-law.

The first effort of a corporation in connection with a sewerage or sewage disposal scheme, (this, of course, applies to almost all schemes of public works in which loans are required), is to obtain the consent of the citizens. How often does it happen that the people are asked to vote upon a scheme, which is only put before them in the vaguest possible manner?

The author has in mind a by-law only recently submitted by a corporation in Canada for extensive main sewerage and sewage disposal, upon the details of which it was impossible for any citizen to obtain any information whatever, beyond the fact that the scheme contemplated lengths of collecting sewers, and some form or another of sewage disposal in a certain vague locality, no other information was forthcoming.

Is it remarkable that by-laws are often defeated when the citizens are not taken into confidence? Or it may even be that no proper matured scheme has even been settled upon by the authorities upon which the people may vote.

It is suggested that before a by-law is asked for, that complete plans of any scheme should be first drawn out. That such plans should be on exhibit at the City Hall, so that everyone who takes an interest in the matter should have the opportunity of knowing exactly on what proposal his vote is asked.

In Great Britain such plans must be on exhibit for at least three weeks previous to a public enquiry, at which any objections raised may be heard.

The cost of such plans is small. And the fact that they provide every member of a corporation with the ability to answer any question that may arise, inspires the public with confidence.

In the case of main sewerage, the plan should show every line of sewer with the names of the streets proposed to be sewered. In the case of sewage disposal the land to be occupied and the character and extent of the scheme should be shown. It is well also that the corporation, (if it is necessary to purchase any land), should have a provisional agreement of purchase, so that no after difficulty may arise in obtaining the land.

The Appointment of an Engineer.

An engineer may be either appointed to act simply as a consulting engineer along with the permanent engineer of the municipality, or he may be given separate and full control over the work from commencement to finish. The arrangement greatly depends upon the ability and skill of the permanent official, and whether his ordinary duties will allow of him attending to extra work over and above the usual routine.

In all cases, however, a proper agreement should be drawn up between the municipality and the engineer, defining both his duties and method of payment. This is satisfactory to both parties and prevents disputes upon what may or may not be the custom, tends to smooth working, and mutual understanding.

The appointment of an engineer to have full charge over the works he has designed, generally proves the most satisfactory solution. It throws the responsibility on to one person's shoulders, on to that person who knows his own scheme best, and is most anxious of all others that it be a success.

The old saying that too many cooks spoil the broth is very applicable to engineering work.

Payment to engineers may either be made by a commission sum being a per centage on the cost of the works, or in the form of a lump sum by arrangement, based upon the amount of his own estimate of the total cost. The latter method of payment is the best. The engineer having no interest in the amounts to, may have from time to time, to certify due to the contractors. His efforts are engaged in keeping the cost within the limits of his own estimate. Further, an engineer is not tempted to underestimate the work in the first instance, which may be done in order to get work commenced at any cost. The eventual cost amounting to much more than the preliminary estimate. A denouement requiring careful explanation, as a rule.

The Duties of the Engineer.

The engineer should engage to make all preliminary plans, profiles, specifications, etc., to the satisfaction of the "Board of Health" or other authority having jurisdiction.

He should be prepared to attend all meetings of the council, to discuss and advise with the corporation in arranging for carrying out the work and obtaining contracts.

He, or his representative, should test and examine all work carried out, and be able from time to time to certify that such work is done satisfactorily.

The number of working visits an engineer should put in, is an open question, depending upon whether there is a resident engineer fully employed on the work or not. However, whether there is a resident engineer or not, it is the duty of the engineer to see personally all lines of sewers and other work tested before certifying.

Sewers can be and should be tested after they are covered up by means of the hydraulic test.

No extra work or any alterations to the work should in any case be made without the written authority of the engineer. The engineer should in all cases obtain the consent of the corporation before ordering alterations causing excess of expenditure.

The Duties of the Corporation

Are not to unduly interfere with the engineer and make his life a burden. If an engineer cannot be trusted with work in which he is a specialist, he should be got rid of. It is better for both parties and better for the work in hand.

Members of a corporation should not act singly. They should remember as individuals they have no locus standi.

When a corporation wishes to instruct or advise with their engineer, it should be by properly convened meetings, at which they have power to act. The alderman or councillor who buttonholes an engineer, and would like this or that done, is not acting in an official capacity unless deputed by the council. He should be content to air his feelings before his brother members, where they may or may not be listened to; and not as a private member of society, take upon himself the functions of a full-grown corporation.

Instructions to the contractor should always be given through the engineer. When instructions are given direct it may have the effect of belittling the engineer in the eyes of the contractor. Especially is this the case when alterations are desired by the council. When a corporation orders alterations or deviations direct, they must remember that they remove all responsibility from the engineer and create in the mind of the contractor an opinion that he may trespass from the lines of the specification without the engineer's authority.

Diplomacy on Both Sides.

A corporation should always bear in mind that an engineer may be more or less of what is popularly called a crank, that is he has decided leanings to one line of thought, and as such should be treated tenderly. Care should be taken of his professional corns. You can always convince a good sound engineer, but you cannot bully him. The man you can bully you may be sure is not a sound engineer and deserves no respect. An engineer should always remember that nothing is gained in being unwisely dogmatic. The golden rule is that there is no rule. What is meant by this is that special circumstances and environment often require special treatment. Useful information may be gained by listening patiently to the opinions and expressions of information from people who know and are apt to continue to know more about the locality in which they have lived for years than the engineer will ever find out for himself. Common sense, as it is called, is very apt to be very common, and leagued with ignorance. But a common sense expression of opinion has at times been of valuable assistance to an engineer in either completely altering his thought-out design or in bringing it clear out of the eddies of probabilities.

The Letting of the Contract.

The axiom which must be kept in mind is, "That cheap work is generally of a cheap nature." "Good work will always command its price in the market." There are two chief methods by which a contract price can be obtained. They are (a) "The lump sum contract;" (b) "The quantity based contract."

"The Lump Sum Contract."

In this case it is the custom for the engineer to prepare plans and profiles together with a description of the character of the work called "specification." He gives no measurements as to amount of material required. The contractors view and study the documents, take their own measurements and arrive at what they consider the amount of material and labor required to complete the work. The advantages of this system is that it saves the engineer a large amount of trouble and responsibility. The objections to the system, however, are many. When a corporation receives bids or tenders, they can never be sure that such are based on the same amount of work and material. When there is a wide discrepancy in the tenders, it is impossible to say that the result is caused by one man being able to do cheaper work than the other, or is simply the result of a false estimate of the amount of work required. The tenders do not therefore stand on the same basis. The higher tender may be for the actual amount of work required, based on an experienced and intelligent estimate of the quantities required. The lower tender may be the result of inexperience and ignorance of a proper method of taking out quantities.

Again, when it is left to the contractor to take his own quantities from the plans, he is apt to be left with the unsatisfactory feeling that items may be left out, and he generally adds a sum to cover any such errors of judgment.

The argument is used, that if the contractor makes a mistake, and puts in too low an estimate, it is his own fault, and he consequently suffers. However, the contractor not only suffers, but the character of the work suffers considerably. Half way through a contract, the contractor can tell whether the work is going to pay or not. If he finds that it is going to loose him money, then his whole efforts will be centred on cutting down expenses even at the cost of good work, whenever and wherever he can possibly escape the vigilance of the engineer. Nothing is more unsatisfactory than the struggle to obtain first-class work from a man who knows that he is losing so many dollars each day. "The laborer is worthy of his hire."

"The Quantity Based Contract."

In this case the engineer as well as preparing plans, specification, etc., also prepares a full list of the quantities of material required throughout the work. This Bill of Quantities, as it is called, itemizes every detail of the work. Against each item the contractor has simply to put his price, including an estimated sum for the labor required. The addition of the sums forming the total contract price. Every contractor wishing to tender is supplied with a full sheet of these quantities. Every tender is therefore based on exactly the same estimate of material. Each tender may therefore be compared not as a whole, but in detail. The corporation have the advantage of knowing what they are paying for every item of the work. Any extra work or diminution of work, can be correctly and easily audited. This is the system which is now generally being adopted in Great Britain. It is advantageous to all parties concerned. It brings work out of chaos into the plane of business exactitude. It is good for the engineer, as in taking out exact quantities, he familiarizes himself with every detail of his own general proposition. He can see the whole of the work in his mind's eye in every detail even before it is commenced.

It may be here objected that the engineer may make a mistake in taking out the quantities. Certainly! He is not infallible. But rather the engineer make a mistake than the contractor. Any error in the quantities is rectified as the work proceeds. Every completed item is measured and if less or more than given in the quantities is deducted from or added to as the case may be. As a rule it will be found that an engineer will prepare his estimate of quantities on the full side. He has no inducement to underestimate. It often, therefore, happens that the completed work costs less after being measured up than the original contract sum. The corporation getting, of course, the benefit of the difference.

The Resident Engineer.

The resident engineer, or clerk of works, as he is often called, is an essential in works of. any magnitude. His business is never to be away from the works while there are men working. He should have a good understanding of the practical trades employed. Should be a competent judge of material and workmanship. He must have the plans and specifications in his mind. Be able to set out work, check levels, and measure up. Above all things he must have a back-bone and an individuality not liable to be absorbed in the human personality of the contractor. His wage should be of a sufficiency, to prevent him relying upon the philanthropy of the contractor for ordinary comforts.

Although there way be times when a clerk of the works may be justified in considering himself a much more able man than the chief engineer who has designed the work, as a simple form of etiquette, it is due to the engineer that his instructions be carried out.

Payment of salary to the clerk of works may either be made by the engineer or the council. This being a matter of arrangement between the council and the engineer.

On Completion.

On completion of the work the engineer should furnish the council with a complete bill of quantities, showing clearly every item for which the contractor has been paid with the price of the same, together with the original bill of quantities in corresponding columns, so that any diminution or addition may clearly stand out, and be audited.

Complete Plan.

The engineer should provide a complete plan showing the whole of the work as carried out. In the case of sewers the plan must show the correct position of each manhole with it. depth, the gradient of each line of sewer as laid, with all junctions for future connections correctly marked with measurement of distances from manholes.

This now concludes what can only be looked upon as a very scant and general survey of a big subject. The author feels that he has gone over much ground which is by no means new to the engineer experienced in public works. The object however has been to put the whole subject in a concrete form, of some value to municipalities and others who may be contemplating works as described, as a new venture.

GENERATING END OF POWER STATIONS.

A. D. Le Pan, B.A. Sc.

As soon as the generation end of the power station comes into consideration, it is necessary to go to the other end of the line and study the field of work to be fed by the station, as surely the nature of the load must determine the characteristics of the generating units. If the power development is to be one of any great magnitude, it will usually be designed to do general work, including street and commercial lighting, electric railway service and the factory power business, thus carrying a direct load, as well as a synchronous and inductive load.

Up to the present time the larger part of electrical power has been generated by continuous current. All the earlier plants are of this type, and even now, when generation by alternating apparatus, polyphase or other, is generally used, the older type of apparatus is still being installed on an extensive scale. New power plants, both here and abroad, are, save for rare exceptions, for alternating currents, and in many cases this practice is absolutely necessary. But there still remain many cases where the conditions are well met by direct current. Chief among these may be mentioned railway work, where certain difficult works at variable heads and loads are at present best handled by direct current machinery.

As a general statement, we may say that for an area not exceeding two miles square, with the power house reasonably near, the centre of the load and the service, ordinary lighting and power, a direct current, three-wire system, operating at 220 volts across the outside wires, may be used with good results. On this 110-220 volt system we may operate incandescent lamps, constant potential arc lamps, and motors with good efficiency. Where a large portion of the load is to be motor load, it is usually found desirable to use an E.M.F. in the neighborhood of 550 volts. For railway work, aside from single-phase systems, 550-660 volts are used in standard practice. With this voltage the maximum distance to which energy can be distributed with economy is from six to seven miles, which distance is too great if the amount of power delivered is large.

With more extended territory, it is necessary to pass to one of two schemes if satisfactory and economical service is to be given. The first of these is to use two or more power plants, operating either singly or in multiple, each serving a territory within suitable limits for the low potential direct current used. This at one time was very common practice, but there is only one combination of conditions under which it should be used, namely, when the load is quite dense and uniformly distributed. Even under these most favorable conditions the efficiency of this plan is not nearly as high as that of the more up-to-date plan outlined below.

This plan, common in all practice to-day, is that of having a central station, and to make use of the higher voltage alternating current for distribution and transmission, transforming this to a suitable voltage and to D.C. where necessary for the receivers. The reason that one large station with transformers and sub-station is preferable to several central stations is that the large station can be operated more economically on account of labor, and because larger and more efficient units may be used, the same being loaded so as to operate at or near maximum economy. If direct current, three-wire systems are still required in certain districts, they are fed from synchronous converters.

(1) But if an alternating supply is found desirable, there still remains the question of selection of voltage, frequency and number of phases, as well as the detailed method of distribution. The principal factor in determining the transmission voltage is the length of the proposed line. If the field is near at hand, a low voltage may be desirable, even as low as 10,000 volts, or in special cases 6,600 volts. Under these conditions, step-up transformers are unnecessary, for a machine voltage up to 11,000 is entirely within the limits of good practice. If, however, many miles of line are required, the transmission voltage should not be lower than 22,000, or preferably 33,000 volts. Perhaps 66,000 volts would be better to meet all conditions. Of course, with any voltage, possibly above 10,000, step-up transformers would be an absolute necessity. As a rule, it is not advisable to have the generator voltage above 22,000 volts unless the generator is to have a very large capacity, say, over 2,000 k.w.

(2) In selecting the size and number of generating units for the central station, the amount of the load to be carried at different periods of the day must be known, and this is best expressed in the form of a load curve representing the average conditions at the period of the year when the load on the station is high. Such load curves are calculated or estimated for a period somewhat in advance of the time when the machinery is installed, usually about three years, so that additions to take care of the increase in load do not have to be made immediately after the first installation. The load curve gives the minimum and maximum demand upon the station. The total capacity of the generating units should be sufficient to safely carry the maximum demand as shown by the load curve, and there should be a reserve capacity sufficient to allow any unit to be laid off for repairs without interfering with the service. The smallest unit should be selected, so that it will carry the minimum load without running for long periods lightly loaded. If the prime mover is one having a high efficiency at light loads as well as at full loads this point is not so important. On the other hand, large units are desirable on account of lower first cost per k.w., decreased floor space required and increased efficiency at normal load. If made too large, either we must sacrifice some reserve capacity, or the normal rate of the plant will be high compared with the actual demand upon it. The size of individual units for the very large stations has increased very considerably with the introduction of the steam turbine.

A uniform size of unit is desirable for the first installation and the reserve capacity may be in the form of an extra unit, or it may be in overload capacity of the generator installed to carry the maximum load when operating at or near normal rating. To illustrate, suppose our curve shows a maximum of 2,000 k.w. and a minimum of 350, the maximum load lasting an hour, the minimum load five hours. We may select four 500 k.w., and three of these will carry the maximum load when overloaded 33 per cent., thus allowing any one to be laid off for repairs. If the installation for regular operation is made up of two 500 k.w. units and a 1,000 k.w. machine, then a fifth unit must be added for reserve, and this could be a 500 k.w. machine. With four or more units the reserves can usually be in the form of overload capacity if the machines are used in regular service. For fuller extension of the plant, the machines may be of larger size, always keeping in mind the question of reserve capacity. A theoretical basis for determining the size of machine added one at a time is k.w. capacity of new unit = previous capacity of the plant × per cent. overload allowable.

(1) F. Osgood, A.I.E.E., April, 1907.

(2) Geo. Shood, Standard Handbook, p. 528.

If generators are to be run at high average load for a considerable portion of the time, and the price of fuel is high, then care should be taken to obtain units of highest efficiency. If the machine is to be used for only a few days throughout the year and fuel is cheap, then reliable machinery of lower efficiency and of lower first cost will reduce the fixed charges and may result in a lower cost per k.w. hour generated.

In determining the capacity of the generator units in hydraulic plants the water condition becomes a factor, for it is desirable to have at least one unit which will be equal to the minimum k.w. output of the stream during periods of low water. Here again, it is advantageous to have all units of an equal capacity, but in low heads, with streams of highly variable flow, this is often impossible. If all units are of equal capacity it makes them interchangeable and facilitates running. When, however, the average flow of a stream would not develop over 500 k.w., it is at once apparent that a 2,000 k.w. machine would give poor service during the low stage period, for a machine works best when nearly loaded to its rated normal capacity. These points merely tend to emphasize the fact that hydraulic and electric features must be considered together.

A general figure for voltage to be used is 1,000 volts per mile of transmission line up to the limiting potentials now in use, say, 60,000 volts. The actual voltage selected should correspond to the values outlined by the A.I.E.E.

The voltage to be selected for the generators depends on several conditions. Generally, if the power is to be distributed at a voltage of 10,000 or less, the voltage of the generators should be the same as that used for distribution. If the line voltage does not exceed 15,000, generators may be purchased that will give this potential without the use of a step-up transformer, but such generators are expensive on account of the insulation required, and they are more liable to injury from lightning if the system is exposed to these disturbances than generators using transformers to step-up the voltage for the line. Where transformers are used it is usually not desirable to generate at potentials lower than 2,200, and the voltage serves for small and moderate size machines, while 6,600 may be used for large units.

(3) Of the standard frequencies, 25 and 60 each has its advantages and disadvantages. A frequency of 60 cycles is preferred for lamps and 25 cycles for motors. While some incandescent lighting is done at 25 cycles, arc lamps do not give satisfactory results at frequencies much below 40. For transmission purposes a frequency of 25 cycles is preferred on account of better line regulation and the operation of synchronous converters is generally conceded to be better at this frequency. Transformers and other apparatus, aside from switching and control devices, cost more at the lower frequencies. On a mixed system of railway and lighting, if the railway load does not exceed one-third of the total, a 60 cycle system should probably be installed. But this is a local question in nearly every case.

In regard to the use of the different phases, single-phase systems are limited to small plants, where the motor load is very small, and to single-phase railways. Since lighting and railway systems may be fed from polyphase lines and a three-phase generator may be loaded to 80 per cent. of its three-phase output, when operated single phase it is difficult to see why single-phase machines should be installed in any station where there is a demand for transmission to any distance, or a possible demand for polyphase motors.

There seems to be no good reason why two-phase should be chosen aside from the fact that in a two-phase, four-wire system we have a near approximation to a single-phase system for lighting service, and we are still supplied with a polyphase system which may be readily changed to a three or six-phase where desired. Three-phase would, of course, be used for transmission, even though the voltage be generated two-phase.

(3) Standard Handbook, p. 604.

(4) As to direct versus independently driven exciters, the most salient points are again economy and reliability. As far as economy goes, there are three ways of driving the exciters. One is to connect it directly to the generator shaft; a second is to drive it by a separate prime mover. The third is to drive it by a motor driven by the prime mover. These methods differ in economy as much as the main prime mover differs from the auxiliary prime mover. As far as reliability goes, one point is that of regulation. On that point the motor-driven and the direct-connected exciters are at a disadvantage, because any variation in speed of the main plant is reproduced in the exciter, which alters the voltage of the exciter in a ratio faster than the speed alters the main generator. This causes a variation in the voltage of the main plant considerably greater than the original speed variation.

Exciters for alternating current generators are usually compound wound, flat compounded, and rated at 125-150 volts. It is especially desirable that they be stable if direct-connected to the shaft of the alternator, as is sometimes done. Standard D.C. machines of good design and of the desired rating are used where the exciters are separately driven, and separately driven exciters are preferable for most plants on account of the fact that the system is much more flexible. Any drop in the speed of the alternator does not cause a corresponding drop in the exciter voltage, and the regulation of the plant as a whole is improved. The use of exciters directly connected to the alternators mounted on the same bed-plate and belt-driven from the alternator shaft is not as common as it once was, due to the increase in the size of individual units.

In all cases it is necessary that there should be sufficient reserve capacity. As an example of the amount of reserve capacity that is sometimes installed, we have the first power plant of the Niagara Falls Power Company, in which four exciters are installed, each one having sufficient capacity to excite the entire plant, and each driven by its own turbine, fed by a separate penstock. General figures for the capacity of an exciter for any machine run from 2.5 per cent. of the capacity of the alternator for any moderate speeds and small sizes to 5 per cent. of the alternating capacity, or a trifle less, for large, high-speed turbine units. Two per cent. is a figure often used in the absence of definite data. This is too low in a very few cases. But more often the error is on the safe side.

(5) The exciter units should be of sufficient capacity to run the whole station with but one exciter. Motor generation sets of electric-driven exciters give good regulation and are economical, as, after the station is in operation, the water-driven exciters in hydraulic plants can be shut down, thus effecting a slight saving of water. Of course, it is an absolute necessity that there be a water-driven exciter, or else the station cannot be started up. Possible failure of this exciter must also be allowed for, so that we have to have at least two water-driven exciters in any hydraulic plant. It is possible to carry an exciter on the man shaft of the generator, usually on the outer end. In some cases each machine may carry its own exciter, or one or two machines only may carry exciting units of sufficient capacity for the entire station. Belted exciters are sometimes used, but rarely in any but very small plants is this method advisable. An exciter driven by a larger unit necessitates the wasting of power. If for any reason the larger generator is unable to carry its portion of the load—and all machines require attention and repairs—the arrangement of each generator carrying its own exciter is a poor one, for if the water-wheel speed is affected, or the generator load is momentarily changed by load fluctuations, then the exciter voltage follows the change. Frequently the very opposite effect from the desired one is the result.

With regard to the position of the exciters in the general station plan, it is primarily essential that they should be in direct communication with the switchboard operator. Their position is then determined by the switchboard, as

(4) P. M. Lincoln, A.I.E.E., February, 1906.
(5) F. Osgood, A.I.E.E., April, 1907.

they should be in sight of the operator on the switchboard gallery.

Switchboards.

The first essential in regard to switchboards and their location is that from the switchboard the operator shall have a clear view of all machinery, or as much as possible, under his control. The reason for this is obvious, for everyone will admit that it means more perfect control in case of accident or abnormal conditions. In a plant of any size the best plan is to have the switchboard located on an elevated gallery in the centre of the plant. This gallery should be large enough so that the operator may move freely and quickly without fear of coming in contact with any apparatus on the switchboard, or so that he can safely turn his back on the switchboard when watching the equipment on the floor of the station.

The voltage regulators can be placed in a panel of the switchboard, preferably on or next to the exciter panel, or they can be hung on supports at the end of the switchboard. The synchronizing device should be placed so as to be visible from the governor of every unit In long stations two synchronizing indicators are desirable, being hung to swing at each upper corner of the switchboard.

When we have a gallery, a good arrangement is to place the low-tension bus-bars overhead at the back of the gallery. Here they are out of the way and are still accessible. With such an arrangement it is best to set the different sets of bus-bars at different heights from the floor, but not over one another. The low-tension bus-bars can also be well arranged if placed in hangers just under the floor of the gallery, although, perhaps, this is not just as satisfactory. Between the machines and the bus-bars there should be knife switches and oil switches—the former to protect the latter in case of failure to act. The oil switches may be motor-driven, but the hand-operated switches are cheaper and perfectly safe for low-tension work. These switches are well located if placed just under the gallery, though they may be placed on the gallery, just under the low-tension bus-bars. They are, of course, placed in chambers of iron, brick or cement, and these chambers should be inclosed with a glass front, set in a metal frame. This allows the operator to see the workings of the switch at all times.

Many engineers prefer to have the high-tension chamber of a development in a separate building, but this is not necessary, though the high-tension rooms should be entirely separated from the operating-room by a fire-proof wall. The main point in connection with this room is plenty of room. Single-phase step-up transformers should be used in three-phase systems, and these should be of the oil-filled, water-cooled type, as they have a much higher insulation break-down point than air-blast transformers.

(6) The magnitude of the transformer units when transformers are used should be determined by the same considerations that apply to generators, except that questions of speed do not have to be considered. The smallest number of transformers that it is desirable to use is that number which will permit the disuse of a single unit without inconvenience. In general, the larger the transformer the higher its efficiency, though this improvement in efficiency is very low after output reaches 25 k.w.

(7) If the transformers are subjected to abnormal pressures, as in the case of lightning storms, surges, etc., it is unusual to have more than one fail, as the very failure discharges the disturbing high pressure; therefore, if single-phase transformers are used, the station loses the capacity of about one-third of the bank, and, even if spares are not available, the remaining two transformers may be re-connected and put into service. If three-phase transformers are used, much inconvenience may result from a breakdown. Single-phase transformers are more costly than three-phase, but the extra money is well spent.

The cables from the line oil switches will terminate in some bus-bar arrangement, to which should be connected the leads of the step-up transformers. These bus-bars are best placed on the wall, back of the transformers, and not on hangers attached to the transformers themselves. As the failure of a step-up transformer is a very serious matter, and, as such an accident may occur at the time of a peak load, it is good insurance to carry an extra bank of transformers, ready for service with the throwing in of a switch. This may be impossible through lack of capital, but in all cases a spare transformer should be at hand ready for connection. The terminals of the transformer leads should be split or of some quickly detachable type, so that no time will be wasted in re-connecting after one transformer is injured.

Between the step-up transformers and the high-tension bus-bars come the multiple switches to make it possible to cut at any bank of transformers. These are usually knife switches, though in very large departments oil switches may be used. But these kill the transformer bank on the low-tension side. If many banks of transformers are used, the connection between the multiple switches and the high-tension bus-bars may be simplified by the use of sectionalized bus-bars. To the high-tension bus-bars are connected the transmission lines, and these connections should be made through switches—knife switches are sufficient.

Just before the lines leave the high-tension room are the taps to the lightning arresters. These may be placed in a separate building or outside, but if the high-tension chamber is well arranged it is perfectly safe to have the arresters in this room, where they can be watched by the operator. Reactance or choke coils should be placed in the line between the arrester taps and the high-tension bus-bars for the serving of transformer leads in bus-bar insulation.

(8) In the consideration of one-phase and three-phase transformers, J. S. Peal sums up the advantages of the three-phase over the one-phase as follows:—

1. Lower cost.
2. Higher efficiency.
3. Less floor space and less weight.
4. Simplification of outside wiring.
5. Reduced transportation charges and reduced cost of installation.

The disadvantages are:—

1. Greater cost of spare units.
2. Greater derangement in case of breakdown.
3. Greater cost of repairs.
4. Reduced capacity obtainable in self-cooling units.
5. Greater difficulties in bringing out taps for a large number of voltages.

This item of lower cost is admitted, but the general opinion in regard to efficiency of the two seems to be that they are about equal. The three-phase transformer set also occupies less room than the single-phase arrangement for the same capacity, and weighs less. But in the single-phase set we have its weight divided in three, and this greatly facilitates handling or moving. In the matter of transportation charges and cost of installation this appears to be a rather fine distinction, as the difference is not great in any case, while in cases of wagon haulage the three small units could be transported much more cheaply than the heavy unit.

To offset these advantages we have the greater cost of spare units. This amounts to a very considerable sum, and certainly has to be taken into account. Then we have the serious defect of derangement in case of breakdown. If the three-phase transformer is star-connected this throws the whole transformer out of service, while with a delta connection on both high-tension and low-tension side it may be possible to run at partial load. The matter of repairs is again an important item. In the three-phase transformer the destruction of one phase with the two others so close to it generally means their destruction as well, while in the single-phase arrangement not likely more than one will be damaged at any one time.

In the matter of coiling oil, insulated transformers we have the forced oil and forced water circulation methods.

(6) Electric Power Transmission, Bell, page 445.

(7) W. H. Tobey, A.I.E.E., April, 1907.

(8) A.I.E.E., April, 1907.

Of these, the forced water has been much longer in use, but is being supplanted in large plants by the oil type. With this latter arrangement we obtain much more efficient results, but require additional apparatus, necessitating additional floor space. To offset the cost of this apparatus we have an initial saving of from 15 to 25 per cent. in the forced oil cooled type. The general concensus of opinion seems to be that for large installations of 4,000 k.w. or over, composed of individual units of not less than 1,200 or 1,500 k.w., the forced oil cooling process is the most efficient and economical in the long run.

GREAT BRITAIN'S FIRST SINGLE-PHASE RAILWAY.

(From Our Special Correspondent.)

A good deal of interest has been excited during the past two years by the work which has been in progress both in London and in the north of England in connection with single-phase electric traction. The latter installation, that of the Midland Railway Company, upon a storm swept branch of their large undertaking, takes the honour of being the first to be opened to the public and at the same time the first single-phase railway to be commercially operated in Great Britain. The line which is in the nature of a fork, has a very slight service—only about one train every 20 minutes—but the main object of the experiment is to determine upon a piece of track where the general conditions are undoubtedly severe, the suitability of single-phase electric traction to ordinary railway working as distinct from the very different conditions of rapid headway and calmer climatic surroundings of suburban lines near a great city. In a way this latter will be tested by the experiment by the London Brighton and South Coast Railway, which is converting one of its London suburban lines to the single-phase system, and this is expected to be in operation by the end of the present year. There are no very severe gradients upon the Midland experimental line, but there are a number of speed restrictions near the three terminal stations.

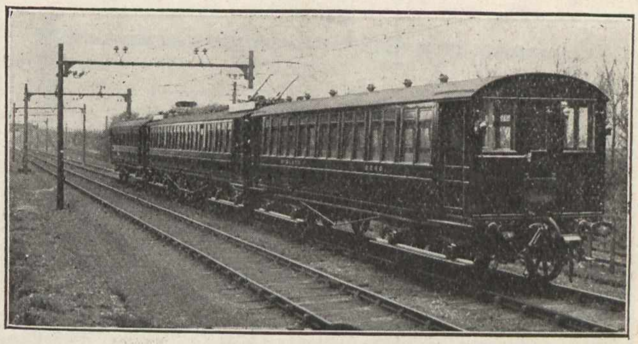
It is to be hoped that the result of the two experiments will be to instill some measure of confidence on the part of railway managers in electric traction for main line purposes which is now badly wanting.

Dealing first with the overhead construction, this has been designed and carried out under the direction of Mr. W. B. Worthington, the chief engineer of the company, in conjunction with Mr. J. Sayers, the telegraph engineer and Mr. Argyle, the northern divisional engineer. As regards the type of suspension, it is similar to that adopted upon the Hamburg-Altona Railway, the patents for which are held in England by Messrs. Siemens Bros., who are carrying out the work in this instance. This latter system has, however, been modified by a new type of catenary wire suspension, designed by Mr. Sayers. The line passes under a large number of over bridges, mostly of the arched shape, and the clearance of these has been a matter of considerable interest. The use of a single bow trolley for travelling in both directions necessitates the bow being symmetrical about the centre of the coach necessarily bringing it very close to the structure of the bridge. In order to get through at all, it has been necessary to take the contact wire well out towards the centre of the arch so that it may come down low and yet be clear of the loading gauge and so that the other side of the bow may clear the structure properly.

The contact wire is of figure 8 section and the height from rail level varies from 18 feet 3 inches in the open to 13 feet 3 inches under bridges. It is suspended from short loops about four inches long from a steel cable or auxiliary wire, upon which these loops are movable. On the other hand, the auxiliary wire is held by the main catenary cables, of which these are two clipped together throughout their length, except for about 3 feet on either side of the insulator, where they divide to pass through the grooves of a ring, the grooves being on opposite sides of the insulators. The catenary is thus free to move for this distance and this equalizes the strain due to unequal loading and experience has proved that it is at the same time secure in the case of the breaking of the wire. The section switches which are provided to isolate the up and down lines or the different sections, are of the double-break air pattern and are fixed on top of the poles supporting the gantries. Each section switch is in addition duplicated and the connection from one contact wire to the section ahead is accomplished by means of a short section of switch wire which requires to be connected to the two contact wires before the line is switched through at this point. In this way a duplicate break is obtained, and, more important still, there is a short length of line into which a car can run without bridging by means of its bow two sections, which it was supposed might require to be isolated.

A separate steel cable connects the gantries together, and this is earthed every half mile, the same earth plates being used for horn lightning arresters, thus diminishing the number of earth plates requiring attention, and at the same time giving better security from danger from leaky insulators so far as the poles are concerned. It is interesting to note that this earthed steel cable has been erected between the contact wires and the telegraph wires, which are open on one side of the line and it is believed that this has had a great deal to do with the reduction of electrostatic induction from the contact wire. The object aimed at has been to avoid putting underground all the overhead telegraph and telephone wires and the feeling at present is that all that will now be necessary to provide a high resistance leak on any wire parallel to the high tension traction system.

Although at one or two places it has been necessary to erect steel lattice poles and lattice girder gantries owing to the big spans, for the most part creosoted wooden poles have

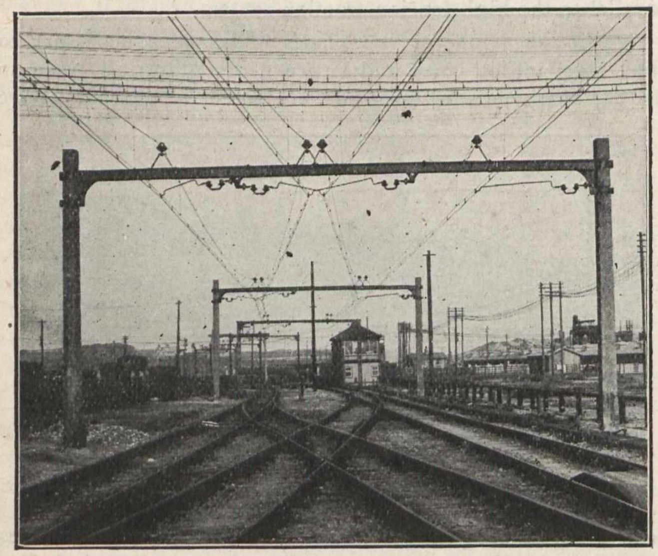


Three Coach Train, Midland Railway.

been used, as seen in the illustrations. Where wooden poles are used the gantries are made of two angles brought together at the ends, but so fitted that there is a great range of adjustment of the insulator position without any necessity for drilling. The type of insulator was decided upon after ascertaining from experiments made by Messrs. Siemens Bros. & Company's staff, the minimum distance at which a 6,600 volt, 25 cycle circuit would maintain an arc in the heaviest weather from an insulator shed. In order to get what amounts to double insulation with one insulator, the steel bolts supporting the insulators are encased with ebonite, in addition to which, in order to get extra strength, the company preferred to make the insulators in two pieces. An interesting point arose in connection with the bonding of the track. Only the outer rail on each line is bonded throughout, the bonds being of the Forest City type, and, although, very great care was taken to prevent moisture getting into the holes whilst they were being drilled, and although after completion all the bonds were found to be first-class, yet the tests carried out afterwards showed a distinct difference in resistance between those bonds carried out during dry weather and those carried out during damp weather. The rails are earthed in the sea at Heysham Harbor by duplicate copper earth plates, whilst at Morecambe they are earthed at the pier by plates which have been dropped in a large cast iron caisson. At Lancaster they are earthed to the cast iron columns of the bridge which rest in the bed of the river. As already indicated the potential of the overhead wire is 6,600 volts, 25 cycles.

At present the rolling stock, which has been built by a railway company, consists of three trains, there being three motor cars, two having Siemens equipments and one a Westinghouse equipment. There are also four trailer cars, whilst in addition a number of old bogie coaches will be used for goods and workmen's traffic. Owing to the conditions prevailing on the line due to the curious shape of the track electrified, and also to the fact that the coaches are liable to reversal in the way they head, driving equipments have been fitted at both ends of the motor cars. As will be seen from the illustrations, the motor cars are of the open central corridor type, the extreme lengths and widths being, respectively 60 ft. and 9 ft. Each has a seating capacity of 72 passengers, the middle seats being arranged transversely and the seats at either end longitudinally. The lighting is from the line current as is also the heating of the motor cars; the trailer cars have not been fitted in this way yet, however, as their extended use during the winter months is not contemplated. On the trailer cars, which have a length of 43 feet and a width of 9 feet, the seats are placed transversely throughout, the accommodation being for 56 passengers.

The specification of the electrical equipment of the cars called for two motors per car, both to be carried on one bogie. A normal train was specified to consist of a motor car and two trailers, the weight being 25 tons for the motor car and 17¼ tons for each trailer, exclusive of any electrical equipment. It was specified to the contractors that they would be permitted to run at 25 miles per hour round the



Over-head Construction at a Cross-Over.

speed restricted curves and on this basis the trains were to be capable of working a 20 minute service from either end, between Heysham and Morecambe, with a single train, and a 15 minute service between Morecambe and Lancaster. The capacity of the motor car was to be such as to enable it to take on occasions two additional main line coaches weighing 26 tons each. The specification further made it a condition that the different equipments of the two contractors should be capable of being worked from the same master controllers. It was thought that two 150 horse-power motors per motor coach would carry out the work, and so it is that we find that motors of the respective makers standard type as near to this as possible have been fitted, viz., 180 horse-power for the Siemens motors and 150 horse-power for the Westinghouse. Although the specification further laid it down that the control was to be all electric, the Westinghouse car has been accepted with their standard electro-pneumatic control, modified in order to enable it to work with all the electric system of the Siemens car. Stringent guarantees of efficiency, energy consumption in watt-hours per ton mile and general performance were required to be given.

As will be seen from the illustration, the Siemens cars are provided with two collector bows, for the reason that it was found impossible to get the firm's standard inverted pantagraph type of bow into the space available under the overbridges; there is a small auxiliary bow controlled by parallel motion. The disadvantage of this type is that it requires balancing by a wind screen, as will be noticed. On the other hand, the Westinghouse Company have adopted their standard type of bow collector and have only one fitted. On both cars the bows are spring controlled, the Siemens being lowered by a master spring which can be thrown out of action by a vacuum cylinder, whilst the Westinghouse master spring is controlled by compressed air, a special compressor having been installed in connection with the control gear. In both cases a small hand pump is made use of for raising the bows when starting out in the morning when no compressed air or vacuum is available. The roofs of all the coaches are covered with an earthed wire netting whose function it is to throw out the station circuit breakers in the event of the overhead wire coming down on the roof. Whereas the high tension wiring of the Westinghouse car is carried in lead covered cable, covered with a further metal protection on the roof and carried down about the centre of the car through a heavy section brass tube, that on the Siemens car is, from the bow down through the high tension chamber to the main transformer, all bare wire being carried on porcelain insulators on the coach roof and underneath the car. The vertical tube through the coach itself is of brass being practically part of the wiring. On the Siemens cars the high tension wire proceeds into the high tension chamber, the door of which is mechanically interlocked with the bows, so that it cannot be opened unless the bows are down. The low tension wiring is not carried in metal tubing for fear of eddy currents, but are substantially surrounded with metal and the coach body and its frames are all covered with sheet iron and asbestos wherever cables are run underneath. The train cable is carried along the outside of the coach alongside the sole bar in a metal tube. The train cable couplers and master controllers for the whole of the motor cars, as well as all the pump motors and their control gear, have been supplied by Messrs. Siemens Bros.

The equipment of the Siemens cars consists of the two motors, the main transformer, the auxiliary transformer, preventive coil, the commutating transformer, high tension circuit breaker and fuse in the main transformer circuit, high tension fuse in the auxiliary transformer circuit, contractor, motor fuses (which also act as motor cutouts) and low tension fuses in the circuit feeding the control, and also a low tension fuse in the circuit feeding the fan. No fuse has been placed in the brake pump main circuits so that if anything goes wrong with the pumps, the main fuse will be blown and the car cannot be worked. Stringent tests at the maker's works gave very satisfactory results. At 180 horse-power and forced draught the motors were very much under the guaranteed temperature, and even did not exceed this rise with natural ventilation on the stand. With forced draught and with only 300 volts (the full voltage being 340) they were tested under specified temperature rise at 200 horse-power corresponding to full voltage to fully 225 horse-power. They were also tested for continuous operation giving at 250 volts —chosen as mean operating voltage—105 horse-power for five hours with a temperature rise of only 115 degrees Fahr., so that at full voltage, allowing nothing for the improved ventilation at the higher speed, the machine can give continuously nearly 150 horse-power. In the sparking tests there was no objectionable sparking at 1,100 amperes at 300 volts, corresponding at full voltage to 350 horse-power, and a torque of fully two and a half times that at the rated horse-power of 180. The commutating transformer has given equally satisfactory results, for during testing on the line currents of over 1,000 amperes per motor have been frequently applied and no sparking has been noticeable even at starting. The master controllers are of the "dead man's handle" type a departure from the usual design being that the release of the forward pressure on the handle by the driver-trips the whole of the contractors at once, no matter on what stop he may be working at the moment and without his allowing the handle to come back to the off position.

The Westinghouse equipment consists of motors, transformers, and auxiliary transformer, preventive coil, high tension circuit breaker in main circuit, fuse in auxiliary high tension and low tension circuits, contractors and control gear. The motors are ordinary series compensated without any special commutating device other than the commutator resistance leads. It is said that the commutating performance of these motors on the line is as good as, if not better than, most heavy direct current traction motors, while the commutator remains in quite as good running order as that of any such motor. The same good qualities are claimed for the Siemens motors as the result of trials. Similarly with the Siemens equipment, the most satisfactory results have been obtained on test, the temperature rise at the end of one hour's full load of 150 horse-power with single-phase current being well within the limit, whilst overloads up to 1,200 amperes, corresponding to 195 horse-power at full voltage and 2¼ times normal full load torque were applied without causing injurious sparking.

With regard to the forced ventilation for the motors on both types of car, it may be mentioned that on the Siemens equipment a suction duct has been carried inside the car under one of the seats. The Westinghouse car has a similar duct, but as their motors require more air there has also been fitted in this case a suction duct with a filter taking air from the outside. In both cases this duct comes direct into the suction eye of the fan, and the delivery duct after leaving the fan splits into two pipes, one of which crosses to the other side of the coach and comes up under the longitudinal seat on that side, thus getting across the cross member of the underframe, and coming down again above the motor, to which the air then proceeds through a rubber concertina pipe. The other half of the duct proceeds direct up under the longitudinal seat on its own side, coming down in a similar way to the other motor. It may be pointed out that on the Westinghouse car there is no interlocking of the high tension chamber with the bow, the high tension circuit breaker and fuse being put in locked cases, and the train staff are not permitted access to these chambers at all.

With regard to the performance of the trains on the road, in a test with a two car train weighing approximately 58 tons, made incidentally in the course of ordinary running, one of the Siemens cars attained speeds of 30 miles per hour in 41 seconds and 48 miles per hour in 80 seconds and a free running speed of 60 miles per hour in 160 seconds, starting, and running for 440 yards, on an up-grade of 1 in 200, there being, however, thereafter about 100 yards of level and then a down grade of 1 in 500 for 1½ miles; this portion of the line is also very considerably curved with curves of 30 and 40 chains.

The power supply for the line is furnished from an existing gas driven generating station at Heysham, used in connection with the lighting and power requirements of the railway company at its large depot there. Mond gas producers are used, and the equipment of the station hitherto has been three 250 horse-power three-cylinder Westinghouse gas engines driving 150 kw. direct current 460 volt generators. In connection with the traction scheme, however, an additional 350 horse-power Westinghouse gas engine driving a 235 kw. generator of the same make has been installed, in conjunction with two motor generators. From the nature of the traffic the demand on the station will be of a very "peaky" character. During these "peaks" the whole possible output of the machinery at work in the station must be utilized, and the intention is for the engines, whatever the actual load they may be working on previous to heavy loads coming on, to work up to their full overload capacity, which is about 20 to 25 per cent. in the case of the old, and 10 to 15 per cent. in the case of the new sets, before the battery is called upon to discharge heavily. The latter will, however, be called on to work up to its full one-hour rate of 750 to 1,000 amperes. The old battery booster not being large enough for these discharges, a new one has been installed, built by the Lancashore Dynamo and Motor Company, whose machine is particularly suited for this method of working. A difficulty was, however, found in that the generators were working on a very falling portion of their characteristics and their pressure dropped badly as their loads increased, this having been compensated for by hand regulation of their excitation, or else during "peaks" they continued to work at their previous loads, and the battery supplied the excess, both courses being inadmissible under the new conditions. Compound winding in the usual way was an extremely expensive remedy since, as the copper necessary for full excitation was already on the fields, new series coils would be excessively large and heavy, added to which was the trouble of entirely dismantling the machines. A very simple solution was found in fitting exciters, each mounted on the engine bed-plate, and compound windings being fitted on these exciters and varying their voltage and consequently that on the main generator fields, so that the existing copper on the latter was fully utilized. This not only proved a very much cheaper arrangement, the exciters being only of 3 kw. capacity and of fairly high speeds, but enabled the whole change to be made in the course of a week, obviating any dismantling or any serious stoppage of the generating sets.

The new booster, with a comparatively low continuous rating, satisfactorily commutates the "peak" discharges up to 750 to 2,000 amperes; and it can be set to make the engines work up to their overloads as above, or to work under practically any other conditions, without any serious drop on the busbar voltage.

The new generating set is of the Westinghouse latest type of gas engine, having three cranks with three sets of cylinders, two in tandem in each case. Its speed is 300 rpm. and its lubrication forced.

The specification for the motor generators called for the machines to be each capable of a continuous output of 150 to 200 kw., with a temperature rise of 80 degrees Fahr., but they were also called upon to be capable of safely carrying output overloads of 900 kw. instantaneous, 600 kw. for half a minute, 500 kw. for three-quarters minute and 300 kw. for 2½ minutes, and were required to be also tested under a regular cycle of these overloads, with underloads in between, for 8 hours. The internal driving losses were also required to be kept down, while on the alternating current side they were required to regulate within 6 per cent. on throwing off a non-inductive load equal to the full continuous load, and within 20 per cent. on throwing off a similar, but inductive load of 0.8 power factor. Further, they were required, with the assistance of external means, if necessary, to restore the pressure to normal within seven seconds of the coming on or throwing off of loads up to 600 kw. at 0.8 power factor, or 300 kw. at power factors down to 0.3. Widely varying proposals were received in connection with these machines, those of the Electric Construction Company being finally selected, their machines being very compact and requiring a small amount of driving current as well as having a high efficiency.

The makers specification was 175 kw. on continuous rating, the machines on test being well within the specified temperature rise, but not excessively so. During the running of the trains at Heysham experimentally each of the sets were several times subjected to loads up to 900 kw. input without commutator troubles of any kind whatever, whilst smaller overloads have been very frequent and have been carried with just as satisfactory result. The alternating current regulation is such that after the switching on or throwing off of a heavy load the voltage is restored to its normal of 6,600 volts within three seconds, while the voltage even then only varies about 300 volts each way. The direct current motor is compound wound with commutating poles, the series winding being a vary slight one, and put in principally to assist the two sets to run in parallel satisfactorily.

The alternator has a three-phase star winding, so that if one winding breaks down the other two may be used for the single-phase supply, otherwise no use is made of the three-phase connections. The machine is of the standard internal revolving field type, and is excited from an exciter which is carried on the end of the bed-plate and spur geared up to about 1,100 revolutions. This exciter has laminated fields and is compound wound, its series winding carrying a portion of the main motor current, so that (so far, at least, as varying loads of equal power factor are concerned) the tendency of the alternator to drop in volts is thus compensated for. Compensation for varying power factor is effected by means of a regulator, designed and constructed by the Electric Construction Company, and the first of its kind, which inserts or extracts resistance from the circuit of the shunt field of the exciters by the action of solenoids; these solenoids are respectively excited as the voltage exceeds, or is less than, the normal.

The direct current motor armature and the revolving field alternator are carried on the same shaft without any intermediate bearing. There are only two main bearings on the machines, and these are ball-bearings. These bearings have, so far, given every satisfaction and have proved very advantageous in reducing the starting currents, which at 460 volts is only about 750 amperes, and the no-load loss, which is about 23 kw., with the exciter and alternator fully excited

The switchboard has been designed and constructed by the railway company, the instruments being of the Westinghouse Company's make. Each of the motor generators is supplied from the low tension busbars through a no-voltage and overload circuit breaker. The shunt circuit is excited through a separate double pole knife switch with kicking contacts and resistances. Starting resistance is cut out by means of a set of knife switches. By means of a throw-over switch these can be used to start either set of the machines, a heavy triple-bladed knife switch being thrown in finally when the machines are fully started up, connecting them direct to the busbars. On the alternating current side each alternator is connected up to the busbars by a hand operated oil switch, and the current passes from the busbar through duplicate automatic circuit breakers to duplicate feeders passing out through overhead lines. All the circuit breakers, both high and low tension, have time limit devices. The exciter shunt fields of the alternators are also connected through double pole switches with non-inductive contacts and resistances. The high tension apparatus is contained in a lockfast expanded metal chamber placed over and at the back of the actual switchboard, the switches being operated from the handles of the latter through rodding. The door of the high tension chamber is interlocked with the holding up coil of the motor circuit breakers, so that unless the door is closed neither motor generator set can be started, while if it is open during running everything stops.

I have to thank the officials of the Midland Railway Company for the illustrations and material contained in this article.

METER RATES IN ERIE, PA.

Twenty (20) cents for each one thousand (1.000) gallons for the first twenty-five thousand (25,000) gallons, and four (4) cents for each one thousand (1,000) gallons consumed thereafter during each current quarter.

Provided: The minimum receipts from each meter (for each quarter) shall be as follows:—

¾ inch or less	$ 3 75
1 inch	4 50
1½ inch	6 25
2 inch	10 00
3 inch	18 75
4 inch	38 75
6 inch	100 00

The contract has been let to the Aberthaw Construction Co., Boston, for the new dam to be built for Bellows Falls Canal Co., Bellows Falls, Vt., in accordance with the plans of Chas. T. Main, engineer, Boston. It will be erected directly in front of and bordering the front of the existing crib dam, and will be about 600 feet long, varying in height from 3 to 20 feet. It will be built of solid concrete throughout. A part of the old dam which this is to replace is over one hundred years old. The present trouble and leakage which the new dam is designed to obviate comes largely from this old construction. Work is to be started at once and pushed rapidly.

ENGINEER'S LIBRARY

THE PUBLIC'S RESPONSIBILITY FOR RAILWAY ACCIDENTS.*

The record of American railroad accidents is appalling. The first step in lessening the number of accidents is a clear understanding of the conditions which are their cause. The Interstate Commerce Commission of the United States tabulated statement of railway accidents contains this list:—

	Killed.	Injured.
Passengers	212	4,398
Employees	2,586	31,983
Others	872	3,147
Trespassers	5,381	5,927
Total	9,051	45,455

The striking feature here is that the majority of the killed were trespassers. For this the railroads should not be held responsible, but is chargeable to the carelessness on the part of the injured. Heedlessness, a desire to beat the law, sheer ignorance—these appear as the causes of by far the larger per cent. of railway accidents. Education and publicity, not legislation, will remedy folly and carelessness.

Railway companies are spending large sums for safety devices—they must continue so to do; but it is not in equipment they will find the solution of accidents due to "perils of the road," but in proper discipline, which discipline cannot be properly maintained without the support of public opinion. Public opinion must be aroused by publicity. Publicity following public and searching investigations. If more attention were given by the newspapers to investigation, reprimand, punishment for carelessness, etc., and less to disasters and loss of life, there would be a more healthy public sentiment supporting railway officials in enforcing regulations.

Mr. J. O. Fagan is quoted as saying: "Nevertheless, in spite of many appearances to the contrary, the problem of the efficient and safe running of trains is a very simple one. Fundamentally, it is not a question of rules or safety devices, but of personal conduct and habits of thought"; and again, referring to fatal accidents, "Now as it seems to me, the all-important facts in these cases do not relate to the nature of the rules, nor even to their non-enforcement, but to the downright neglect of railroad men (employees) to do as they are told."

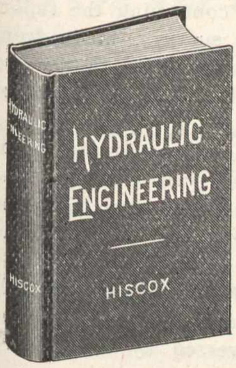
The efficiency tests have not improved during recent years because the efficiency of the railroad employee has deteriorated. The railways are dependent upon the human element, the responsibility of the employee.

"And how is this realization of responsibility to be brought home to the employee? By the help of the public; by the force of their opinion. It must discriminate between the bad and the good in passing judgment on corporations and their officers. Wholesale disapproval breeds wholesale disloyalty in the industrial army serving them. The unnatural and hostile conditions that have resulted from the attitude of the press and the public toward corporations must be replaced by peace and co-operation; and, while not abating its condemnation of abuses or relaxing its determination to correct them, it must in the exercise of its determinaion give the support of its all-powerful opinion to the earnest efforts of railroads to improve discipline, increase safety, and generally raise the standard of service."

* Abstract of an article in "Appleton's" for July by Julius Kruttschnitt, Director of Maintenance and Operation of the U.P. and S.P. Railway system.

BOOK REVIEWS.

Books reviewed in these columns may be secured from Vannevar & Company, 438 Yonge Street, Toronto, Ont.



Hydraulic Engineering.—A Treatise on the Properties of Water, and Power and Resources of Water for All Purposes. By Gardner D. Hiscox, M.E., author of "Machanical Movements," "Gas, Gasoline and Oil Engines," "Compressed Air and Its Uses," "Modern Steam Engineering," etc. New York: The Norman W. Henley Publishing Company. Cloth, 6 x 9¼ inches, pp. 315; 305 illustrations, $4.00.

In preparing this book, the author has endeavored to give the public a general treatise on hydraulics in all its branches, and in a measure has succeeded in condensing a large amount of matter into comparatively little space.

For the hydraulic engineer the book is too elementary to be of any use, much more space being taken up in explanation of simple mathematical calculations than is devoted to useful matter on hydraulic engineering. Not only is a large part of the book devoted to the simplest steps in calculations, but these are often put in a form which is not only misleading but erroneous. As an example, we quote from page 86: "Thus the fifth power of 2 is 2 x 2=4 x 2=8 x 2=16 x 2=32." This is the first time we have noticed that 2 x 2=32.

As a reference book on hydraulics for engineers engaged in other branches of the profession, the lack of any logical arrangement of the matter renders its use doubtful. The only persons who could get any real value out of the book would be the student who wishes to acquire a general knowledge of the practice of hydraulics, the farmer who is planning irrigation on a small scale, and the various classes of mechanics and workmen who are engaged on minor hydraulic enterprises.

In Chapter I. is given an historical introduction to hydraulics, dating from prehistoric times, which though interesting takes up a large amount of space that might be devoted to more useful matter. The properties of water are taken up in Chapter II., the latter part of which is devoted to various forms of hydraulic presses, punches, etc. Chapters III., IV., and V., take up the flow of streams, and the discharge of orifices, weirs and pipes, and contain some very useful information for persons unfamiliar with this class of work. The syphon and water ram are taken up in Chapter VI. Although we fail to find any satisfactory explanation of the principles of the syphon, space is devoted to no less than twelve illustrations of various types of syphons that have practically no use outside the laboratory.

Chapter VII. deals with the construction of dams and reservoirs, most of the illustrations being of early forms of timber dams, while we rgret to note that no consideration is given to the modern types of reinforced concrete dams. Chapter VIII. takes up city and town waterworks, stress being laid on the necessity of filtration and other expedients for securing a pure supply.

Chapter IX. is devoted to ordinary wells with a few pages dealing with artesian wells. The latter are, however, taken up at length and in a clear and concise manner in Chapter XI., the intervening chapter dealing with the principles of the air-lift method of raising water with a short description of the hydraulic air compressor plants in Quebec and British Columbia.

Chapter XII. on irrigation is probably the most useful part of the book, and deals at length with the various methods in use in the United States. Some useful information is given on the amount of water required for irrigation in various districts and the methods of applying it to the soil.

Chapter XIII. is devoted to water wheels and turbines, and illustrates the usual types of mill wheels and wheels used for raising water for irrigation purposes. Pumps and pumping machinery are taken in Chapters XIV. and XV., and hydraulic power transmission in Chapter XVI.

Chapters XVII. and XVIII. contain information on various subjects, such as hydraulic mining, canals, ditches, and pipe lines for irrigation. The remaining two Chapters XIX. and XX. are devoted, respectively, to resistance and skin friction of bodies moving through the water, and to a short description of various devices for developing power from wave motion and tidal flow.

In conclusion we would say that although this book is of very little use to the professional engineer, it would be of value to the large class of men who, though not engaged on technical work, are interested in hydraulic engineering, either financially or through business connections. This would apply especially to those who are connected with propositions on irrigation or water-power development.

R.E.C.

Railway Surveying.—By B. Stewart. Published by E. & F. N. Spon, Limited, 57 Haymarket, London, Eng. Size, 4 x 7; pp. 130. Price, 50 cents.

The author was for some time assistant engineer on the Cyprus Government Railway and the Grand Trunk Pacific Railway of Canada, and it was doubtless while serving in these positions that he conceived the idea of publishing a book that would be useful to the beginner on railroad work. The book is an elementary work on field practice, and is carefully written, aiming at making clear the various operations in chaining, levelling and cross-sectioning.

Chapters I. and II. deal with "chaining," explains the various chains used, and devotes some fourteen pages to methods of chaining around obstacles.

Chapters III. and IV. describe the operation of levelling, setting cross-section stakes, and gives a page, showing the author's method of keeping a field book for level notes.

Chapter VI., on vertical curves, is one of the best in the book, giving clearly methods of laying out vertical curves, yet not giving so much detail and mathematics that the reader becomes confused.

The concluding chapter is devoted to hints and problems, all of which are simply explained and clear in their application. For the young man just entering upon railroad work the book will be helpful.

Elements of Railroad Engineering.—By William G. Raymond, C.E. Publishers, John Wiley & Sons, New York. Size, 6 x 9; pp. xvi. + 405. Illustrations and diagrams.

The volume is divided into three sections. Part I. describes the permanent way in some detail; Part II. discusses the fundamental principles governing the design of the grade line, while Part III. describes the methods of applying these principles to secure the most economical location and construction. The book is evidently prepared by a man familiar with railroad location, construction and operation, familiar with it from actual working experience. Under the head of permanent way, alignment; rail manufacture, life, shape, and inspection; rail fastenings, joints, and spikes are fully discussed. A chapter on cross-ties is one of the most valuable in the book. Ballast and Roadbeds in some four pages. Bridges and Culverts are discussed at some length, a few designs submitted and formulæ given that may be used in estimating weight and cost of structures.

Chapter IV., covering twenty pages, describes and illustrates, with dimentioned sketches, various types of bridges, culverts, and minor structures. Timber, concrete masonry and steel structures are described. Turnouts, side tracks, and yards are fully discussed, and drawings illustrating the various types given.

In the chapter on the elevation of the outer rail, after the matter has been discussed and formula derived, the following rule is given: The difference of level in inches of the two rails of a curved track of standard gauge is from two-thirds to seven-tenths of one one-thousandth of the square of the speed of passing trains multiplied by the degree of the curve.

Part II. is devoted to Locomotives and their parts, and contains chapters of great interest and value to the civil engineer. In this section train resistance, grade resistance, curve resistance, etc., are dealt with; also mile-train costs.

Part III. deals with railroad location, construction and betterment surveys, and, although it disposes of the whole matter in one hundred pages, yet, considering the limited space, the subject is well handled and clearly stated.

The Old Loyalist.—By A. R. Davis, C.E. Published by Wm. Briggs, Toronto, Ont. Size, 5 x 7, pp. 367; illustrated. Price, $1.25.

The first chapter is descriptive of the rustic life of an old Loyalist family on the Bay of Quinte, and much that is contained in it gives the reader an idea of the class and type of the early settlers. The Clinton family and an old, faithful negro are the chief characters in the first fifteen chapters. The story of a black walnut box, the property of far-off connections of the Clintons, may be said to be the thread of the narrative in these chapters, interspersed by the social and amorous interchanges of the period of time which they cover. The frustration of the Fenian Raiders through the pluck of Squire Clinton and Curtis, his grandson, who were captured and imprisoned by the enemy, but were freed by the Attorney-General of the county, whom Curtis, the boy, sought out after his escape from the prison, so as to shed light on the trial which was being conducted for the murder of Jake Sullivan, the captain of the "Mayflower," and the ringleader of the raiders, who, in attempting to wreck vengeance on Quinte, the old negro, on account of the burning of his ship by the squire, fell from the pier on which he stood, calling for a boat to take him off, and was drowned. The arrival of Curtis on the morning of the trial was the providential saving of Quinte's neck, as on further investigation by the doctor and the Attorney-General, guided by Curtis, it was found that Sullivan, in falling from the pier, struck the head of a protruding bolt, which caused his death. By the utilizing of this evidence at the last moment, when the judge had finished charging the jury, the life of Quinte was prolonged. The ill-feeling toward the old negro descended to Horace Sullivan, the son of Jake, despite the facts which were clearly proven. Some time after the affair had blown over and the raid was a thing of the past, Horace Sullivan became engaged to Gertie Westwood, the squire's adopted daughter, who, although not in love with him, was willing to sacrifice her happiness for her parents, as her marriage to him would be the means of clearing off a mortgage on their estate. For interruption in his affairs Sullivan, Jr., pays Quinte a visit in the dead of night, and would have murdered him in cold blood but for the arrival of Gertie, who awoke with the feeling that Quinte was in trouble and calling for help, and hauling on some garments went down across the farm to the log cabin just in time to save his life. Again, however, he threatens her happiness. Leaving his district he goes contracting for work along a new railway line, and here meets Curtis, who was on the engineering and surveying staff. Some dispute arose between them as to the right proportion of work, and Sullivan refers to Curtis' family in a malicious and disrespectful manner, at which Curtis fells him with a blow right from the shoulder. Getting on his feet again, however, Sullivan, the cur as he was, brains Curtis with a rock, which all but killed him. The closing chapters may be said to be very satisfactory to the reader, as Horace Sullivan, through his licentious living and tyrannical disposition, became a thorough lunatic and disappears from the lake in an iron cage for the Kingston Asylum. Squire Clinton was knighted and redeemed his estate at the hammer, having attained vast riches, which were discovered in Virginia, the search of which was begun on the opening of the black walnut box, which Quinte had preserved for the family.

A. N. K.

PUBLICATIONS REVIEWED.

Waterworks Commissioners.—The report of the Waterworks Commissioners of the city of Erie, Pa., for 1907. Report contains plan of Presque Isle settling basin, details of intake pipe, and cribs; also detailed plan of public swimming pool. Geo. C. Gensheimer, secretary.

Topographical Surveys.—The annual report for 1906-07 of the Topographical Surveys Branch, containing the report of the Surveyor-General, schedule of surveys, made from July 1st, 1906, to March 31st, 1907, report of twenty-two surveyors on their field work; list of D.L.S. examination papers. Size, 6 x 9, pp. 350.

Quebec Bridge Inquiry.—Being the report of the Royal Commission appointed to report on the Quebec Bridge disaster. Appendices Nos. 1 and 2 are not given in this volume. Thirty-seven plans accompany the report. Size, 6 x 9, pp. 210.

Lake Nipigeon and Sturgeon Lake.—A report by W. H. Collins, of the Geological Survey Branch, Ottawa, on the section of North-western Ontario traversed by the G.T.P. Size, 6 x 9, pp. 30. Illustrated.

CATALOGUES AND CIRCULARS.

Storage Batteries.—The D. P. Battery Co., Limited, Lumford Mills, Bakewell, Eng., are distributing a catalogue describing their storage batteries. Besides giving a complete description of their batteries it also contains pages of information usually found in handbooks, instructions as to the care and operation of D. P. batteries. The booklet is completely indexed. Pages 50.

Roofing.—The Barrett Manufacturing Co., of New York, are distributing a booklet illustrating some of the newest large hotels that are roofed according to the Barrett specifications.

Concrete Blocks.—The Ideal Concrete Machinery Co., of London, Ont., are distributing a 30-page booklet containing copies of letters of commendation received from users of their machines.

Power Plant Equipment.—The John McDougall Caledonian Iron Works Co., Montreal, in Bulletin No. 105 describe their Erie City water-tube boiler, Economic tubular boiler, four-valve engines, high-speed direct-connected type Worthington boiler feed-pumps and impulse water wheels.

Incandescent Lamps.—The Sunbeam Incandescent Lamp Co., Toronto, Ont., are distributing a wall catalogue showing fifty different types of incandescent lamps, varying in power from ½ C.P. to 150 C.P.

Mine Fans.—The Jeffrey Manufacturing Co., Columbus, Ohio, are sending out Catalogue No. 26, describing their mine fan and attachments for the complete ventilation of mine. The catalogue also contains a page of engineering formulæ used in calculation necessary in ventilation problems. Illustrated. Pages 30.

Mechanical Stokers.—The illustrated catalogues of the Jones Under-feed Stoker Co. is a splendid example of what a trade catalogue should be. Not only does it illustrate pictorially the Jones stoker, but diagrams, sections and drawings, are given, illustrating and explaining the apparatus and its installation so that the engineer may be able to judge for himself of its merits. The catalogue will be sent upon request.

Cableways.—The Lidgerwood Manufacturing Co., of New York, has just issued a new catalogue describing and illustrating Lidgerwood cableways and their many successful applications on great engineering works and for numerous other purposes where large quantities of materials have to be hoisted, conveyed and delivered with celerity and economy. Size, 8 x 11, pp. 170.

Moulders' Supplies.—The J. W. Paxon Co., of Philadelphia, Pa., are distributing Bulletin No. 18, covering information regarding their fleet of ocean and inland barges for carrying their own products. It also describes moulding sand, core sand, fire sand, gannister, fire clay, kaolin and mica schist as never described before. Core-making machines, wooden core boxes and rosin-grinders, core sand, sand blast machines and sand blast sand, as well as fluxings, alloys and partings for iron, brass and steel foundries are also mentioned.

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.

New Brunswick.

ST. JOHN.—Tenders for Dixon's wharf repairs, North Head, N.B., will be received at this office until 4.30 p.m. on Friday, August 14th, 1908, for repairs to Dixon's wharf at North Head, Grand Manan, Charlotte County, N.B. R. C. Desrochers, assistant secretary, Department of Public Works.

Quebec.

MONTREAL.—Tender for the construction of the building for the Montreal School of High Commercial Studies, will be received at the office of the architect of the school, M. L. Z. Gauthier, Savings Bank Building, 180 St. James Street, rooms 7 and 8, up to 4 p.m. Friday, August 14th, 1908, for the construction of the said edifice. Honore Mercier, secretary-treasurer.

Ontario.

BRANTFORD.—Tenders will be received until August 17th, 1908, for sewer extension and cast iron pipe in the city of Brantford. T. Harry Jones, city engineer. (Advertised in The Canadian Engineer.)

COBALT.—Tender for bridge will be received up to 12 o'clock, noon, August 10th, 1908, for the construction of overhead bridge north of Cobalt. A. J. McGee, secretary-treasurer, T.N.O. Railway, 25 Toronto St., Toronto.

CORNWALL.—Tender for repairing washout will be received at this office until 16 o'clock on Monday, August 10th, 1908. Form of the contract to be entered into can be seen on and after Wednesday, the 29th July, 1908, at the office of C. D. Sargent, Resident Engineer, Ontario St. Lawrence Canals, Cornwall, Ont., at which place forms of tender may be obtained. L. K. Jones, secretary, Department of Railways and Canals.

FENWICK.—Tenders will be received by the undersigned for the construction of about 4,000 square feet of concrete walk in the village of Fenwick. Said tenders to be in not later than August 10th. D. C. Althouse, Commissioner, Fenwick, Ont.

MALDEN.—Sealed tenders, addressed to the undersigned, will be received at The Molsons Bank, Amherstburg, up to 3 p.m., of Saturday, the 15th day of August, 1908, for the construction of a cement bridge over the 7th Concession Road Drain and Townline Anderdon. James Honor, township clerk, Malden, Ont.

OTTAWA.—Tenders are invited by the National Transcontinental Commission for six more sections of that railway.

The sections are from a point near Weymontachene, in the Province of Quebec, 196.38 miles west of the north abutment of the Quebec bridge, westerly for a distance of about 107 miles.

From a point about 107 miles west of Weymontachene westerly to the end of the Grand Trunk Pacific Railway Company's contract, a distance of about 114.97 miles.

From the western end of Fauquier Brothers' Abitibi contract in the Province of Ontario, in a westerly direction of about 104 miles.

From a point about sixty miles west of the easterly boundary of District E in the Province of Ontario, easterly to the end of Faquier Bros. contract, north of Lake Nepigon, a distance of above 100 miles.

From the western end of Fauquier Bros. contract north of Lake Nepigon, westerly to a point at or near Dog Lake, a distance of about 126 miles.

From Dog Lake, Ontario, to a point at or about mile 2.6 west of Peninsula Crossing, a distance of about 23.76 miles by the northerly route, and 24.13 miles by the southerly route, the selection of the route to be at the option of the commissioners.

The contracts are all to be completed by December 31st, 1910, except the last two, which are to be finished on September 1st, 1910, and September 1st, 1909, respectively. Tenders will be received up to August 20th.

OTTAWA.—Tender for the renewal of a portion of the West Pier at Port Maitland will be received at this office until 16 o'clock on Friday, the 14th August, 1908. (Advertised in The Canadian Engineer.)

OTTAWA.—Tender for steel rails and tender for rail fastenings, respectively, will be received at the office of the Commissioners of the Transcontinental Railway at Ottawa, until 12 o'clock, noon, of the 1st day of September, 1908, for 44,447 gross tons of 80-pound steel rails (open hearth or Bessemer, at the option of the Commissioners) and the necessary fastenings, in strict accordance with the specifications of the Commissioners. P. E. Ryan, secretary, the Commissioners of the Transcontinental Railway.

Manitoba.

WINNIPEG.—Tenders will be received until September 15th, 1908, for electric lighting plant and carbons. For fuller information apply F. A. Cambridge, city electrician, or M. Peterson, secretary Board of Control, Winnipeg. (Advertised in The Canadian Engineer.)

CONTRACTS AWARDED.

Nova Scotia.

ANTIGONISH.—Tender for McPherson's Cove Wharf, N.S., will be received at this office until 4.30 p.m., on Friday, August 21st, 1908, for the construction of a wharf at Mc Pherson's Cove, Cape Breton County, Nova Scotia. R. C. Desrochers, assistant secretary, Department of Public Works, Ottawa, July 22nd, 1908.

SYDNEY.—W. A. McKay & Company, electrical contractors, have secured a contract with the Newfoundland Government for the electrical installation in connection with the museum at St. John's, Newfoundland. They have also made a contract with the Canadian Government for the electrical work in connection with the new Government building at Shelburne, N.S.

Quebec.

VERDUN.—At a recent meeting of the Council the contract for building the new pumping station and filtering plant was awarded to C. E. Deakin. Nine tenders in all were considered.

Ontario.

ALVINSTON.—Tenders were received, opened and found as follows for the construction of the "9th concession drain Brooke and Enniskillen." J. J. Churchill, $6,200; John Hollingshead, $6,124. Mr. Hollingshead's tender was accepted.

GUELPH.—Mr. C. H. Conery has been awarded the contract for the construction of the cement reservoir. Contract price being $9,000.

Manitoba.

PORTAGE LA PRAIRIE.—The contract for laying the 12-inch intake pipe, 404 ft. long, was awarded to Holmes and Kirimond at $3,630. Murphy Bros. tendered at $3,838.

Saskatchewan.

REGINA.—General satisfaction is expressed here at the manner in which the sub-contracts for the Government buildings are being let by Peter Lyall & Sons, contractors for the buildings. In all cases the sub-contracts are being awarded to local concerns. Hastings & Willoughby, a local firm, have been given the contract for the metal work. Other sub-contracts let to Regina firms are: Excavation, John Brodt & Co.; electric wiring, North-West Electric Company; plastering, the May-Sharpe Construction Company.

REGINA.—The contract for the new warehouse for the Provincial Railways and Telephones Department has been let to the Saskatchewan Building Company. The building, is to be of brick construction and to cost $6,350. Its dimensions will be 30 feet by 60 feet.

British Columbia.

GRAND FORKS.—A contract has been let by Messrs. Morrell and Bonnacci for two hundred ft. of tunnel work on their group of claims about two miles south of the McKinley mine. The contract was let to Messrs. Bruno and Ferdinante, the price being $12 per lineal foot.

RAILWAYS—STEAM AND ELECTRIC.

Quebec.

MONTREAL.—The Grand Trunk Pacific is now assembling the first twenty passenger cars for use on the new line west of Winnipeg. So far as freight equipment is concerned the G.T.P. will have 2,000 box cars in the West for use on the section of the line that will take part in the handling of this season's crop. Altogether it has 5,500 built, but the majority of these will during the present autumn be employed by the Grand Trunk in the movement of grain from lower lake terminals eastward.

Ontario.

GUELPH.—J. W. Moyes, president of the Ontario West Shore Electric Railway, announces that construction work on the Goderich to Kincardine section will start in a few days. The work will be begun at the big cutting to be made at Port Albert.

Alberta.

EDMONTON.—J. Alex. Hutchison, M.D., medical superintendent of the Grand Trunk Pacific Railway, was in the city on a trip of inspection of the Western division. He has travelled over the whole of the G.T.P. from Fort William to Edmonton and as far west as the Pembina River, looking into the health of the men in the various camps and keeping in touch with the physicians in charge. Dr. Hutchison stated that he found the general health of the men in the camps very satisfactory. There had been comparatively little typhoid fever, the greatest amount being at Clover Bar and Battle River. Comparatively few accidents have occurred along the line, the prairie sections being especially free from these, as there was no dangerous rock work.

EDMONTON.—A proposal by Mayor McDougall at the City Council last evening that the city construct and operate a street railway line in Edmonton and Strathcona before the end of the year at an estimated cost of $100,000 or $125,000 was favorably received by the aldermen. The matter is being discussed more fully to-day, and if the scheme is as practical as it seems at first sight, it is probable that prompt action will be taken to construct lines. The mayor stated that there was a strong probability that the city could obtain possession of the charter held in Strathcona by the Strathcona Radial Tramway Company and could build and operate a line in that city. It is estimated that if three miles were constructed in Strathcona and four or five in Edmonton and a half hour car service given the line would pay expenses from the start. He believed that the city would have sufficient power from the new power plant to operate this line.

Saskatchewan.

TUGASKE.—A. C. Smith & Son have finished the heavy fill south of the town, on which they have been working since spring, and have moved part of their outfit onto the townsite to finish grading the station grounds, while the remaining teams went south to surface the grade for the steel gang. When Mr. Smith completes his contract, which will be in a few days, the grade will be ready for the steel at least to the Qu'Appelle Valley.

Manitoba.

WINNIPEG.—The C.N.R. between Winnipeg and Portage la Prairie is being relaid with 80-pound steel.

British Columbia.

PRINCE RUPERT.—When the grade of the Grand Trunk Pacific is completed and ready for the steel there will be no lack of ties on the Skeena River section. For some months past contractors have had camps established and cutting ties at different points along the river; while the British Columbia Tie and Timber Company's saw mill at Seal Harbor already have many thousands cut. Richardson & Morison have taken a contract to cut 100,000 ties and are now putting up their camp near Copper River. Wilfred Loiselle has just finished cutting 11,000 ties at Kitsumkalum River, and he also has 14,000 near Hole-in-the-Wall that were cut last winter.

Foreign.

SALT LAKE CITY, UTAH.—The Denver and Rio Grande Railway Company, the new corporation combining the Denver and Rio Grande, the Rio Grande Western and several subsidiary railway companies, which have been operated as one system for several years, filed its articles of incorporation at the office of the county clerk of Salt Lake County. The new company has a capital stock of $88,000,000. T. Jefferey, of New York, is president and the directors include George J. Gould, Howard Gould and Edwin Gould.

LIGHT, HEAT, AND POWER.

Ontario.

SMITH'S FALLS.—Smith's Falls Council has leased what is known as the Foster grist mill and water power plant for ten years at $1,000 per annum, with the option of purchasing within two years for $16,000. The water commission will use the power in connection with the water pumps, and thus save considerably in the purchase of coal. At present the system is going behind financially, and the Council had to take some steps to stop the expenditure.

Manitoba.

KILLARNEY.—Voting took place on the by-law to grant a franchise and a bonus of $2,000 to George Collison, of Estevan, to establish an electric light plant in this town. The by-law was carried by 107 for and 17 against.

Alberta.

EDMONTON.—The city commissioners report that in view of the substantial surplus in the electric light and power department in the past year, a substantial reduction in electric light rates could be made this year. Commencing August, they suggested that the minimum rate be reduced from 75 cents to 50 cents per month. The new rate for light will be 8 cents per Kw. an hour, and for power there will be a reduction of one cent all around.

MISCELLANEOUS.

New Brunswick.

ST. JOHN.—The two large lumber mills of Stetson, Cutler & Company, have closed down on account of the dull markets, and others may soon close for the same reason. The trade is also extremely dull on the Miramichi River.

Ontario.

NEWMARKET.—Work on the Newmarket end of the Lake Simcoe Canal is being pushed with considerably more vigor the last couple of weeks. Not only has the force of men and teams been largely augmented, but there are now a steam shovel, a steam scraper, and three other steam labor devices at work.

PELEE ISLAND.—Applications are invited by the Municipal Council of the Township of Pelee for the position of engineer and commissioner, to operate the pumping works of the Big Marsh Drainage System in the said township, as provided by the amendment to section 81 of the Municipal Drain-

-age Act, for the term of one year, commencing on the first day of September next. Tenders close at noon on the 29th day of August next, tenders by mail must, however, be in the clerk's hands not later than the 28th on account of mail service. Address all communications to William Stewart, township clerk, Pelee Island, Ont.

MARKHAM.—The range of the Independent Telephones in this district will shortly be still further extended by connection with the Uxbridge and Scott Company's line, and the extension of the Bethesda and Stouffville Company's line to Richmond Hill.

TORONTO.—Dr. Sheard reports on his visit to Cleveland that the reduction of garbage by cooking to grease and fertilizer gives that city a profit of $128,000 a year. Dr. Sheard thinks the plan might prove profitable in Toronto, but will take careful working out, as Cleveland has the advantage of natural gas, and a better market for fertilizer than Toronto.

Manitoba.

WINNIPEG.—It is expected that the Provincial Government will be in readiness to create a new drainage district in the Big Grass marsh by Lake Manitoba early this fall. There is a corps of surveyors at work laying out the ground at present. The area to be drained will be about 250,000 acres. It is not yet known which will be the most feasible direction for drainage. To drain into the lake will necessitate a 30-foot cut through the Kinosota ridge near the lake. It is possible that a large portion of the district will be drained into the White Mud river. All will be ready for construction work next spring.

RECENT FIRES.

New Brunswick.

SACKVILLE.—The lower end of this town was completely swept by fire early this morning. Among the structures burned was the Enterprise Foundry plant, owned by Emerson & Fisher, St. John, and consisting of warehouse, office building, mill room, pattern shop, moulding shop, fitting shops, new power house, and store-room. The loss on the foundry plant will be $80,000 or more. The net insurance is about $52,000. The fire started by lightning striking the mill room in the foundry.

Ontario.

HAGERSVILLE.—An explosion of gasoline, which was being poured into a brazier, caused a destructive fire. The blaze originated in J. Head's repair shop, and was confined to that block by the fire walls. The places destroyed are: Head's repair shop, photo gallery, bicycle store, music store, and the Erie Telephone central office; loss $25,000; insurance about $1,500.

PERSONAL.

MR. SAMUEL WALKER, late of the G.T.R., has been engaged as superintendent of the installation of the new pumps, and inspector of filtration for Verdun, Que.

MR. ORMOND HIGMAN, chief electrical engineer of the Dominion Government, with headquarters at Electrical Standards Laboratory, Ottawa, is spending the day in Winnipeg. He is making a month's inspection trip through Canada and leaves for the Pacific coast to-night.

MAGNALIUM.

Magnalium is an alloy of aluminum and magnesium, manufactured in Germany (90 to 98 per cent. aluminum). And now that this new alloy is being used in America the following notes may be of interest.

It is imported in pigs or ingots for castings or forgings, and can be handled by the ordinary foundryman or blacksmith. It forges about like Swedish steel. It can be delivered in plates, bars, rods, wire, tubing, etc., and in any form it shows a far greater strength than aluminum in spite of its being lighter, its specific gravity being about 2.5 while that of pure aluminum 2.64.

It can be worked or machined about like brass, giving a smooth surface of silvery color. Clean, sharp holes can be bored and perfect screw threads can be cut in the metal The finest files can be used on its successfully. The tool speed is about twice that of aluminum.

It attains and maintains a high polish, resists oxydization, is unaffected by dry or damp air, water, gaseous ammonia, carbonic acid, sulphurate of hydrogen and most organic acids. It is very slightly affected by saltpeter or sulphuric acid and more rapidly by alkalies or strong alkaline solutions. It is slightly attacked by salt water and should be lacquered where it is exposed to sea water.

It is very close grained and can be polished, etched, engraved, pickled, etc., without any trouble. It is very ductile and can be forged, rolled, annealed, drawn, etc.

Magnalium, unlike aluminum, can be soldered by any ordinary workman with magnalium solder after a little practice.

Its electric conductivity is 56 per cent. of that of pure copper.

The melting-point is 1,185°-1,250°F., the specific heat 0.2185.

The following table gives the qualities of various well-known metals as determined in reputable German engineering laboratories and added is a column, showing the comparison of strength of various metals, weight for weight. This is done by dividing the strength in pounds per square inch. By the specific gravity in each case, which gives the strength in pounds per square inch for a unit specific gravity. For instance if one metal is three times as heavy and three times as strong as another, dividing the tensile strength in each case by the specific gravity, the factors resulting would be equal and weight for weight the metals are equally strong.

Metals.	Specific gravity.	Strength in lbs. per sq. in.	Per cent. reduction of sectional area.	Strength in lbs. per sq. in. divided by specific gravity.
Siemen Martin Steel plus 2 per cent. aluminum	7.9	113,794	12.5	14,404
Soft steel	7.7	71,121	16.17	9,237
Rivet steel	7.	52,630	22.	7,518
Cast iron	7.	17,780	0.5	2,540
Manganese bronze ..	8.25	36,272	19.	4,400
Phosphor bronze ...	8.5	36,983	10.	4,351
Copper	8.8	31,293	42.	3,556
Brass	8.4	22,760	75.	2,709
Aluminum bronze, 5½ per cent. al.	8.37	56,897	64.	6,800
Aluminum bronze, 10 per cent.	7.3	90,324	11.	12,373
Pure aluminum (cast)	2.56	16,358	3.	6,390
Ordinary cast al.....	2.7	10,383	1.175	3,846
Magnalium Class "X" sand castings	2.50	18,491 to 21,336	3.75	7,396 to 8,534
Magnalium Class "X" chilled castings ...	2.51	22,759 to 25,604	5. to 8.	9,067 to 10,206
Magnalium Class "X" 90 per cent. aluminum chilled castings	abt. 2.51	60,090	4.19	abt. 24,359
Aluminum (rolled) 20.1 red.	2.61	33,427	4.3	12,807
Magnalium "Z" annealed plates	2.49	42,246	17.8	16,966
Hard rolled aluminum 80.1 red.	2.7	38,405	4.2	14,224
Magnalium Class "Z" hard rolled plates.	2.51	52,203	3.7	20,798

Magnalium Class "Y" forgings	........abt. 2.51	28,448	5.	abt. 11,334
Magnalium drawn wire	............abt 2.45	41,000 to 53,000		16,735 to 21,633
Magnalium drawn rods	............abt. 2.43	60,000		24,691
Magnalium drawn tubing	..........abt. 2.4	74,000		30,833

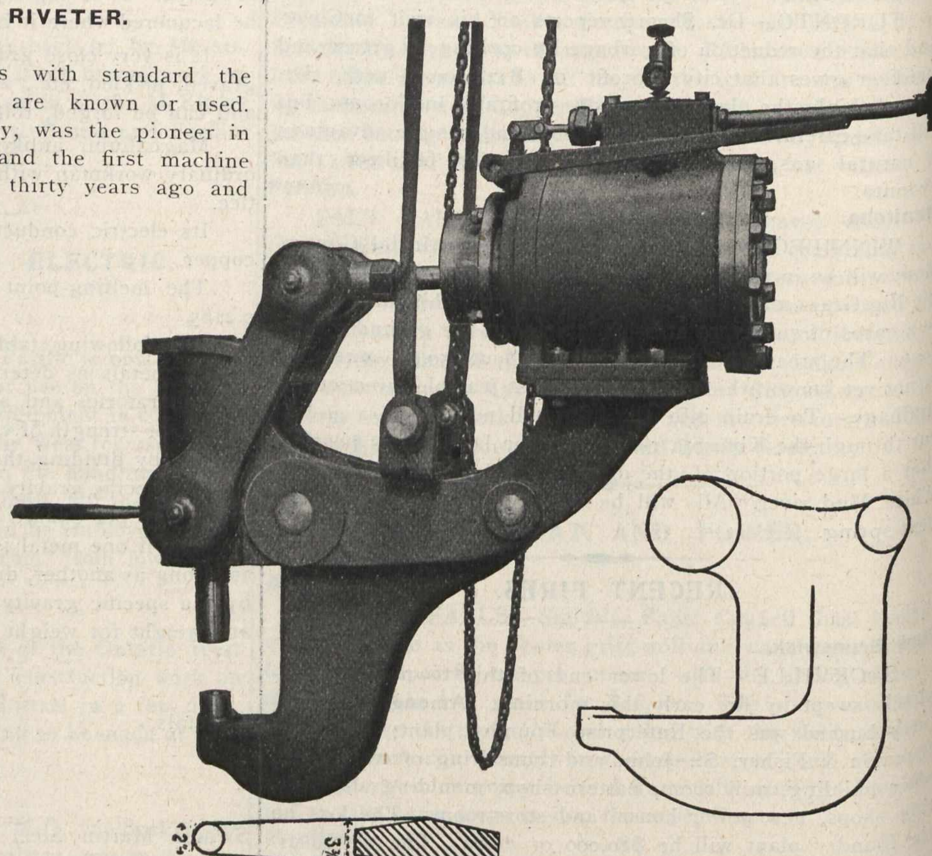
ALLEN COMPRESSION RIVETER.

The name Allen is synonymous with standard the world over where riveting machines are known or used.

John F. Allen, of New York City, was the pioneer in the manufacture of power riveters, and the first machine of this kind was built by him over thirty years ago and met with great success. The Allen tools have from that time kept pace steadily with the varying demands of their ever-widening field of usefulness, improvement following improvement, and the quality constantly set at a higher mark, all making for continual progress in the development of the perfect power riveter.

The design and operation of various types of riveters built by John F. Allen to-day at his large works, 370-372 Gerard Avenue, New York, is generally well known, and it is the quality of these tools for boiler, tank and structural iron-working purposes that is now of especial interest.

Often machines of different makes and of apparently equal merit, as far as performance is concerned, will be found to differ widely in durability, workmanship, and air consumption. thus making the use of one well-nigh prohibitive in comparison with another. The builder, John F. Allen, has recently been making some experiments resulting in the same, marking a new status in riveting machines.



The Allen Riveter, with Detachable Stake.

The items of pressure, stroke and air are of special interest in connection with the Allen tools, as the following data show:—

	8-in. Cyl.	10-in. Cyl.	12-in. Cyl.
Pressure at 90 lbs....	30 tons	45 tons	65 tons
Pressure at 100 lbs...	35 "	50 "	75 "
Stroke	3½ "	3½ "	4 "
Air consumption per rivet at 80 lbs.....	2 cu. ft.	4 cu. ft.	6 cu. ft.

Mr. Allen says: "We are prepared to prove it in a contest with any other tool or before a jury of experts that on a given size of cylinder our tool will far excel in pressure. In recommending our tool we always aim to give surplus pressure rather than just enough. For example, where a ⅞-inch rivet is the maximum to be driven, statistics show that 45 tons pressure is required to do it. In offering for such work our 10-inch cylinder riveter, with 50 tons pressure, a surplus pressure exists that surpasses a uniform pressure at the end of the stroke."

MONTREAL STREET LIGHTING.

Serious Position Now Arises—Difficulties in Way of Solution—Bank of St. Hyacinthe Affairs.

Montreal, August 3rd, 1908.

After years of negotiation with the Montreal Light, Heat and Power Company for better terms for electricity and gas, the city of Montreal is face to face with a somewhat serious situation arising out of the non-renewal of the contract. The contract for street lighting expires on the last day of this year, and the vice-president of the company, in an interview in the daily press, declares that if some arrangement is not arrived at before that time the city will be in a sorry plight. He says that the impression that the city will be able to make a contract with the company for a year or so at the expiry of the present contract is entirely erroneous. The company would not make a contract for less than five years and might insist upon a ten-year contract. Unless this contract is made before the 31st December out will go the lights with the tolling of the midnight bell. The company is figuring on selling the 1,500 horse-power now under reserve for the city under its contract, and will not carry it over on the chance of the city taking it. As to the company's attitude, the vice-president naturally spoke as though it was of little concern whither the city took the power or not.

May Return to Old Gas Lamps.

After making due allowance for the interest the company has in representing the situation as disadvantageously to the city as possible, there is certainly considerable truth in what they say. The company has been carrying matters with a high hand for many years past. A year or so ago it began to look as though they would secure a renewal of their contract and practically have a monopoly of the lighting service of the city. But the City Council not long since made a contract with the Robert Syndicate, admitting them to the privileges of the city streets for the transmission of power. Within a few years this service will be available. Meantime it is hard to say what could be done if the Montreal Light, Heat and Power Company should force the situation by threatening to turn off the power from the city streets at the end of the year. It is suggested that the city might return to gas lighting, there being still 300 of the old gas lamps on the city streets, and the contract for street lighting, with the old Montreal Gas Co., now incorporated in the Light, Heat and Power Company, holding good till May 1st, 1910. At the same time, it would be but a poor resort to have to substitute gas lights for electricity on the streets of a modern city, and it is doubtful whether the citizens would stand for it.

The company has already begun to apply pressure in the direction of getting the contract for electric street lighting arranged for another period. Some time since, the fire and light committee made an appropriation to cover the cost of ninety-six arc lights which were required. After installing some forty of these lights, the work ceased and the company made the explanation that, owing to the uncertainty of the situation, they did not feel justified in making an expenditure of ten or fifteen thousand dollars, especially as, even if the contract were renewed, some other type of lamp might be required.

If the city insisted on having lights installed, the company would supply incandescent lamps of 32 or 65 candle power, or would remove the are lights now used in parks and squares and make use of them as street lights. The company claims there is no contract for lighting squares and parks, although the city takes the opposite view. The aldermen would not consent to the company's proposition to remove the lights from the squares and parks, and the matter was left for the lighting superintendent to arrange for future consideration.

Company Wants Arbitration.

At the present time, the company has a proposition before the City Council, asking to have the price of electric street lighting fixed by arbitration. The company would name one arbitrator; the city, the Board of Trade and the Chambre de Commerce the second, and these two would select the third. The company deposited a bond of $50,000 to abide by the decision. The company claims to have asked for its money back, owing to the delay in accepting the proposition, but without success.

The company also points out that when the recently annexed municipalities became part of the city their rates for street lighting were reduced to the prices the city was paying. Some of the contracts had a considerable time to run and were at the rate of $120 per light per annum, or almost double the price paid by the city. As soon as the contract with the city expires, these municipalities will be again held under their old contracts for the unexpired portion of time.

After reading all these reasons why the city should lose no time in renewing its contract with the Power Company, one cannot but accept with a grain of salt the claim made by the company that it would be just as well pleased if the city would notify it that they would not require the company's light after the end of the present year.

When refusing, recently, to pay its proportion of the expenses of clearing away the snow from the streets, the Montreal Street Railway charged that this work was costing far more than it should and that payment was being drawn for men who actually were not at work at all. This week, City Treasurer Robb reported to the Roads Committee that Charest, one of the chief formen, was apparently guilty of stuffing the corporation pay lists. It would seem that his system was to send a young woman to draw the wages of three men whose names were on the pay roll, but who were purely imaginary. The young woman, who, the detectives say, was the daughter of Charest, but who was innocent in the matter, carried notes to the paymaster's office at the City Hall, and got the money. In this way it is claimed that Charest has drawn some $1,800 in an illegal manner. The claim is made that there were others who have known of the same carried on by Charest for some weeks past. Charest has not been seen around his home for several days and it is thought will be absent for a long time.

Two Alternative Offers.

The Banque de St. Jean is not the only one for the continuation of the existences of which a desperate effort is being made by those interested. A meeting of the depositors and shareholders of the Banque de St. Hyacinthe was held at the town of St. Hyacinthe, on Tuesday night, having been called by Messrs. L. P. Morin, M. Archambault, F. X. A. Boisseau, Joseph Roy, L. O. Dauray and Joseph Morin. The object of the meeting was to lay before the depositors an offer by which they would accept 75 cents on the dollar for their claims, payable at three and six months, security being meantime offered for the fulfilment of the offer. An alternate offer was for the depositors to accept 50 cents on the dollar and paid-up shares for the balance of their claims. It was decided to appoint a committee of depositors to make full inquiries into the situation. A committee of nine was appointed and will report results at a meeting to be held in the same place next Tuesday.

MOTOR VEHICLES AND THE ACCIDENT HAZARD.

Statistics were recently given in the Coroner's Court, of London, showing how motor-driven vehicles have added to the death-roll in the Metropolis. The figures for the Metropolitan area for 1907, excluding the city of London, were:—

	Accidents.	Injuries.	Deaths.
Motor 'buses	4,723	1,068	36
Private cars, motor cabs, and cycles.	5,959	2,055	66
Horses and motor-drawn licensed vehicles	37,415	11,696	269

These returns exclude tramways, which were responsible for 5,328 accidents, causing injuries to 1,986 persons, and deaths to 21. The city statistics are set out much more clearly, being as follows:—

	1907.	1908, to June 30.
Killed	5	2
Injured by:—		
Motor omnibuses	194	94
Motor cabs	35	36
Motor cars	42	21
Other motor vehicles	19	10

MARKET CONDITIONS.

Toronto, August 7th, 1908.

The situation in the building trade is pretty well shown by the remarkable increase in house construction in July in Toronto compared with six previous months. Elsewhere there have been increases in building, though none so pronounced as here. Values are as a rule maintained, brickmakers are fairly busy, cement men not so well employed. Iron and steel cannot be described as very active, but in metals generally there is more activity during these last ten days than for weeks previously. Merchants say they are being pretty well paid, but they are keeping careful watch on the weak merchant or sanguine buyer.

British advices are that pig iron is steady, while structural steel is less firm. Of other metals, copper and tin are active and even buoyant. An improvement is shown in lead. American intelligence is that the New York market is not so full of confidence, because the railways are not stocking up as was expected. Indications in Buffalo, Detroit, and Chicago, however, are of better business.

The following are wholesale prices for Toronto, where not otherwise explained, although for broken quantities higher prices are quoted:—

Bar Iron.—$2 base, from stock to the wholesale dealer.

Boiler Plates.—¼-inch and heavier, $2.40. Fair supply, prices steady. Boiler heads 25c. per 100 pounds advance on plate.

Boiler Tubes.—Demand limited. Lap-welded, steel, 1¼-inch, 10c.; 1½-inch, 9c. per foot; 2-inch, $8.50; 2¼-inch, $10; 2½-inch, $10.60; 3-inch, $12.10; 3½-inch, $15.30; 4-inch, $19.45 per 100 feet.

Building Paper.—Plain, 30c. per roll; tarred, 40c. per roll. Orders still of a limited character.

Bricks.—Common structural, $9 to $10 per thousand, wholesale, and the demand is still active. Red and buff pressed are worth, delivered, $18; at works, $17.

Cement.—The quotation now for 1,000 barrel lots and perhaps smaller parcels is $1.60 exclusive of cotton bags; if bags are included price is $2; small lots cost without bags $1.75 to $1.80.

Copper, Ingot.—The market is firm and rapidly rising. We quote 14 to 14½c. here.

Detonator Caps,—75c. to $1 per 100; case lots, 75c. per 100; broken quantities, $1.

Dynamite, per pound, 21 to 25c., as to quantity.

Felt Paper—Roofing Tarred.—As if in defiance of dealers' predictions the price did go down to $1.80.

Fire Bricks.—English and Scotch, $32.50 to $35; American, $25 to $35 per 1,000. Demand continues fair.

Fuses—Electric Blasting.—Double strength, per 100, 4 feet, $4.50; 6 feet, $5; 8 feet, $5.50; 10 feet, $6. Single strength, 4 feet, $3.50; 6 feet, $4; 8 feet, $4.50; 10 feet, $5. Bennett's double tape fuse, $6 per 1,000 feet.

Galvanized Sheets—Apollo Brand.—Sheets 6 or 8 feet long, 30 or 36 inches wide; 10-gauge, $3.25; 12-14-gauge, $3.35; 16, 18, 20, $3.50; 22-24, $3.70, 26, $3.95; 28, $4.40; 29 or 10¾, $4.70 per 100 pounds. Demand more active, prices unchanged.

Iron Pipe.—Black, ¼-inch, $2.03; ⅜-inch, $2.25; ¼-inch, $2.63; ¾-inch $3.56; 1-inch, $5.11; 1¼-inch, $6.97; 1½-inch, $8.37; 2-inch, $11.16; 2½-inch, $17.82; 3-inch, $23.40; 3½-inch, $29.45; 4-inch, $33.48; 4½-inch, $38, 5-inch, $43.50; 6-inch, $56. Galvanized, ¼-inch, $2.85; ⅜-inch, $3.08; ½-inch, $3.48; ¾-inch, $4.71; 1-inch, $6.76; 1¼-inch, $9.22; 1½-inch, $11.07; 2-inch, $14.76. The supply on hand is fair.

Lead.—Very active and higher, say $3.95 to $4.

Lime.—In plentiful supply and moderate movement. Price for large lots at kilns outside city 21c. per 100 lbs. f.o.b. cars; Toronto retail price 35c. per 100 lbs. f.o.b. car

Lumber.—Dressing pine we quote $32 to $35 per thousand for usual lengths (12, 14, and 16 ft.), and stock sizes of boards, and $38 to $40 for special lengths, common stock boards, as to grade, $24 to $28; culls, $20. June was a good month and July is keeping up well in volume. Southern pine firmer, with an advance in price all round; Norway pine continues easier with considerable stock moving. Hemlock is also active, with an easy feeling. British Columbia shingles have advanced to $3.20, and another advance is looked for, the supply is not large, and they came forward slowly. Spruce flooring is worth $25. Lath are somewhat firmer. Good white pine is moving a little more freely, and keeps firmer than any other grade of stock, the outlook negativing any idea of lower prices.

Nails.—Wire, $2.55 base; cut, $2.70; spikes, $3.15.

Pitch.—Limited trade at 70c. per 100 lbs.

Pig Iron.—A moderate trade, prices unchanged. Clarence quotes at $19.50 for No. 3; Cleveland, $19.50 to $20; in Canadian pig, Hamilton quotes $19.50.

Steel Beams and Channels.—Quiet. We quote:—$2.50 to $2.75, according to size and quantity; if cut, $2.75 to $3; angles, 1¼ by 3-16 and larger, $2.55; tees, $2.80 to $3 per 100 pounds Extra for smaller sizes of angles and tees

Steel Rails.—80-lb., $35 to $38 per ton. The following are prices per gross ton; Montreal, 12-lb. $45, 16-lb. $44 25 and 30-lb. $43.

Sheet Steel.—There are some signs of weakness in the lower numbers, but we quote: 10-gauge, $2.65; 12-gauge, $2.70; American Bessemer, 14-gauge, $2.45; 17, 18, and 20-gauge, $2.60; 22 and 24-gauge, $2.65; 26-gauge, $2.80; 28-gauge, $3.

Tool Steel.—Jessop's special pink label, 10½c.

Tar.—There is little activity and no large orders; $3.50 per barrel the ruling price.

Tank Plate.—3-16-inch, $2.50.

Tin.—Firm at 32½ to 33c.

Zinc.—Active, prices unchanged, at $4.90 to $5.

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Montreal, August 6th, 1908.

There is a report that the United States Steel Corporation has in operation about 75 per cent. of its plant, against about 40 per cent. at the worst of the depression. The mills are principally operating upon sheets, wire and higher finished grades of goods. A few blast furnaces have been blown in, but pig iron production has not materially increased, sufficient stocks being on hand to take care of an improvement in more finished lines. As far as pig iron prices are concerned, there is no change. Reports of sales at reduced prices are heard occasionally, as are also reports of the intention of railways to place large orders, but what truth there is in these reports is hard to say. The probability is that there is political import in the stories regarding the railways.

There seems to be very little taking place in England, the tendency, however, being apparently towards slightly lower prices. This, at any rate, is what mail advices received here for some weeks past, regarding Cleveland warrants, would lead one to believe, the remarkable fact being, however, that, notwithstanding these reports, cables continue to quote the situation unchanged. In pig iron, good Scotch grades are now down to an extremely low level, and, as compared with Middlesboro' brands, are an excellent purchase. The East coast mills have all along been maintained at relatively high prices, owing to low stocks and to the fact that export demand, especially to Germany, has been well maintained.

The local market shows quite a little improvement, as is natural at this time of the year when consumers are covering for their fall and winter requirements. Of course, purchasing is not nearly as heavy as at this time last year, yet several good round lots have been taken and a number of satisfactory inquiries are now before producers. Canadian-made pig continues to be sold by a Western mill and an Eastern one at prices which are considerably below those at which import metal can be laid down here. It is stated that some sales have been made at $17.50 per gross ton, delivered at Western points, such as Hamilton, Toronto, Brantford and Guelph, as well as in Montreal. Importers can more readily compete in the latter place than in the West, freights to the West being proportionately higher for the importer than for the Canadian mills. This means that where importers are able to do business at all, they are compelled to accept very low margin of profit. As a matter of fact, at points distant from Montreal, import sales are impossible, save of Scotch brands which are always bought in fair quantities for mixing purposes.

Prices of the following lines have held steady during the past week:

Antimony.—The market is full and steady, at 8¾ to 9c. per lb.

Bar Iron and Steel.—Prices are steady all round, and trade is decidedly dull. Bar iron, $1.90 per 100 pounds; best refined horseshoe, $2.15; forged iron, $2.05; mild steel, $1.90; sleigh shoe steel, $1.90 for 1 x ⅜-base; tire steel, $1.95 for 1 x ⅜-base; toe calk steel, $2.40; machine steel, iron finish, $2.

Boiler Tubes.—The market is steady, quotations being as follows:—2-inch tubes, 8c.; 2½-inch, 10c.; 3-inch, 11½c.; 3½-inch, 14¾c.; 4-inch, 19c.

Building Paper.—Tar paper, 7, 10, or 16 ounce, $2 per 100 pounds; felt paper, $2.75 per 100 pounds; tar sheathing, No. 1, 60c. per roll of 400 square feet; No. 2, 40c.; dry sheathing, No. 1, 50c. per roll of 400 square feet, No. 2, 32c. (See also Roofing).

Cement—Canadian and American.—Canadian cement, $1.65 to $1.75 per barrel, in cotton bags, and $1.90 and $2.05 in wood, weights in both cases 350 pounds. There are four bags of 87½ pounds each, net, to a barrel, and 10 cents must be added to the above prices for each bag. Bags in good condition are purchased at 10 cents each. Where paper bags are wanted instead of cotton, the charge is 2½ cents for each, or 10 cents per barrel weight. American cement, standard brands, f.o.b. mills, 85c. per 350 pounds; bags extra, 10c. each, and returnable in good condition at 7½c. each.

Cement—English and European.—English cement is steady at $1.85 to $1.90 per barrel in jute sacks of 82½ pounds each (including price of sacks) and $2.20 to $2.30 in wood, per 350 pounds, gross. Belgian cement is quoted at $1.75 to $1.85 per barrel in bags, and $2.05 to $2.20 per barrel, in wood.

Copper.—The market is steady at 14 to 14½c. per pound. Demand continues limited.

Explosives and Accessories.—Dynamite, 50-lb cases, 40 per cent. proof, 18c. in single case lots, Montreal. Blasting powder, 25-lb kegs, $2.25 per keg. Special quotations on large lots of dynamite and powder. Detonator caps, case lots, containing 10,000, 75c. per 100; broken lots, $1. Electric blasting apparatus:—Batteries, 1 to 10 holes, $15; 1 to 20 holes, $25; 1 to 30 holes, $35; 1 to 40 holes, $50. Wire, leading, 1c. per foot; connecting, 50c. per lb. Fuses, platinum, single strength, per 100 fuses:—4-ft. wires, $3.50; 6-ft. wires, $4; 8-ft. wires, $4.50; 10-ft. wires, $5. Double strength fuses, $1 extra, per 100 fuses. Fuses, time, double-tape, $6 per 1,000 feet.

Iron.—Prices continue steady, pig iron now arriving being as follows for carload lots, on cars, on dock, Montreal; for larger lots, lower prices would be taken: No. 1 Summerlee, $19.50 to $20 per ton; No. 2 selected Summerlee, $19 to $19.50; No. 3, soft, $18.50 to $19; Cleveland, $18.50; and No. 3 Clarence, $18; Carron, special, $19.50 to $20; Carron, soft, $18.50 to $19.

Lead.—Trail lead is weak, but prices hold steady, at $3.60 to $3.70 per 100 pounds, ex-store.

Nails.—Demand for nails is moderate, but prices are steady at $2.30 per keg for cut, and $2.25 for wire, base prices.

Pipe—Cast Iron.—Small sizes of pipe are in good demand. At the moment 6-inch pipe is selling fast, and this occasions a slight advance in price: $33 for 8-inch pipe and larger; $34 for 6-inch pipe; $34 for 5-inch, and $34 for 4-inch at the foundry. Pipe, specials, $2.10 per 100 pounds. Gas pipe is quoted at about $1 more than the above.

Pipe—Wrought.—The market is quiet and steady at last week's range:—¼-inch, $5.50, with forty-eight per cent. off for black, and 48 per cent. off for galvanized; ⅜-inch, $5.50, with 59 per cent. off for black and 44 per cent. off for galvanized. The discount on the following is 69 per cent. off for black and 59 per cent. off for galvanized; ½-inch, $8.50; 1-inch, $16.50; 1¼-inch, $22.50; 1½-inch, $27; 2-inch, $36, and 3-inch, $75.50; 3½-inch, $95; 4-inch, $108.

Roofing.—Ready roofing, two-ply, 90c. per roll; three-ply, $1.15 per roll, or $1.50 complete, including one pound, each, of caps and roofing nails, and two gallons of cement.

Spikes.—Railway spikes are in dull demand and prices are unchanged at $2.50 per 100 pounds, base of 5½ x 9-16. Ship spikes are also dull and steady at $3 per 100 pounds, base of ⅝ x 10-inch and ⅝ x 12-inch.

Steel Shafting.—Prices are steady at the list, less 25 per cent. Demand is on the dull side.

Steel Plates.—Prices are unchanged. Quotations are:—$2.15 for 3-16, $2.15 for ⅛, and $2.15 for ¼ and thicker; 12-gauge being $2.20; 14-gauge, $2.10; and 16-gauge, $2.10.

Tar and Pitch.—Coal tar, $3.50 per barrel of 40 gallons, weighing about 500 pounds; coal tar pitch, No. 1, 75c. per 100 pounds, No. 2, 55c. per 100 pounds; pine tar, $4.35 to $4.50 per barrel of about 280 pounds; pine pitch, $4.25 per barrel of 180 to 200 pounds.

Tin.—The market is steady, and is now quoted at 32½ to 33c. per pound.

Tool Steel.—Demand is light, but the market is firm. Base prices are as follows:—Jessop's best unannealed, 14½c. per pound, annealed being 15½c.; second grade, 8c., and high-speed, "Ark," 60c., and "Novo," 65c.; "Conqueror," 55 to 60c.; Sanderson Bros. and Newbould's "Saben," high-speed, 60c.; extra cast tool steel, 14c., and "Colorado" cast tool steel, 8c., base prices. Sanderson's "Rex A" is quoted at 75c. and upward; Self-Hardening, 45c.; Extra, 15c.; Superior, 12c.; and Crucible, 8c.; "Edgar Allan's Air-Hardening," 55 to 65c per pound.

Zinc.—The market is unchanged, at 5 to 5¼c. per pound.

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Winnipeg, August 5th, 1908.

All lines of work are progressing very favorably in the West in connection with the large contracts and other engineering matters now in hand. There is very little new work being contracted for, but the work now on hand will keep the large contractors busy for some time to come. The prices of lumber are reported to have taken a slight drop, which is credited to the inability of the mills in British Columbia to create a stronger demand for the special lines on which they have lowered the prices. The drop in prices will not affect the list prices of the lumber firms, as they will merely make a larger discount on their charges. Prices of all other lines remain the same, and with the splendid prospects for a large crop, the dealers all through the country are gaining increased confidence in the business outlook, and look for a very heavy increase in building for the coming year.

Anvils.—Per pound, 10 to 12½c.; Buckworth anvils, 80 lbs., and up, 10¼c.; anvil and vise combined, each, $5.50.

Bar Iron.—$2.50 to $2.60.

Beams and Channels.—$4 to $4.5 per 100 up to 15-inch.

Building Paper.—4½ to 7c. per pound. No. 1 tarred, 84c. per roll; plain, 60c.; No. 2 tarred, 62½c.; plain, 56c.

Bricks.—$11, $12, $13 per 1,000, three grades.

Cement.—$2.65 to $2.75 per barrel.

Chain.—Coil, proof, ¼-inch, $7; 5-16-inch, $5.50; ⅜-inch, $4.90; 7-16-inch, $4.75; ½-inch, $4.40; ⅝-inch, $4.20; ¾-inch, $4.05; logging chain, 5-16-inch, $6.50; ⅜-inch, $6; ¼-inch, $8.50; jack iron, single, per dozen yards 15c. to 75c.; double, 25c. to $1; trace-chains, per dozen, $5.25 to $6.

Iron.—Swedish iron, 100 lbs., $4.75 base; sheet, black, 14 to 22 gauge, $3.75; 24-gauge, $3.90; 26-gauge, $4; 28-gauge, $4.10. Galvanized—American, 18 to 20-gauge, $4.40; 22 to 24-gauge, $4.65; 26-gauge, $4.65; 28-gauge, $4.90; 30-gauge, $5.15 per 100 lbs. Queen's Head, 22 to 24-gauge, $4.65; 26-gauge English or 30-gauge American, $4.90; 30-gauge American, $5.15; Fleur de Lis, 22 to 24-gauge, $4.50; 28-gauge American, $4.75; 30-gauge American, $5.

Pipe.—Iron, black, per 100 feet, ¼-inch, $2.50; ⅜-inch, $2.80; ½-inch, $3.40; ¾-inch, $4.60; 1-inch, $6.60; 1¼-inch, $9; 1½-inch, $10.75; 2-inch, $14.40; galvanized, ½-inch, $4.25; ¾-inch, $5.75; 1-inch, $8.35; 1¼-inch, $11.35; 1½-inch, $13.60; 2-inch, $18.10. Lead, 6½c. per lb.

Pitch.—Pine, $6.50 per barrel; in less than barrel lots, 4c. per lb.; roofing pitch, $1. per cwt.

Dynamite.—$11 to $13 per case.

Roofing Paper.—60 to 67½c. per roll.

Nails.—$4 to $4.25 per 100. Wire base, $2.85; cut base, $2.90.

Tool Steel.—8½ to 15c. per pound.

Lumber.—No. 1 pine, spruce, tamarac, British Columbia fir and cedar—2 x 4, 2 x 6, 2 x 8, 8 to 16 feet, $27.25, 2 x 20 up to 32 feet, $38.

Timber.—Rough, 8 x 2 to 14 x 16 up to 32 feet, $34; 6 x 20, 8 x 20 up to 32 feet, $38; dressed, $37.50 to $48.25.

Boards.—Common pine, 8-inch to 12-inch wide, $38 to $45; siding, No. 2 white pine, 6-inch, $55; cull red or white pine or spruce, 6-inch, $24; No. 1 clear cedar, 6-inch, 8 to 16 ft., $60; Nos. 1 and 2 British Columbia spruce, 6-inch, $55; No. 3, $45.