THIS ISSUE CONTAINS { Bearing Power of Piles
Pumping Wells by Compressed Air

Canadian Engineer

A WEEKLY JOURNAL
For CIVIL, MECHANICAL, ELECTRICAL and STRUCTURAL ENGINEERS and CONTRACTORS

MONTREAL OFFICE: B 32 Board of Trade Building

WINNIPEG OFFICE, Room 315, Nanton Building

Vol. 16. Toronto, Canada, April 9th, 1909. No. 15.

BUYER'S REFERENCE—PAGE 48—50.

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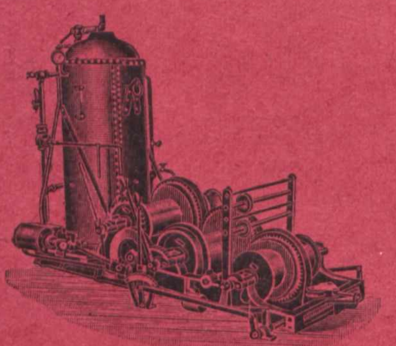

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INDEX TO ADVERTISEMENTS.

* Every Other Week † Once a Month

CONSULTING ENGINEERS

NEW INCORPORATIONS.

Thamesville, Ont.—Thamesville Telephone Co., $10,000; W. J. Mitton, Camden Township; T. Marven, J. Coutts, Thamesville.

Ottawa.—Hassan Mines Development Co., $500,000; S. E. St. O. Chapleau, A. K. Armstrong, J. E. Cox. Boland-Thomson Silver Mining Co., $1,000,000; R. Masson, A. T. Shillington, W. L. Marler.

Railroad officers are now seeking to find a practicable method of preventing damage to their track equipment and consequent danger to trains by the dripping of brine from refrigerator cars. Figures compiled by the Michigan Central Railroad for a year show that on 545 miles of track the deterioration ascribed to this cause amounted to $25,000 on bridges alone, and the damage to rails, angle bars, spikes, etc., brought the total loss up to $145,000.

Dr. Eugene Haanel, Director of Mines, has received a letter from Ludvika, Norway, announcing the projected installation of the first electric furnace for the production of pig-iron in the world on a commercial scale. The contract was given recently, and the first installation will be built this summer. It will include two high furnaces of 2,500 horse-power each, and two steel furnaces of 600 horse-power each. All the furnaces will be supplied with two-phase current. Later four more high furnaces of the same size will be built and four larger steel furnaces.

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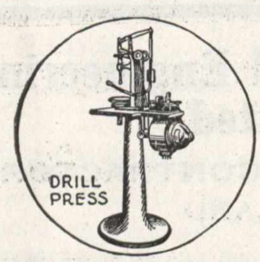
Now it is just that saving that we wish to tell you of. Even though your plant is equipped much above the average, it is to your interest to know about this still better system.

We want to give you all the facts about Western Electric Induction Motors and prove to you conclusively what saving in dollars and cents and what increase in efficiency that system of power will effect in your plant.

Look your plant over and figure out how many tons o. metal you keep rotating over the heads of your workmen and how many square feet of belting you keep travelling at express train speed.



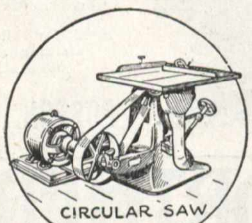
The individual motor driven machines form compact units in themselves, thus allowing the workmen to get around them better and do better work. Besides this you pay only for the power used in actual production—only the machines which are actually employed in turning out your product need be kept running.

Western Electric Induction Motors are the result of 30 years of untiring efforts at improvement. That the Western Electric Company have produced $230,000,000 worth of electrical apparatus during the last five years is a significant fact that speaks volumes for the efficiency of their apparatus.

These are but a few of the facts about Western Electric Induction Motors. If you are interested in increasing the efficiency of your plant—if you are interested in cutting down the cost of your power—write to-day for Bulletin No. 307.

We would be glad to have our engineers look over your plant and prove to you by actual figures what a saving you can effect by installing Western Electric Motors. This service is absolutely free and puts you under no obligation to us.

Write to-day for Bulletin No. 307 and full particulars.



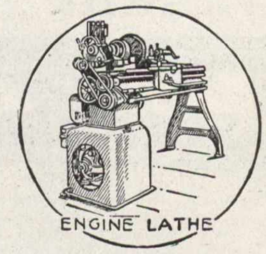
It takes power to keep that mass of non-productive machinery moving. Power that costs you money and adds nothing to the production of your plant.

Twenty-five to fifty per cent of power developed by your engine is lost by the line shaft and belt transmission system. This fact has been repeatedly proven by actual tests.

You can save this loss—add it to your profits by installing West rn Electric Induction Motors.

They can be mounted on the floor, wall or ceiling as required, or on the machines which they are to operate, thus eliminating all belts and hangers.

Western Electric Induction Motors are the simplest of all electrical machines. In operation they are as simple as a shaft rotating in its bearings and require no attention beyond that given to bearings.



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The Canadian Engineer

WEEKLY

ESTABLISHED 1893

VOL. 16. TORONTO, CANADA, APRIL 9th, 1909. No. 15

The Canadian Engineer

ESTABLISHED 1893.

Issued Weekly in the interests of the

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

Editor—E. A. JAMES, B.A. Sc.
Business Manager—JAMES J. SALMOND

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Everything affecting the editorial department should be directed to the Editor.

NOTICE TO ADVERTISERS

Changes of advertisement copy should reach the Head Office by 10 a. m. Monday preceding the date of publication, except the first issue of the month for which changes of copy should be received at least two weeks prior to publication date.

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TORONTO, CANADA, APRIL 9, 1909.

CONTENTS OF THIS ISSUE.

RAILWAY ACCIDENTS.

The returns of railway accidents in Canada for 1908 show that 449 persons were killed and 2,347 injured. As compared with 1907, the fatalities were 149 less. Railway accidents are proportionate to the volume of business, but it is also noticeable that the accidents increase in greater ratio than the business.

An method that will reduce the number of avoidable accidents is worthy of great consideration, and every effort should be made to place the responsibility for accidents where it belongs.

Through the efforts of the Dominion Railway Board and the Comptroller of Railway Statistics, records of railway accidents are more complete than formerly, and are now accessible to all. Notwithstanding this, the railways still continue their policy of secrecy in reference to the probable cause and the extent and result of railway accidents. We cannot see the wisdom of such a policy. Railway employees see accidents, the results of their mistakes, whitewashed. They quickly acquire the habit of giving, even to their superiors, little information, or information colored as they wish it. A spirit of disloyalty goes abroad, and the men are more anxious to shift the responsibility than to inquire as to the cause or seek a remedy.

To cure a disease the doctor must first intelligently diagnose the trouble. The prevention of accidents lies in a knowledge of the cause. If you know the cause, you can c ertainly apply the remedy.

Following every railway accident a thorough and public inquiry should be made. Railway employees should be encouraged by their superiors to give freely of their information. The statute books may make all sorts of requirements of them, but these they will surely avoid so long as the employee fancies it in the interest of his road that the general public and the politicians be as little informed as possible upon the questions with which the railroad man has to grapple.

Unless the railroad men are willing to let the politician, with his inexperience and theory, undertake to direct and legislate in railway matters to the detriment of the railway, they must take the public into their confidence and bring home criminal carelessness in every cause. This carelessness may be in mechanical design, construction or operation. It may be in reference to matters f or which the railway lay has no fixed penalties; yet the general public is satisfied with justice, and any corporation that is fair and impartial will secure and retain the respect and confidence of the public if they show courage in investigating the cause and fixing the responsibility for accidents.

Publicity will not make it more difficult to enforce the rules, but will fix the responsibility on the man rather than upon the system, for, after all, public sentiment is stronger than law.

THE TRACTION ENGINE ON THE HIGHWAY.

For over a dozen years the law has permitted traction engines not exceeding in weight twenty tons to be employed for the conveyance of freight and passengers upon the public highways of the Province of Ontario, subject to certain provisions.

The member for East Wellington has introduced into the Legislative Assembly a bill which proposes to modify Section 2 of Chapter 242, and should such bill become law, ten tons shall be the limit in weight for traction engines hauling loads upon the highway.

This does not seem to be a reasonable amendment. The weight of traction engines has increased, and so has their usefulness. Within the last ten years their usefulness in rural districts has doubled, and with the inreased usefulness the manufacturer has found it necessary to turn out a more powerful, speedier, and necessarily a heavier machine.

To-day, the traction engine is required to develop at least twenty-five horse-power, and frequently as high as thirty-two horse-power, for the work on the farms. A thirty-two horse-power engine will weigh over fifteen tons, and to stipulate that these machines shall not haul freight or machinery would, under present conditions, be to exclude from the highway one of the most necessary machines in the rural district.

It was not reported that, when presenting the measure, the honorable gentleman stated his reasons for this amendment, but if it is to protect the highway and its bridges, some other means than this, we think, must be adopted. The engineer in designing structures during recent years must have allowed for the large load, and, in many cases, the factor of safety used was large.

To limit the weight of the traction engine to ten tons would be to attempt at making a saving of the wrong kind.

EDITORIAL NOTES.

For many years in certain districts of Canada railway fences and railway crossings have been a matter of considerable contention between the railways and the settlers. The Dominion Railway Board are attempting to form new regulations in reference to railway fences, crossings and cattle-guards. In the draft regulations it is stipulated that a fence four feet six inches high shall follow as the line of railway is graded; that the fence shall turn into the cattle-guards, and that swing gates shall be provided at farm crossings. In reference to rural crossings they suggest that the road surface for highways be twenty feet, and on bush roads and sidelines sixteen feet; that the width of bridges at rural railway crossings made in cuttings be not less than twenty feet clear, and that the planking or paving between the rails and the rural railway crossing be twenty feet long on concessions and main roads and sixteen feet on side and bush roads.

* * * *

From letters in the daily press one would suppose that the Canadian Society of Civil Engineers is again agitating for a close corporation bill. It is very doubtful if those who are at all informed on the question will consider these items of news seriously. For the present at least it is understood that the majority of members of the society are quite content to leave matters as they are.

RAILROAD EARNINGS

Name of Company	For Month of March, 1909	For Month of March, 1908	+ or — *	From Jan. 1st to Mar. 31st, 1909	From Jan. 1st to Mar 31st, 1908	+ or — ‡
	$	$	$	$	$	$
C.P.R. ...	6.441 000	5,374 000	+1 067,000	16,021,86	13,848 00	+ 2,173.86
C.N.R.	738,70	625,300	+ 113,400	1,767.500	1,689,100	+ 78.400
G.T R.	3,181,462	3,030,301	+ 151,161	8,351,349	8,239,850	+ 111,499
T. & N. O.	119,.05	63,841	+ 55.464	296,52	116 998	+ 139.552
Mon. St. ..	266,218	2 8,3 9	+ 7,869	811.930	763,502	+ 48.428
Tor. St.	29 ,742	262.508	+ 25,234	860 568	8 2,567	+ 58,001
London St	17.777	16.611	+ 1,164	51.447	49.390	+ 2,0 7

*Increase or decrease over 1908
‡Aggregate increase or decrease over 1908.

PRECIPITATION FOR MARCH 1909.

The precipitation recorded in Canada during March was less than the usual quantity except over a large portion of Ontario, Eastern Quebec, and the Maritime Provinces, where the normal amount was slightly exceeded.

Depth of Snow.

On the last day of the month the ground over a large portion of Canada was snow covered. In British Columbia, the higher levels were well covered; also the northern districts of Alberta. In Saskatchewan and Manitoba there was a depth of from 3 to 7 inches. Northern Ontario recorded from 5 to 11 inches, elsewhere in the Province the ground was practically bare. A depth of 16 inches at Montreal increased eastward to 52 inches at Quebec. New Brunswick was also largely snow covered, the depth decreasing rapidly southward to a trace near the Bay of Fundy.

Thickness of Ice.

Thickness of ice is reported from the several stations as follows:

Western Provinces—Edmonton, 24.5 inches; Battleford, 28 inches; Medicine Hat, 12 inches; Qu'Appelle, 30 inches; Minnedosa, 16 inches.

Ontario—Port Arthur, 11 inches; Bruce Mines, 25 inches; Southampton, 1 inch; Kingston, 14 inches; Rockliffe, 20 inches.

Maritime Provinces—Chatham, 18 inches; Sydney, 12 inches; Charlottetown, 8 inches.

The table shows for thirteen stations included in the report of the Meteorological Office, Toronto, the total precipitation of these stations for the month.

Ten inches of snow is calculated as being the equivalent of one inch of rain.

Station.	Depth in inches.	Departure from average of of 20 years.
Calgary, Alta.	0.70	—0.05
Edmonton Alta.	0.30	—0.38
Swift Current, Sask.	0.30	—0.57
Port Stanley, Ont.	2.70	—0.18
Toronto, Ont.	2.77	+0.28
Parry Sound, Ont.	2.60	—0.24
Ottawa, Ont.	3.90	+1.22
Kingston, Ont.	3.30	+0.70
Quebec	3.30	—0.15
Montreal	2.70	—1.16
Chatham, N.B.	4.50	+0.96
Halifax, N.S.	5.10	—0.36
Victoria, B.C.	0.70	—1.31

COMING MEETINGS.

American Society of Mechanical Engineers.—May 4-7. Spring meeting at Washington, D.C. Secretary, Calvin W. Rice, 29 West 39th Street, New York City.

American Electrochemical Society. — May 6-8. Annual meeting at Niagara Falls, Canada. Secretary, Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

American Foundrymen's Association.—May 18-20. Annual meeting at Cincinnati, Ohio. Secretary, Richard Moldenke, Watchung, N.J.

American Railway Association.—May 19. Annual meeting at New York City. Secretary, W. F. Allen, 24 Park Place, New York City.

American Waterworks Association.—June 8-12. Annual convention at Milwaukee, Wis. Secretary, John M. Diven, 14 George Street, Charleston, S. C.

American Railway Master Mechanics' Association.—June 16-18. Annual convention at Atlantic City, N.J. Secretary, Jos. W. Taylor, 390 Old Colony Building, Chicago, Ill.

RAILWAY EARNINGS.

	Week ended	1909	1908
C. P. R.	March 31	$2,164,000	$1,804,000
C. N. R.	March 31	280,200	216,500
G. T. R.	March 31	1,122,733	1,037,702
T. & N. O.	March 31	38,738	24,750
Montreal Street	March 27	66,275	63,996
Toronto Street	April 3	69,015	62,312

TEN MILLION DOLLAR LOAN

To the Grand Trunk Pacific—Will Cover Increase in Cost of Prairie Section.

(The Monetary Times.)

Loan to G.T.P.	**$10,000,000**
On guarantee of	**Grand Trunk Ry. Co.**
Nature	**4th mortgage on prairie sec.**
Rate of interest	**4 per cent.**
Reason for loan	**Increased cost, prairie sec.**
Western division	**Winnipeg to Prince Rupert**
Distance	**1,755 miles**
Sections of Western division	**Prairie and Mountain**
Being constructed by	**Grand Trunk Pacific**
Eastern division	**Moncton to Winnipeg**
Distance	**1,804 miles**
Being constructed by	**Transcontinental Ry. Com.**
Provision made, p.m., Prairie	**$23,482**
Gov'nt engineer's estimate	**$34,943**
G.T.P. engineer's estimate	**$34,059**

The ten million dollar loan by the Dominion Government to the Grand Trunk Pacific Railroad Company came up for discussion in the House at Ottawa this week. The subject evoked heated discussion and the firearms ranged from public ownership to high finance. Mr. W. F. Maclean even went so far as to suggest that the C.P.R. or the C.N.R. would later gobble up the G.T.P. Hon Mr. Fielding, Minister of Finance, explained that the object of the resolution was to assist that company in meeting the unexpectedly large increase in the cost of the prairie section of the Transcontinental Railway. The resolution did not contemplate any change in the contract between the G.T.P. and the Government. The proposed loan was in the nature of a banking transaction. The Transcontinental Railway extended from Moncton to Prince Rupert, a distance of 3,506 miles. The Eastern division, from Moncton to Winnipeg, was a fraction over 1,804 miles, and that portion was being constructed by the Government through the instrumentality of the Transcontinental Railway Commission, and would ultimately be leased to the G.T.P. The Western division, from Winnipeg to Prince Rupert, extended to a distance of 1,755 miles, and was being constructed by the Grand Trunk Pacific. This Western division was divided into two sections, known as the prairie section and the mountain section.

On the prairie section the Government guaranteed the bonds of the company to the extent of three-fourths of the cost provided the cost did not exceed $13,000 per mile. Respecting the mountain section the Government guaranteed the bonds of the company to the extent of three-fourths of the cost without limitation as to cost per mile. The prairie section extended from Winnipeg to Wolf River, the distance being 916 miles, while the mountain section from Wolf River to Prince Rupert was estimated to be 839 miles.

The contract of 1903 provided that the Government should guarantee the bonds over the prairie section, the proceeds to equal three-fourths of the cost, but not to exceed $13,000 per mile. If they applied the $13,000 per mile to the 916 miles they found that the contemplated guarantee would provide the sum of $11,980,000. The balance required under the contract was to be raised by the G.T.P. on the guarantee of the parent company, the Grand Trunk Railway. The company estimated that balance at $10,220,000. There was thus available for the road the proceeds of the Government guarantee, amounting to $11,908,000, and the proceeds of the G.T.R. guarantee, amounting to $9,601,926, making a total available for the prairie section of $21,509,926. That provision was equal to $23,482 per mile for the 916 miles. If the road had cost no more than $23,482 per mile there would have been no need of any further advance. But the road had cost much more than the earlier estimates.

The estimates, continued Mr. Fielding, of the G.T.P. and the Government engineers as to the cost of the prairie section varied. The company's estimate gave a cost per mile of $34,059, and Mr. Schreiber's estimate $34,943. The balance required, according to the company's estimate, was $9,688,425. The balance required, according to Mr. Schreiber's estimate, was $10,497,522.

CANADIAN GENERAL ELECTRIC COMPANY, LIMITED.

It is rather more than twenty years since a group of enterprising business men, impressed by the modern discoveries in electrical science, and feeling assured of the coming common use of that fluid for at least illuminating purposes and very possibly for other ends, founded the Toronto Construction and Electrical Supply Company with the modest capital of $50,000. They later bought out the Edison Company, already in existence here, having factory building in Peterborough and proceeded with the manufacture of dynamos and other electric machines and appliances. Their works were soon abreast with the best disclosures then made in electricity on this side the ocean.

From that time until the present, the same two Toronto men, W. R. Brock and H. P. Dwight, have been respectively president and vice-president of the company. And Mr. Frederic Nicholls has been continually associated in the management of the enterprise for all these years.

What was begun as an experiment has succeeded. Although all the features of its enterprise have not been uniformly prosperous the company has grown and flourished. For sixteen years it has, with only one year's exception, been able to pay from six to ten per cent. dividend annually. The Canadian General Electric, to use the company's new name, acquired additional lands, premises, and plant at Toronto, Montreal, and elsewhere. Of later years it has branched out into the casting of pipe, the making of pumps, locomotives, steam shovels, steel bridges, etc.

The last-named department of the company's business, the Canada Foundry Company establishment, has become very extensive. It took time and patience to put it on its feet, and for a long time it showed no profit. But to-day, it is declared to have become one of the best paying portions of the company's business.

On Monday was held the annual meeting, when was submitted a report and balance sheet, the latter certified by a very conservative firm of Old Country accountants. The company's stock amounts now to $6,700,000, of which $2,000,000 is preferred and $4,700,000 common. Its capital assets are patents, contracts, patterns and drawings $715,304; real estate, buildings and power plant, $3,506,231; tools and machinery, $1,602,876, making $5,824,810. Current assets, namely, cash, bills receivable, etc., including raw material and work in progress, are $3,963,053, and there is $213,467 put down for "investments." Among the liabilities are mortgages assumed, $275,249; bank advances, $738,035; accounts payable $355,088. The surplus shown is $1,814,763 at end of December 1908.

Analysis of this surplus by Price, Waterhouse & Company, London and New York, shows that it has grown from $1,689,762 at close of 1907 to the present figure. The gross earnings of 1908 were $753,088, or, deducting $96,274 interest and $146,246 depreciation, $510,367, which permits the payment of seven per cent. dividend for the year.

The report of the directors shows how the prevailing depression in all trade during 1908 reduced the company's output and affected its earnings. Operating expenses were pared down, economy practised all around, and the original issue of $300,000 preferred stock was retired, as also the $160,000 maturing bonds of the Northey Manufacturing Company. It is pleasing also to find current liabilities, reduced by more than a million dollars, "as a result of a smaller inventory of raw materials and finished stock, acquired for a lesser volume of business." It is further very satisfactory to observe, that in estimating the value of material on hand, the company takes the conservative plan of using either cost or market price, whichever is the lower.

Considering the great growth of this company's business, which may be said to have kept pace with that of the country itself, and its expansion in directions hardly calculated on at first, its earning power has been great. All its departments, however, as has been said, have not been equally prosperous. Such a thing was hardly to be expected. The present year promises thus far to yield rather more current business, and the report mentions the receipt already, besides, of several important contracts. The scale upon which its operation has been planned, and the character of the modern machinery installed within its walls render this one of the most important industrial concerns in Canada. It possesses plant capable of handling the largest work; and it may be reasonably thought will always be likely to command an adequate share in the yearly increasing volume of that kind of trade.

CANADIAN WESTINGHOUSE.

At the annual shareholders meeting of the Canadian Westinghouse Company at Hamilton, the annual report to the shareholders showed net profits for the year ended December 31st, 1908, of $320,377.36. From these profits the usual dividends, at the rate of 6 per cent. per annum, were paid during the year, amounting to $240,938.09. Thirty thousand dollars was added to the reserve for depreciation, making total reserve for this purpose $250,000, and a balance of $431,724.82 carried forward to profit at January 1st, 1909. The remaining calls amounting to $354,900 on the capital stock matured during the year and were promptly paid. Notwithstanding low prices, the cost of production was reduced in relation to the billing of shipments.

The re-elected directors and officers are: George Westinghouse, president; H. H. Westinghouse, vice-president; L. A. Osborne, vice-president; Paul T. Myler, vice-president and general manager; T. Ahearn, Warren Y. Soper, Hon. J. M. Gibson, C. F. Sise, Geo. C. Smith, Chas. A. Terry, and John H. Kerr, secretary.

THE

Sanitary Review

SEWERAGE, SEWAGE DISPOSAL, WATER SUPPLY AND WATER PURIFICATION

PURIFICATION OF WATER BY "OZONE."

Last week's issue of this Review contained an article on "Ozone," more particularly dealing with its application to water supply.

The author, Mr. R. M. Leggett, is the engineer in charge of the ozone plant in course of adoption at Lindsay, Ont. He also represents the United Water Improvement Co., Philadelphia, U.S.A. It may, therefore, be taken that anything he has to say on this subject is supported by experience and knowledge.

The article in question states: "Ozone is applied as a bacteriacidal agent in the purification of public water supplies. Slow sand filtration, coagulation and sedimentation no doubt go a long way towards reducing the dangers from impure water, but efforts should not cease until absolute purity is secured."

No fault can be found with the above statement. It is simply one of fact.

Several towns are mentioned where ozone as a means of water purification has been adopted, Lindsay being noted, dealing with one and a half millions gallons per day. European laboratory experiments are given, showing absolute bacteria removal.

Lindsay is, we understand, the first Canadian town to adopt this system, and here it is claimed that an economy of gas production is effected by what is known as the "Bridge" system.

The question of cost is, of course, of great importance, and this must depend somewhat upon the cost of power available locally, apart from special apparatus.

The data required, however, are a comparison of exactly what in practice ozone will do towards removal of pathogenic bacteria as compared with other processes.

Laboratory experiments are, unfortunately, an unreliable index of working efficiencies. Such tests can be made to show absolute efficiencies with most processes.

We know fairly well what can be done in practice by filtration, both mechanical and otherwise. Experience in both Europe and America has established reliable data. The annual reports of the various American State Boards of Health provide precise and voluminous information.

It is acknowledged that any system of filtration is biologically imperfect, but well-managed filtration is very near perfection, and where adopted the death rate from typhoid has generally shown a marked decrease. Only perfect sterilization can possibly supersede it in efficiency.

We understand that certain guarantees of purity have been given at Lindsay. We further understand that the standard of purity guaranteed has not yet been reached, the reason given being that the water is not sufficiently treated by the process of rapid sand filtration which precedes the ozone treatment.

Dr. Amyot, the Provincial bacteriologist, is awaiting the completion of the proper balance between these two processes before taking samples of the effluents from both the filtration and ozone treatment. The subsequent analyses of these samples should show clearly just what proportion of bacteria removal is due in the first instance to the filtration plant, and in the second instance to sterilization.

Purification of water by means of ozone may be said to be on its trial in Canada. We await the verdict with interest.

There are several towns where this system has been adopted, principally in Europe, notably in Paris. It has been suggested for the great London water supplies. It, however, does not appear to take the place of filtration, but is generally adopted as an extra safeguard, and this appears to be the case at Lindsay.

Sterilization is of no value in the removal of turbidity or suspended matter. In this connection filtration or sedimentation must be resorted to.

Where the ozone treatment has been adopted we find it difficult to get any exact information or data of the amount of biological impurities removed.

We have before us recent literature, consisting of lectures and addresses, in which ozone treatment is referred to, but in no case is exact information obtainable.

The various State Boards of Health in America appear to have given the subject no attention.

We will welcome at any time this information, as we consider that any absolute, practical and economic method of water sterilization, especially in cases where sewage contamination exists, is bound to take an important position in hygienic engineering.

CONTACT VERSUS PERCOLATING FILTERS.

The Chadwick lectures for 1908 in connection with the University of London have just been issued in book form, Mr. W. D. Scott-Moncrieff, C.E., is responsible for the lectures; and as a general summary of the sewage problem they will be read with great interest.

The author is among the early pioneers of bacterial sewage disposal, and personally claims that he was the first engineer in Great Britain to give such principles practical expression. There has existed a sort of friendly rivalry between Scott-Moncrieff, and Dibden, (chemist to the London County Council), on this point, both claiming precedence over the other as the originator of biological sewage treatment. The question has lately formed the subject of some correspondence in "The Surveyor and Municipal and County Engineer" journal, (Britain).

In Great Brintain, however, it would appear that Sir Percy Frankland has the best claim to recognition as the pioneer of what are now accepted as approved methods. Frankland showed that a filter did not choke if the sewage was applied in comparatively small doses, and each dose allowed to trickle away before the application of the next. He named this method "intermittent filtration."

As far as absolute biological treatment is concerned, it is a matter of fact that several scientists, both chemists and engineers, became practically interested in the subject simultaneously, as a result of the valuable experiments and data published by the Massachusetts State Board of Health in 1887.

In 1892, Santo Crimp, along with Dibden, prepared experimental filters at Barking, and in 1896 Dibden recommended the adoption of this method at Sutton. These filters were all constructed on the "Contact Bed" system. Independently at the same time J. Corbett, the Borough Surveyor of Salford, worked out a biological method, based on the Massachusetts experiments, the further development of which has surpassed the London methods.

In 1891 Scott-Moncrieff constructed what he called a cultivation tank. The arrangement being a septic tank, filled with stones, the sewage entering at the base and leaving at the top. The liquor from this tank was treated on a filter of the percolating type, provided with trays containing coke.

It appears clear, although both Scott-Moncrieff and Dibden were working at biological methods of sewage purification, that Scott-Moncrieff began just where Dibden was compelled to leave off.

The contact filter has proved a failure, while the percolating filter has been found up to the present to meet the requirements of a biological filter. We find, at Sutton, percolating filters are in process of supplanting the contact filters formerly installed.

It is not, therefore, surprising to find that a portion of the "Chadwick lectures" are devoted to the relative qualities of the two methods.

The contact filter appears to have had an empirical origin. Its method of operation does not appear to have any foundation in theory or principal. The frame-work of such a filter is water-tight in construction, and is so constructed that it may stand full to the point of saturation with sewage. The object being that the sewage be brought into contact for a period of time with the micro-organisms existing in the filtering material, and then slowly drawn off and the filter given a period of rest.

It was said that the organic matter both in suspension and solution was attacked by the various organisms, while the sewage remained in contact, with the result that such matter was nitrified or reduced to its inorganic components, and by this means was chemically changed and rendered non-putrescible.

That such an idea could ever receive acceptance, could only result from, either a want of knowledge, or a reluctance to give proper consideration to the factors relating to putrefaction on the one hand and nitrification on the other.

It is perfectly clear that during the period of contact, these filters present conditions, anaerobic in character, that is, free oxygen is eliminated from the filter and its place taken entirely by sewage. No doubt when the sewage is drawn from the filter oxygen enters and takes its place, but this must at once be again discharged when the filter is filled. We, therefore, appear to have a sort of combined septic and nitration scheme.

The contact bed shows every evidence of being a fluke or chance hit, without any scientific reason or data for its existence.

A large filter being constructed, after the tpe of the small experimental filters of the Laurence Experimental Station, it was necessary to have some means of distributing the sewage, both over its entire surface and throughout its entire interior. The idea was, therefore, hit upon of filling it to the top with sewage so that every pore of the media was charged with sewage. By continual dosing, it was found after a short time, that the effluents began to show signs of chemical change, nitrates and nitrites put in an appearance, and the filter was said to be matured.

Because of this chance experiment, based on no scientific principal and supported by no known data, vast sums of money have been practically thrown away.

Before scientific tests and careful experimental work could be applied to the Bacterial Contact Filter, it was received with favor and adopted by many towns in preference to chemical sewage disposal. It was claimed in many instances that such filters accompanied by septic sedimentation tanks did not only solve the problem of obtaining a non-putrescible effluent, but also the serious problem of sludge disposal. It was assumed that the energy of the bacteria was so great as to decompose the substances, to such an extent, that, no clogging of the filter would ever occur.

In Massachusetts it had been assumed at first, that, the bacteria decomposed organic matter, while the sewage passed through the soil, so in England it was thought that this decomposition took place whilst the sewage was standing in the filter. The object of giving the filters a rest, between the periods of contact, was simply to allow of the bacteria again becoming, as it were, hungry and ready for a fresh attack.

The experiment was simply an attempt to copy Laurence Filter No. 16A, using the contact method of operation with a coarser filtering material of coke, clinker, broken bricks, etc.

In applying septic treatment, as a means of removing the grosser solids, it became customary to apply the term anaerobic exclusively to this process, and in applying bacterial contact filtration to the sewage liquor from the septic tanks, the term aerobic was exculsively used. It being held, that, by the combination of the two processes, ideally presented for the propagation of the two distinct types of bacteria. The full benefits of the dual processes of putrefaction and nitrification were obtained. The first, apart from the presence of light and air; the second exposed to light and in the full presence of air.

It is, however, apparent that in the contact filter, the aerobic conditions are only present after the sewage has been drawn from the filter, and that while the sewage is present, or in contact, anaerobic conditions prevail. It, therefore, becomes evident that we have either a paradox presented, or that the matter is based on a fallacious assumption. It has now become apparent, from the result of further experiment, that a fallacious assumption is the basis of the contact filter.

Nitrification does not take place while the sewage remains in the filter.

Nitrification only takes place during the period of rest after the filter is matured.

The nitrates and nitrites, representing the oxidised organic nitrogen, which are given off with the filter effluents after the filter is matured, are the effects of the oxidation of organic matter of previous fillings. The maturing of a filter depends upon the growth of a gelatinous film or coating which gradually covers the surface of the filtering material, this growth gradually becomes thicker and thicker, diminishing the volume of the pores, but increasing the water retaining capacity up to certain limits, after which the water capacity decreases. As the film becomes thicker the purifying action of the filter increases. A microscopical examination of this film shows that it contains bacteria and other low forms of life as well as amorphous substances. The film has a honey-comb structure a cubic millimetre, presenting a surface of over two million square millimetres. "The film has an internal as well as an external surface, and can absorb gases in very large quantities, as well as many organic and inorganic substances, coloring matters, scented and bitter substances, resins, tannins, enzymos, and other substances of high molecular weight. If solutions of albumen, or similar liquids are poured over a filter matured with this film, the dissolved organic solids are absorbed and retained." *

The growth and purifying power of this gelatinous film depends upon the presence of bacteria and air.

The process which takes place in a biological filter is therefore, first, one of retention or absorption. While the sewage remains in contact with media, the organic particles in suspension and in solution are absorbed only to be oxidised after the liquid has been removed in the presence of an unlimited supply of air.

It has been shown that it is not necessary to retain sewage in a mature filter for a period of more than 5 minutes. The separation of organic matters in solution does not occur gradually, due to the decomposing action of bacteria, but on the other hand quite suddenly.

The second process which takes place is one of nitrification. The organic matter retained by the gelatinous film is mineralised by the action of the micro-organisms contained in the film. A balance between the absorptive and oxidising properties of the film must be maintained.

Overdosing a filter with sewage means that nitrification cannot keep pace with the absorption. Absorption, therefore, weakens, and a period of rest must be allowed.

It now becomes evident, that, when a balance of work can be struck between the absorptive and nitrifying processes; and when these two processes can be carried on simultaneously, a condition is established, which does not exist in the

*Dr. Dunbar, (Principals of Sewage Treatment).

contact filter, a condition, however, which rests on a scientific basis.

The principals that, **Effects in Sewage Disposal should bear distinct Scientific relation to defined Causes,** has throughout marked Mr. W. D. Scott-Moncrieff's work. He has nothing but good natured sarcasm for the man or body of men who make guess work, a balance of chances, or th: prejudice born of precedent the hypothetical basis of their work. His address to the "Managers of Sewage Works Association," at the end of last year, on the tedious methods and lack of standards employed by the Royal Sewage Commission is a master-piece example of good natured chaff, impregnated with serious truth.

As soon as it was found that the principal of the contact filter was fallacious, there was at once produced a spirit of eagerness and enquiry as to what a filter would do, without this period of contact, granted that there were ways and means of obtaining even distribution.

The period of contact was found to be a waste of time which might be employed in work of oxidation. It was an extension of the putrefactive process of the septic tank, eliminating the atmosphere, so absolutely essential to nitrification.

It was foud that the period of contact occupied by the sewage in percolating continuously from the surface of the filter to the base, was quite sufficient, granted that the sewage was discharged in broken up or divided quantities in the form of rain, and that air was continually drawn through the filter by the percolating sewage.

The sanitary world all now recognize the principal contained in Scott-Moncrieff's filter of seventeen years past.

The Royal Commission in their fifth report put it that in order to deal with one million gallons of average domestic sewage per day it requires 25,000 cubic yards of filtering media with contact filters, whereas to obtain equal results with percolating filters only 11,494 cubic yards are required—less than half. Taking the cost of clinker or slag, including carriage and grading at $2 per cubic yard; this alone allows a saving in first cost of over $27,000 per million gallons of sewage treated. Further percolating filters do not necessitate water-tight built tanks, and the saving in construction is enormous.

Such filters do not readily choke. The period between times of cleansing with 3-inch diameter material, is given by the Royal Commission from 10 to 15 years.

Contact beds have not fulfilled their guess-promise as to choking. The anaerobic conditions of the contact period tend to produce a non-absorbent spongy condition of the filtering material.

Excess of matter retained in the percolating filter is easily washed out in the character of a non-putrescible humus, easily settled out of the effluent, if required.

There are various methods and appliances for obtaining equal and good distribution over the filter surface, here the engineer has a varied choice.

We agree with Scott-Moncrieff as to his objections to the spray,—not only from a sanitary point of view, but the distribution is unequal. One portion of the wetted area may be receiving sewage at the rate of 6,000,000 gallons per acre, while another portion at the rate of 1,000,000. While with a system of relatively small wetted circumferences, only about 50 per cent. of the filtering area is in use. Scott-Moncrieff's Chadwick lectures are noted in our book column, and name of publishers, etc., given.

SEWERAGE AND WATERWORKS.

Quebec.

MONTREAL.—P. McGovern, the contractor for the construction of the covered concrete conduit parallel with the aqueduct, has been able to resume the work, which was interrupted by the severity of the weather in December last, and it is confidently expected that the contract will be completed and water turned through the conduit for domestic use in the city from the widened portion of the aqueduct within three months' time. The civic Water Committee will at its next meeting take up consideration of, a proposal to call for tenders for putting down an intake pipe further into the St. Lawrence, with the view of insuring a purer supply of water for the city. This work will cost, it is estimated, between sixty and seventy thousand dollars, and with the expenditure to be made this year of making the aqueduct a uniform width from its mouth to the wheelhouse, this will carry the total costs of waterworks enlargement undertaken late in 1907 to over two million dollars. Up to the present, one million dollars for this work has been raised by special loan. The balance is to be borrowed during the current year.

Ontario.

WATERLOO.—The Town Engineer is preparing a profile in connection with the construction of a sewer on Victoria Street and tenders will shortly be called for work.

BRANTFORD.—City Engineer Jones has started work on the sewer to be laid on Erie Avenue. The first pipes laid will be 12 feet underground.

HOW NEWSPAPERS REPORT AN ENGINEER'S ADDRESS.

THE CANADIAN INSTITUTE, TORONTO.

Mr. T. Aird Murray, last Saturday evening, lectured before the above Institute on the subject of "Modern Biological Sewage Disposal." By the use of large scale diagrams and plans he explained the two processes of, first: Removal of solids from sewage; second, the nitrification of the sewage liquid, by which the organic water was mineralised and the effluent rendered putrescible. He showed that 270,000 gallons of sewage could be purified by tank sedimentation and continuous bacterial filtration at the rate of 200 gallons per cube yard of filtrate. The lecturer laid great stress upon the advantages of percolating filters as compared with the older form of contact filters. The question of sludge digestion and the various processes of both putrefaction and nitrification were fully dealt with.

In the after discussion mention was made of the Toronto city proposed method of sewage disposal by several speakers.

In replying Mr. Murray said that he did not agree with the proposal to discharge unpurified sewage into the lake, but thought that a great gain to the city lay in the fact that in future the sewage would be concentrated at one point, and that future purification or sterilisation might be adopted if considered necessary.

This is the way that a Toronto daily paper reports Mr. Murray's lecture. Mr. Murray never at any time referred to Toronto sewage disposal during the course of the lecture, and only to answer questions put to him during discussion. He expressed no agreement with the experts, or the City's plan, nor has he ever advised the City on this point.

SEWAGE DISPOSAL PLANT.

Mr. T. Aird Murray Addresses Canadian Institute.

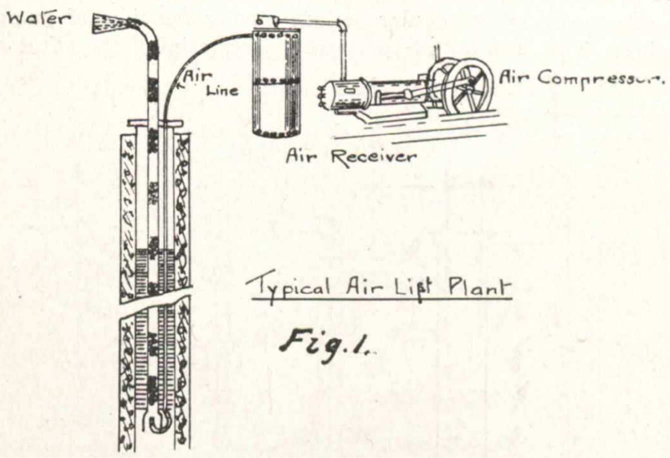
Toronto's sewage disposal system, shortly to be installed, was explained to a large gathering at the Canadian Institute on Saturday night by Mr. T. Aird Murray, C.E. Mr. Murray showed by diagrams and drawings how the system would be operated, and also told of similar works in Pittsburg and Berlin. The experts called in by the city had, he said, approved of the plans here, which he claimed, was cause for satisfaction. Mr. Murray took credit for having advised the city to adopt such a system years ago.

PUMPING WELLS BY COMPRESSED AIR FOR WATER SUPPLY AT PALMERSTON, ONTARIO.

O. W. Smith, A.M. Can. Soc. C.E.*

The Air Lift.

The air lift as a pumping device was probably first used we are told, at least experimentally, as early as 1797. Patents of the contrivance have been taken out from time to time in America, but not until late years has it been brought into practical use. Little accurate scientific knowledge was obtained regarding the method up to a few years ago. Investigators during the past few years have taken the matter up,



Typical Air Lift Plant

Fig. 1.

and acquired many valuable facts regarding it, but as the most thorough of the tests have been made by companies, having patents on the market, or manufacturers of air machines, their conclusions and deductions have not become widely known by the engineering profession.

The theory of the operation of the air lift has been fruitful of much discussion, and the principal of its working has been variously stated.

The principal of its action is generally conceded to be due to the lessened specific gravity of the water, in which the air is contained in considerable quantities, or through which it is rising in bubbles.

The following description of its operation, as abstracted in the "Canadian Engineer"' from tests made by the Westinghouse Air Brake Company, of Pa., gives a clear description of its action.

As the compressed air enters the discharge pipe, slightly above the pressure corresponding to the hydrostatic head, the column of water is forced upward. Air continues to enter, filling up the space left by the rising body of water, until the top of the water column reaches the discharge opening (Fig. 1). The moment that a portion of the rising water is discharged, the weight of the column is thereby reduced and the air below will correspondingly expand, reducing the pressure on the water at the base of the discharge pipe below the air inlet. The weight of the water outside the eduction pipe then forces the water up into the discharge pipe stopping for a moment the inflow of air.

The pressure of the air is quickly reinstated from the supply, so that it again forces an entrance into the discharge pipe. This is repeated until the whole eduction pipe is filled with alternate bodies of water and air rising to the discharge, the combined weight of which is enough less than the water in the well ouside the discharge pipe to keep up a continuous flow from the free opening.

As each body of air rises, the total weight of water above it grows less, and it consequently expands, until it reaches the surface where it discharges at atmospheric pressure.

In this way a continuous flow of water is maintained from the well, as long as a sufficient quantity of air is supplied, and the capacity of the well is not overtaxed. Several methods of applying the air have been used as illustrated by the accompanying views.

* Of Galt & Smith, consulting engineers, of Toronto, Ont., and Vernon, B.C.

Methods No. 1 and 3 are the most commonly used. The well casing if in good condition may also serve as the eduction pipe, provided proper ratios of air pipe and discharge pipe can be obtained. (Fig. 2.)

It is maintained that one method is as efficient as the other, but some investigators claim that the first method is more efficient because in it the column of water is offered no impediment to its free discharge, the area of available section is greater, and the friction correspondingly less.

It may here be noted, however, that method No. 3 is the most convenient for altering the air line to suit any change in the conditions of the well. Providing the eduction pipe is long enough, the air line may be altered to suit a variety of submergence ratios without lifting the discharge pipe.

Especial advantages have been claimed for various types of air nozzles for releasing the air at the bottom of the pipe. These have been of many forms, including a perforated head or slotted pipe, a contracted nozzle turned upward or downward, etc.

No reliable or accurate data relative to their advantages, if any, over the plain open pipe, are yet obtainable. At the present time probably the majority of applications are from the open pipe only.

The size of air pipe depends upon the quantity of air required, its pressure, and velocity. These in turn depend upon the quantity of water to be raised and the amount of lift, and distance of well from compressor.

The drop in air pressure resulting from friction should be kept as small as possible to insure economical operation. The air piping should be so proportioned as to have not more than 5 per cent. frictional loss. The size of the eduction or discharge pipe will of course vary with the quantity of water to be delivered. The friction in the pipe of maximum discharge should not consume more than a few feet of head, and the velocity of the water ordinarily should not be over four feet per second.

The following table is submitted as approximating to the proper sizes of air and discharge pipes, corresponding to various charges.

Table 1.

Dicharge gals. per min.	Size of discharge pipe	Size of air pipe
135	3½ inches	1¼ inches
180	4 "	1½ "
280	5 "	2 "
460	6 "	2 "

The depth to which the air pipe is submerged and the consequent pressure of the air required has an important

AIR LIFT PUMPS
Showing Methods of Applying the Air

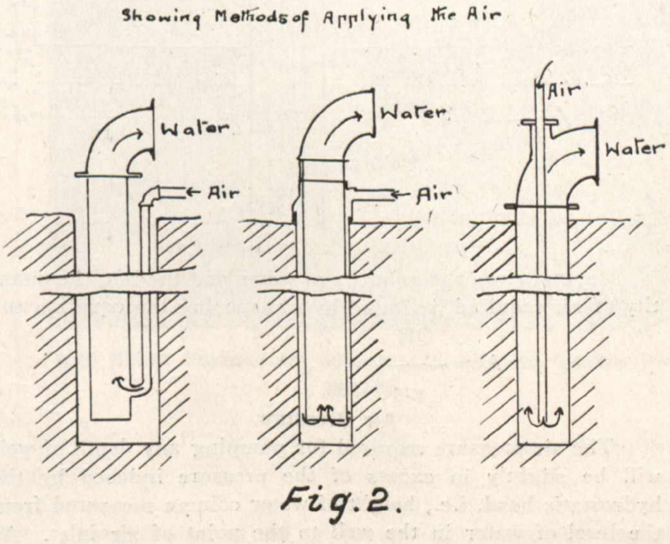


Fig. 2.

bearing upon the efficiency. The result of tests which have been made show that the quantity of air used per gallon decreases with the depth until a minimum is reached, when it begins to increase. This point of minimum air consumption is the proper submergence, and is usually taken from

55 to 65 per cent. of the total length of air and water column.

The submergence is usually expressed, as the ratio of the portion of air pipe submerged to total height of the air and water columns, measured from the point of its application to its free discharge into the atmosphere.

Air Consumption.

The formula commonly used to determine the various factors of the air lift problem, is stated thus in Turneaures and Russill's Public Water Supplies:—

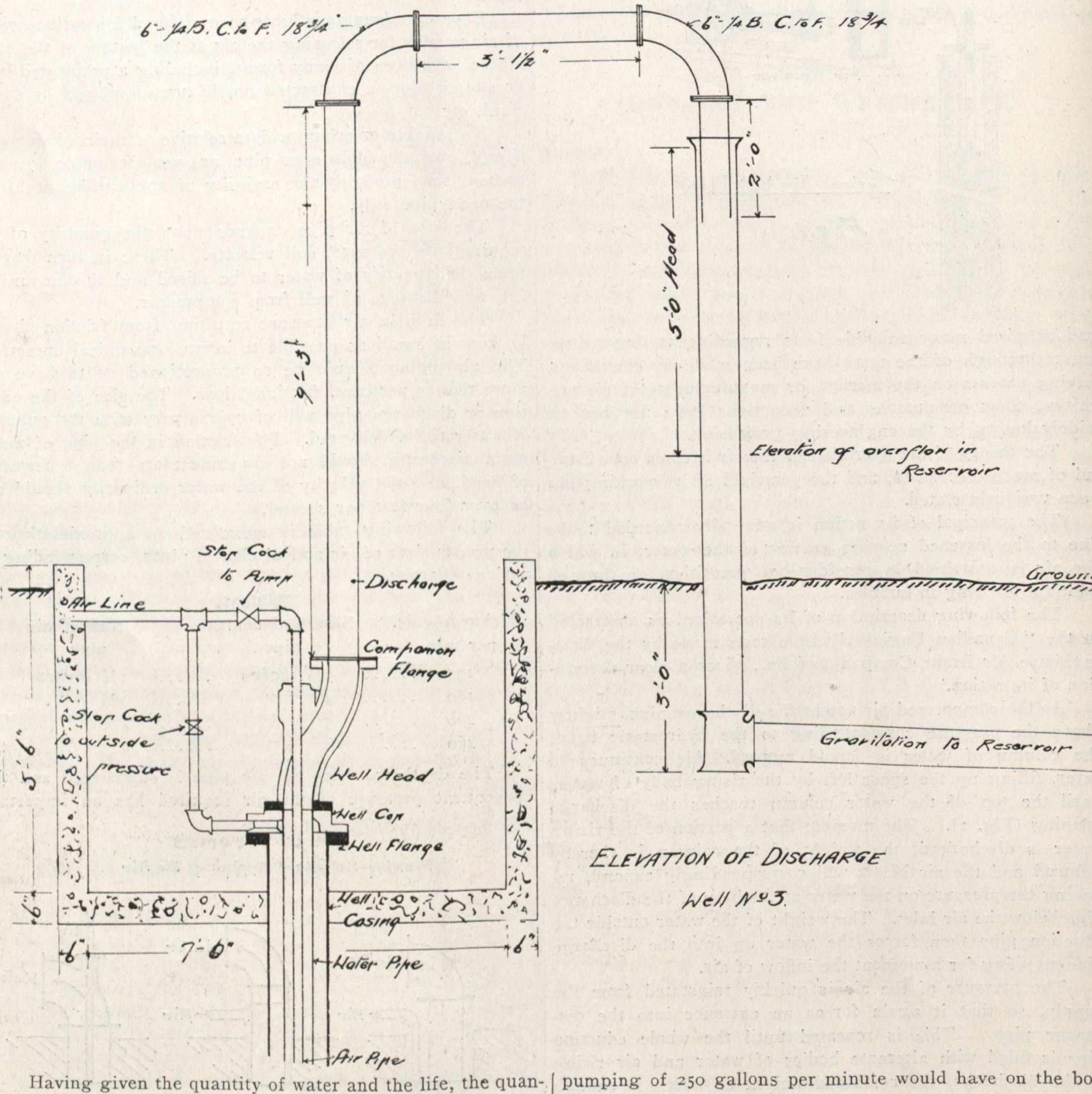
$$Q = \frac{125\ A}{H}$$

In which Q = gallons per minute.
A = cubic feet of free air per minute.
H = Amount of lift in feet.

This underground supply is tapped by two 8-inch wells drilled to a depth of about 300 feet below the surface. Water is encountered about 150 feet from the ground level and it rose to within 16 feet of the surface, before reaching its static level.

Under a ten hour's test with the air lift these wells each developed a discharge of 250 gallons per minute, the water level in that time dropped from 16 feet to 40 feet below the ground surface. For the last five feet this drop in water level was very slow and uniform, and when at the depth of 40 feet below ground the water level remained practically constant with a discharge of 250 gallons per minute from each well.

The wells were also tested singly and the water level was measured at regular periods during the time of pumping. This was for the purpose of ascertaining the effect of



ELEVATION OF DISCHARGE
Well No. 3.

Having given the quantity of water and the life, the quantity of air required, is found by transposing the equation to:

$$A = \frac{QH}{125}$$

Air Pressure.

The air pressure required for pumping any depth of well will be slightly in excess of the pressure induced by the hydrostatic head, i.e., height of water column measured from the level of water in the well to the point of air inlet. As the ratio of lift to submergence increases the air pressure decreases.

Palmerston Plant.

The water supply at Palmerston is taken from the underground limestone strata.

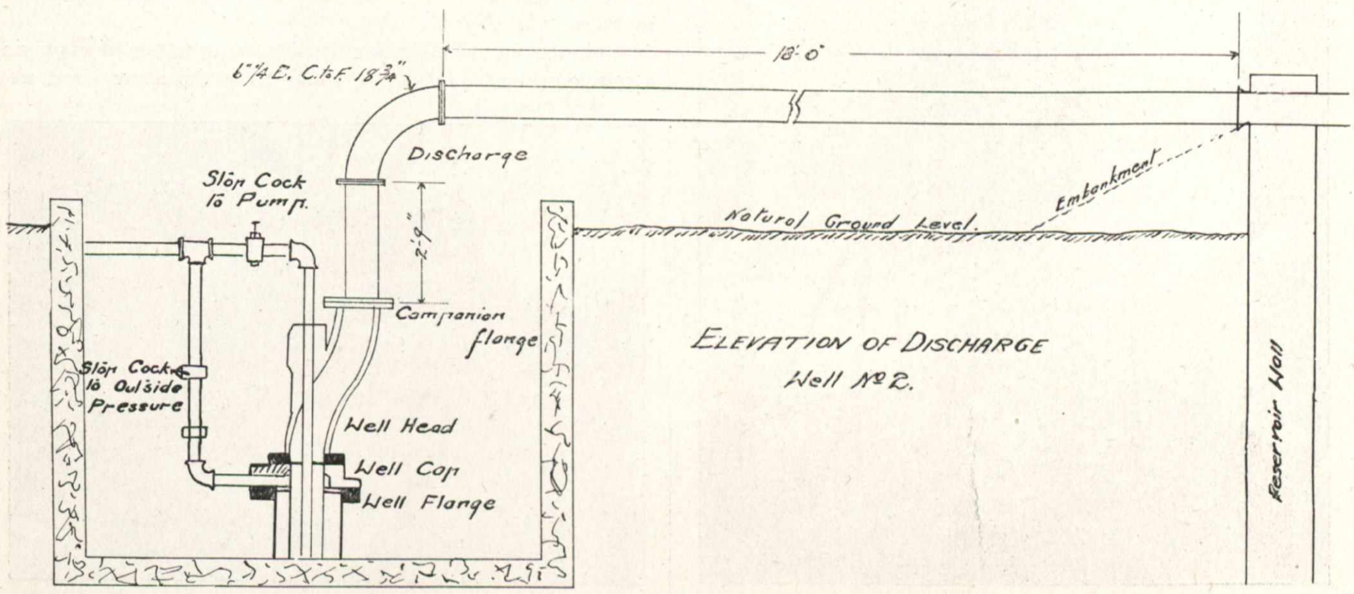
pumping of 250 gallons per minute would have on the body of underground water.

The water level in the well, which was located over 200 feet away from the one which was being pumped, fell regularly during the operation, but maintained a level 10 feet higher than the one in operation, showing that this was the head necessary to force the water being pumped through the sub-strata surrounding the well for a radius of 200 feet.

From this the advantage of locating the wells at some distance apart is evident.

The complete layout of the system is shown by the accompanying plan. Both wells are pumped by the air lift, and delivered into a concrete storage reservoir, 42 feet diameter and 10 feet deep, containing 100,000 gallons of water. Well No. 2, which is close to the side of the reservoir delivers directly into it. Well No. 3 discharges into the open end of an upturned 8-inch pipe and is gravitated back to the reservoir.

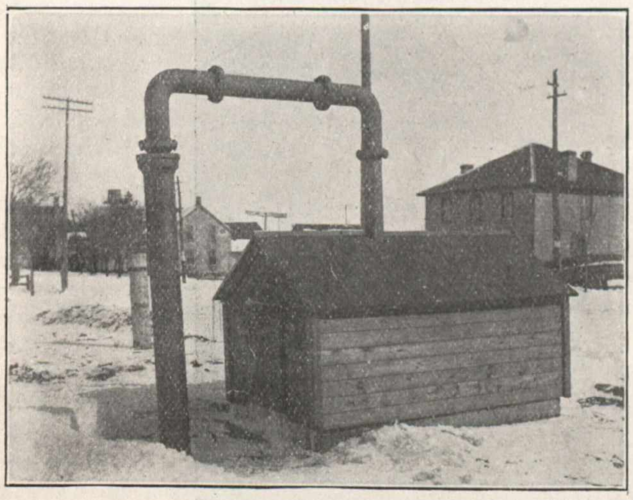
The horizontal discharge from the air lift should not be greater than 30 feet. For this reason, it was necessary to gravitate the water from well No. 3 to the storage reservoir. To provide the head necessary for this and to take care of the splashing which it was foreseen would occur, in the upright pipe, the height of the discharge of well to No. 3 is made 5 ft. above the level of the overflow point of the reservoir. An 8-in. return main takes the water from this well and



also serves as a supply pipe from the stand pipe to the concrete reservoir. By an arrangement of valves, as shown, the storage water in the stand pipe can be connected with that of concrete reservoir and both used for fire service when required.

From the concrete reservoir the water is pumped into the distribution mains and stand pipe by a compound duplex direct acting pump.

The air lift apparatus installed in the wells consists of a 5-inch eduction pipe placed inside of the 8-inch well casing, and screwed to a patent well head which is connected to the well casing by special flanges. The air line is 1½-inch pipe



Discharge Piping of Well No. 3.

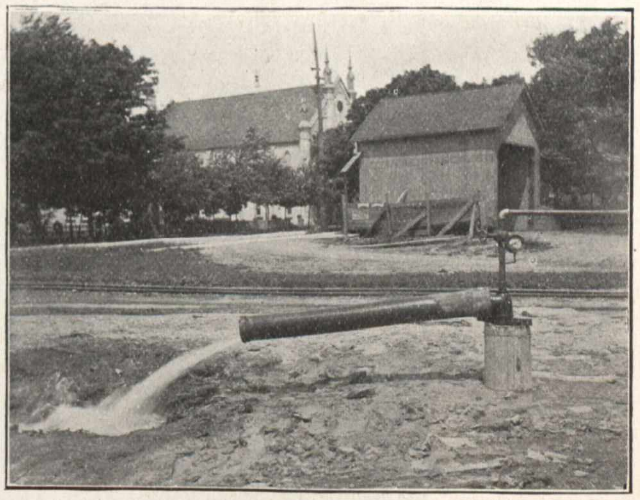
placed inside the eduction pipe, and is provided with a patented air nozzle, consisting of perforated brass cylinder. attached to the end of air pipe in the well. (Fig. 3.) An air by-pass is taken of the main air line and keeps air pressure on the surface of the water between the discharge pipe and well casing. This is for the purpose of preventing the air surging up between the discharge piping and well casing.

The air discharge or outlets were placed at the same level in both wells, and are each about 100 feet below the ground surface. As the water level in the wells is a varying quantity during periods of pumping, it was not possible to obtain a ratio of absolutely correc submergence for all conditions, but it was found that a 60 per cent. submergence figured for a water level of 38 feet below the surface gave satisfactory results in both wells. The compressor is a compound duplex machine with 12-in. horse-power steam cylinders, 16-inch horse-power steam cylinders and duplex air cylinders 12 inches diameter with strokes of 12 inches.

The compound duplex pump has horse-power steam 10-inch diameter low pressure steam 16-inch duplex water plungers 12 inches diameter with stroke of 12 inch. Both machines run condensing, being supplied wih a Burnham surface condenser, with combined air and circulating pumps. The surface condenser uses the water from the storage reservoir for cooling water, before it is pumped to the stand pipe.

The whole pumping plant, including the device for air lift in the wells, was supplied by the Canadian Rand Company, of Toronto.

The compressor is supplied with an air receiver from which the air pipes are led to the wells. From this receiver, which is placed in the pumping station close to the compressor, a two-inch air pipe is laid to the most distant well,



Well Being Pumped by Compressed Air, 200 Gallons Per Minute.

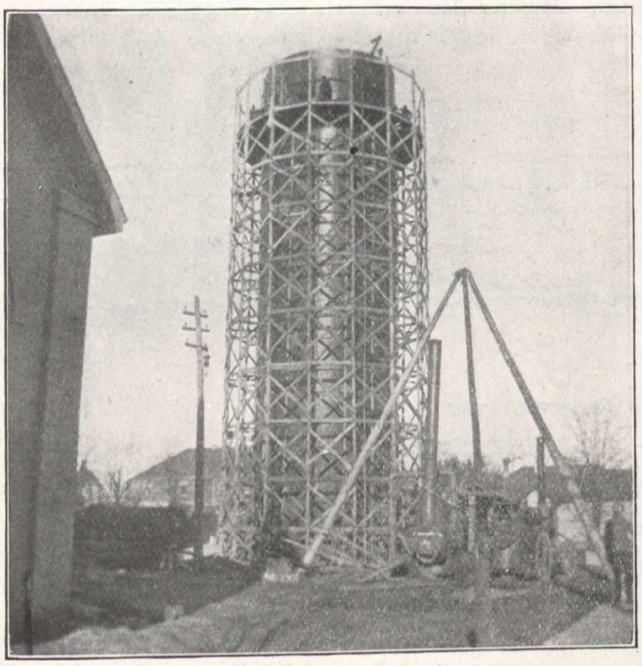
to reduce the fiction loss in the pipe. The balance of the air piping is 1½-inch diameter.

Tests.

Several tests of the operating efficiency of the pumping plant were made, and it was found that when both wells were discharging collectively 450 gallons per minute into the reservoir, under an average lift of 39 feet 0.38 cubic feet of free air per gallon was required. This is assuming the volumetric efficiency of the compressor to be 80 per cent.

When the compressor was running condensing with 20 inches of vacuum, a duty of 16,000,000 foot lbs. per 1,000 lbs. of steam was developed for the pumping apparatus including the compressor. The air pressure in the air reservoir ranged from 31 lbs. at starting to 27½ at the end of a two hour's test.

In starting pumping operations air was admitted at first slowly to the wells, the valves on the air lines being only



Stand Pipe 20 Feet, Diameter 100 Feet High During Erection

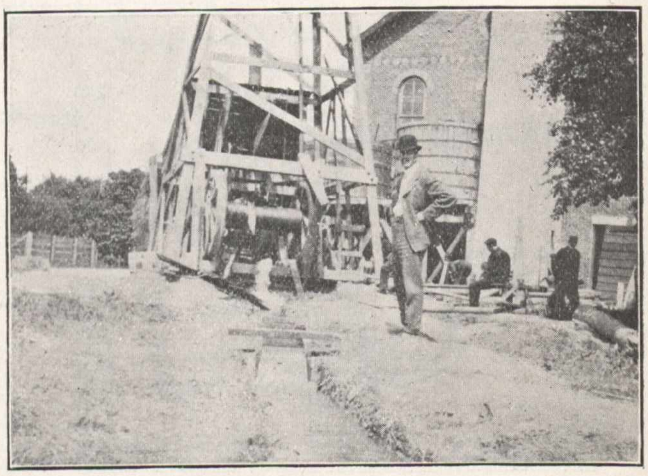
opened a small amount, allowing the air to gradually build up the pressure required. After the elapse of a few minutes the water comes with a great rush, after which pumping operations continue more uniformly. If insufficient air is admitted an intermittent flow will result; the valve should then be opened gradually, until the flow becomes continuous and this is the proper position in which to leave it.

The next care is the proper propotioning of air and discharge pipes and the selection of the correct ratio of submergence of the pipe in the water to the total average lift.

The most efficient scheme is the straight lift either to the surface or elevated tank, all long horizontal work being as far as possible avoided.

In the air lift pump the ultimate efficiency is necessarily low on account of the many transformations of energy and its poor method of application. One of the principal losses is due to a slip back of a portion of each layer of water in the discharge pipe. Each change in diameter of pipe or irregularities due to joints or curves appears to materially increase this slip.

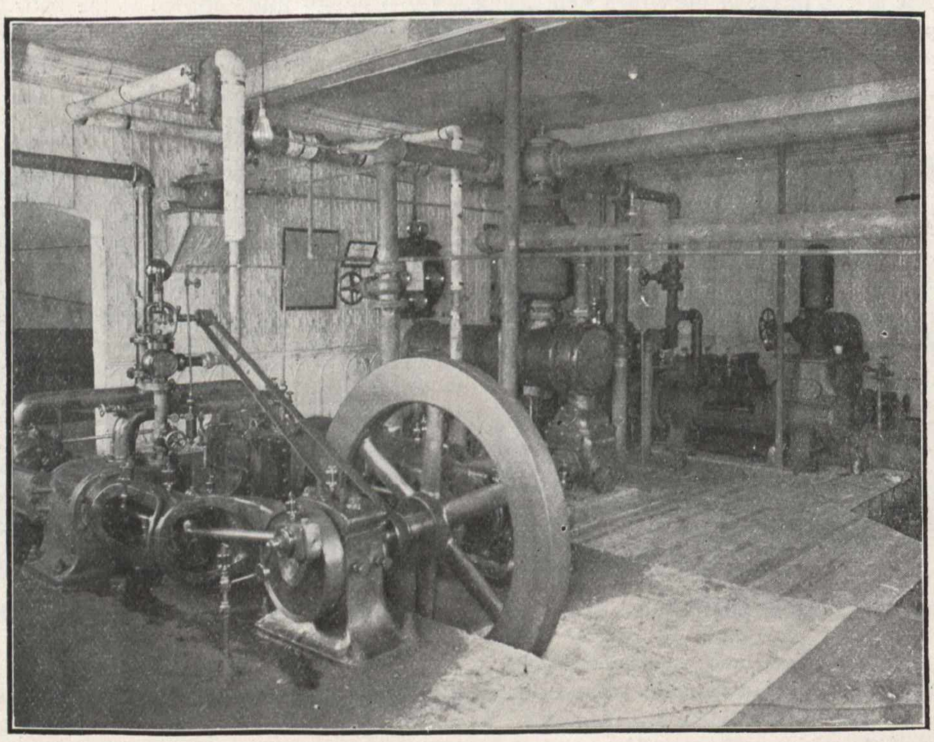
The economy in the air lift lies in its power of supplying a much greater quantity of water from the same sized well,



Pumping Well No. 3 Discharging 250 Gallons per Minute, and Measuring Weir in Foreground.

than deep well pumps, except in cases of low submergence when it would be unwise to adopt this method.

There is also economy in the absence of working parts down in the well, thus saving the frequent repairing and replacing common to ordinary deep well pumps, and much loss of time and money. In certain cases there is also great



Pumping Plant Showing Compressor, Pump and Condenser.

The cost of delivering the water depends in the first case on the efficiency of the air compressor, and it is important that the compressor should be carefully designed with properly proportioned valves, and air ports to keep the volumetric efficiency high, and the air as cool as possible.

advantage in being able to operate wells placed at some distance apart, from one central air plant.

Properly installed and properly looked after it represents, under certain conditions, the least troublesome and a very desirable system of obtaining water from deep wells.

BEARING POWER OF PILES.

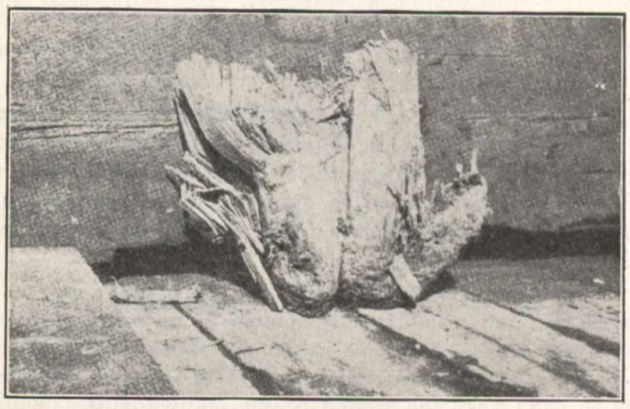
M. C. Hendry, A. M. Can. Soc., C.E.

The bearing power of piles is a very difficult quantity to estimate. In actual work the "unknowns" are so great that it is usually an estimate only. The driving of piles cannot be reduced to an exact science, for this work it is hard to specify.

Driving Specifications.

One railroad specifies that "the piles shall be driven until they will not move more than one inch under the blow of a hammer weighing 2,200 lbs., and falling a distance of 25 feet at the last blow." Some specify a penetration of as low as ½-inch from a blow of 2,500-lb. hammer falling 20 feet.

There is always the danger in hard driving of crushing or crippling a pile so that it is better not to punish a pile too severely. The present opinion regarding the weight of the hammer is that it is better to drive with a heavy hammer falling a short distance than with a light hammer falling a great distance. While, of course, there is often a great variation in the length of piles used in any one piece of work and a consequent variation in the weight of the piles, a general rule is that the hammer should weigh twice as much as the piles. The Boston and Maine Railway specifies a 2,600-lb. hammer falling 15 feet, and giving a penetration not exceeding 16 inches in the last ten blows. In a great number of cases it has been the practice not to specify either the weight of the hammer, the fall or the penetration, but simply "that the piles shall be driven to a firm bearing to the satisfaction of the engineer. Where the work is in charge of an experienced man this is perhaps the most satisfactory method of specifying. But, on the other hand, if the engineer is not greatly experienced, and in order that the contractor may estimate closely, some definite figure should be set, but not before some determination of the nature of the soil to be encountered had been made, either by borings or by the sinking of test piles.



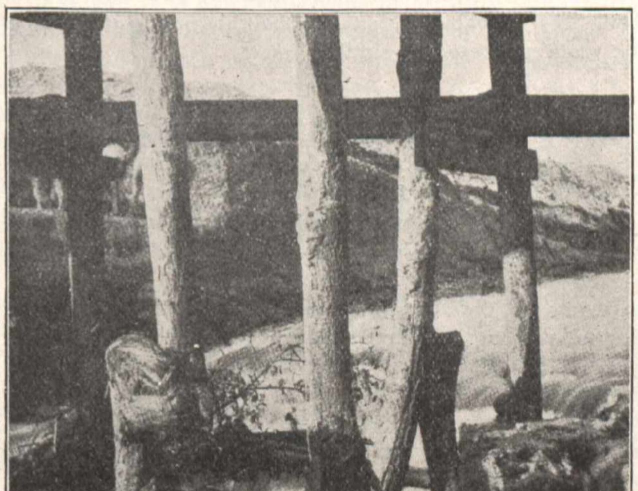
Point of Overdriven Pile.—A. R. E. and M. Ass. Report.

Action of Soil.

While piles are often used simply as columns supporting a mass of masonry and transferring the load to a firm footing upon which the lower extremity rests, deriving at the same time a certain amount of lateral support from the surrounding soil, they are sometimes used simply to make more compact the soil into which they are driven through the compression to which it is subjected owing to the displacement caused by the penetration of the pile. The bearing power of the soil is then increased about in proportion to the total volume of the piles driven over a given area. Usually, however, the piles act directly against the forces to be sustained and are held in place simply by the resistance of the soil into which they penetrate. This resistance may, under increased external forces, prove insufficient, and movement of the pile thereby results.

An instructive experiment, throwing some light on the nature of the support given to a pile by the earth into which it is driven, is to take a glass-fronted box, fill it with lightly compacted sand, and push down between the glass and the sand half-round sticks, similar to a pile in shape. This experiment discloses the fact that a compact cone of earth is formed under the foot of a blunt stick and remains there, being pushed forward through the ground as the stick descends. This cone acts exactly like the sharp end of a pointed stick or pile. It will always form under any load which soil is required to carry and, consequently, the bearing power of the latter is one of the elements helping in the support of a loaded pile. In most soils this bearing power is known to increase with increase in depth below the surface, and it would, therefore, be expected that the bearing power of a pile would increase as it is driven deeper and deeper into the ground. Therefore, if a curve be constructed showing the supporting of a pile for different penetrations, it should, according to this, start from a soil, the co-ordinate of which would be penetration = zero and supporting power = supporting power of soil at the surface and be a straight line inclined at some angle to the axes of reference depending upon the rate of increase in the bearing power of the soil.

The penetration of the stick into the sand discloses, around the pointed end, flow lines along which the earth moves as it is pushed aside and compressed by the penetration of the stick. The extent of the region throughout which movement occurs in this way depends upon the compressibility of the soil at the point. Theoretically, this compressibility should decrease with increase of depth beneath the surface, but the actual variation is so slight as in no wise to affect the supporting power of piles. The displaced soil in contact with the pile is pressed against the latter by its own elasticity and by the influence of the stresses in the surrounding earth. Theoretically, the resistance to motion of the pile from this source should increase directly as the depth below the surface, so that the curve of supporting power already described must be compounded with a second straight line starting from the origin, and slanting at a certain angle with the axes of the reference, depending upon the amount of friction observed. The actual amount of this frictional resistance varies greatly with many circumstances.



Overdriven Piles in Temporary Construction.— A. R. E. and M. Ass. Report.

The fact that piles enter loose ground and mud with equal penetration for equal blows, no matter how far driven, would tend to show that the frictional resistance was so small as not to be observable, and that the main resistance in this case was the supporting power beneath the pile. On the other hand, where the pile has been driven between stones or logs into a compact soil, the frictional resistance offered must be far greater than all other means of support. In the first case, however, the small frictional resistance may be greatly increased after a time by the compacting of the soil around the pile, either from the driving of piles near it or from the natural settlement of the soil, against the pile which had been disturbed during driving.

While a pile is supported entirely by the frictional resistance, the actual region supporting the pile is at some deep ground level to which the frictional resistance supporting the pile has been transferred through the earth in the shape of a conoid of pressure, the base of which gives the total bearing value equal to the load and a unit bearing value which the earth at the lower level will support. Each kind and degree of compactness of earth will give a different angle for the slope of the conoidal surface. When the frictional resistance is relatively small, more of the pile must be in the ground or the pile will settle through the immediately surrounding earth. Under excessive load, if the frictional resistance is high and the bearing power of the earth small, the pile will carry down the earth surrounding and in contact with it.

As the exact nature of the soil is seldom known, any assumption based upon the same would be valueless in determining the supporting power of the pile. The engineer may use any information he may have on this point only in the determination of the spacing of the piles. When the piles are held by the real bearing power of the earth they will act simply as columns and may be driven solidly. When supported by frictional resistance they must be driven to such a depth or be spaced at such a distance that the increased area of bearing developed by the conoid of pressure having he required altitude of frictional resistance meets a level which will afford the required support before intersecting the conoid of a neighboring pile.

No criterion for the supporting power could be determined with absolute certainty, because one cannot say that after whatever test may be made a pile will act, when subjected to identically the same test, in exactly the same way. The possibilities are very great, however, that if similar conditions are observed as far as possible, a pile under two similar tests will act in nearly the same manner, and with perhaps a little less probability that two neighboring piles will act alike when subjected to similar tests.

Basis of Formulae.

Since it is necessary, in the design of foundations, that we be able to assign with some degree of accuracy a value for the supporting power of a pile, and as we are unable to determine this with any certainty from the nature of the soil, the only resource to be had is from a study of the phenomena observed during driving.

Owing to the relation being one of impact to that of quiescent pressure, the determination of the ultimate supporting power of the pile by a study of this phenomena is at test quite uncertain.

A great many men have investigated this question quite deeply, and evolved formulae of greater or less intricacy, yet instead of there being an agreement among them or rather a corroboration, when these formulae are applied to a typical case, the results obtained are anything but uniform. This wide variation proves conclusively that some of the assumptions made upon which the formulae are based are seriously in error.

In speaking of bearing piles it would be well to divide them into two distinct classes. The first class would be composed of those which, being driven to a perfectly solid foundation and transferring the load imposed upon them to that support, act as pillars and hence are in reality columns and should be so named. See Fig. 15a. The other class consists of those which transfer their load to the surrounding material, through which they have been driven, by means of the friction of that material and these are what are properly termed piles. See Fig. 15b.

In a paper written by Rudolph Herring, M. Am. Soc. C.E., published by the Engineering News, he deals with the subject of sustaining power of piles and discusses some of the formulae. The following extracts are taken from that paper.

The action of a pile acting as a column and that acting purely as a pile being governed by different conditions require different theoretical considerations, and will be treated separately.

1.—**Piles Acting as Columns.**

The following is a table giving values for the safe load per square foot sectional area of column $= \frac{L}{a}$

Authority.	Values as given,		Value of $\frac{L}{a}$
Rankine and Mahan.	1,000 lbs. per sq. in.		144.000
Peronnet.	786-990 lbs. per sq. in.		113.185-142.560
Stoney.	1/10 crushing wt. of dry timber, viz.:—		
	Elm,	1,000 lbs. per sq. in.	144.000
	Ash,	860 " " " "	123.840
	Spruce,	650 " " " "	93.600
	Cedar,	610 " " " "	87.840
	Oak,	600 " " " "	86.400
	Yel. Pine,	538 " " " "	77.472

As these values ascribe a much greater bearing capacity to the piles than they can bear without sinking deeper into the ground, when friction alone is the supporting power, great care must be taken in applying them, remembering that they are only reliable when the piles act as columns and rest on a firm foundation.

It should also be remembered that the columns rest on a pointed end only which in long columns is an important consideration, and as the above values are safe crushing resistance of wood without regard to length of columns they can only be valid when the ground is sufficiently compact to prevent lateral bending of the piles; otherwise the formula for the supporting power of long columns would have to be applied to obtain the correct value.

Notation.

In the formula deduced, the letters employed have the following significance:—

Q = Extreme load (in pounds) which driven pile will sustain without sinking.
F = Factor of safety used in loading a pile.
$L = F \times Q$ = safe load (in pounds) which pile can bear.
L/a = Safe load, in pounds per sq. ft., of sectional area.
L = Safe load on test pile.
W = Weight per sq. ft. upon foundation.
w = Weight of hammer (in pounds).
p = Weight of pile.
h = Height of fall of hammer (in ft.).
l = Length of pile.
S = Distance pile sinks under last blow (in ft.).
S_1 = Distance test pile sinks under last blow (in ft.).
d = Distance in ft. C. to C. of pile if equal in both directions.
b = Distance in ft. C. to C. of pile if measured longitudinally.
c = Distance in ft. C. to C. of pile if measured at right angles to "b."
a = Sectional area of pile (in sq. ft.).
E = Modulus of elasticity of material of pile (lbs. per sq. ft.). Must therefore multiply modulus in pounds per sq. in. by 144. E then equals $1,600,000 \times 144$, a sufficiently close value for ordinary timber.
C = Coefficient of elasticity, as before $C = (3,000 \times 144)$ for ordinary timber.

Note:—Value of "a" for columns is smallest sectional area.

Value of "a" piles (supported by friction) is mean sectional area.

Formulae For Maximum Blows.

"A pile having been driven to a perfectly solid foundation, the following formulae would be useful to determine the weight of hammer necessary for a given fall or vice versa such that the material of the pile would be compressed to its elastic limit but not beyond it."

$$w = \frac{a\,l}{2\,h} \times \frac{C}{E} \qquad h = \frac{a\,l}{2\,w} \times \frac{C}{E}$$

If we substitute the values for C and E these formulae may be written thus:—

$$w = 405\frac{a.l}{h} \qquad h = 405\frac{a.l}{w}$$

Formulae for Size of Piles or Column and Disposition.

"Each column will have to support a load brought upon it by its proportion of the foundation. Supposing the column to have a sectional area a, then it will have to sustain b × c × w lbs., or $d^2 \times W$ lbs.

$$\therefore a \times \frac{L}{a} = b.c.W = d^2\,W \text{ lbs.}$$

Formulae for Size of Piles or Column and Disposition.

"Supposing columns to have any form of section, but same sectional area (a) and same sustaining powers.

Given sustaining power of column per sq. ft. $\left(\frac{L}{a}\right)$ = values according to preceding table.

Required sustaining power per sq. ft. $\left(\frac{L}{a}\right) = \frac{b.c.W}{a} = \frac{d^2\,W}{a}$

Sectional area of column a $= \dfrac{b.c.W}{\left(\frac{L}{a}\right)} = \dfrac{d^2W}{\left(\frac{L}{a}\right)}$

Wt. per sq. ft of foundation $W = \dfrac{a\left(\frac{L}{a}\right)W}{b.c.} = \dfrac{a\left(\frac{L}{a}\right)}{d^2}$

Distance from C. to C. of columns b $= \dfrac{a\left(\frac{L}{a}\right)}{c.W}$

" " " " " $c = \dfrac{a\left(\frac{L}{a}\right)}{b.W}$

" " " " " $d = c = b = \sqrt{\dfrac{a\left(\frac{l}{a}\right)}{W}}$

Piles Supported by Friction.

While, as has been stated before, there have been a great many formulae derived or compiled for determining the sustaining power of piles, some are very cumbersome, envolving, as will be seen, later, the weight of the pile and hammer, compressibility of the soil, elasticity of pile and hammer, air resistance, etc. While on the other hand, some are extremely simple. One of the simplest forms, and it might be safely said, the one most in use at least on this continent, is that known as the "Engineering News" formula. This was first brought forward about 1888 by the Engineering News after a discussion of the then existing formulae. During the following years up till 1893 this and other formulae came in for a great deal of discussion at the hands of authorities on the subject; but the general consensus of opinion has been that it is not only a simple but also a trustworthy formula.

The formula is as follows:—

M. the max. load $= 12\dfrac{w.h}{s+1}$. Where w is the weight of the hammer expressed in some unit, h is the fall of the hammer in feet, and s is the set of the pile in inches under the last blow, (this is determined by taking the average set under the last four blows). To obtain the safe load L = by this formula the factor 6 is applied when $L = \dfrac{M}{6} = 2\dfrac{w\,h}{s+1}$.

See figure for application of formula to test pile.

Discussion of Formulae.

Rudolph Herring, M. Am. Soc. C.E., in a valuable paper on bearing piles, has tabulated some 14 different formulae attributed to 10 different authorities, and when these are applied to find the bearing power of a single pile, using the same data for each, 14 different results are obtained. (See table).

Mr. Foster Crowell, discussing this table in the Engineering News of October 27th, 1892, says: "It is evident from an inspection that the authorities, as has already been stated, differ not only as to safe loads, wherein there is reasonable room for such divergencies, but also to a very marked extent in the theoretical, extreme, sustaining power. But if we look a little closer at the forms of the formulae, we see why such variations occur, and may perceive that if we had taken some other case with a different weight of hammer and a different fall, we should have obtained another, and quite different, set of variations.

All formulae are based upon the mechanical principle of accumulation of work. If we could eliminate the elasticity and compressibility of the hammer, pile and soil and, neglecting the consideration of their relative weights and resistances to the motion of the hammer, regard it as a question of dynamics, then the theoretical sustaining power of the pile might be expressed as follows:—

$$F = \frac{\text{weight of ram} \times \text{fall.}}{\text{space hammer moves through after reaching pile.}}$$

This is, of course, impossible owing to the complex case of impact and also the difficulty of applying principles to the working conditions. The authorities have sought in various ways to overcome the difficulty and obtain a form which would cover all cases, and this has led to the neglecting of the various considerations, such as compressibility, weight of piles, hammers, etc., in some cases, and considering them in others, and this is the cause of the difference in results obtained."

It is evident that however interesting and involved the theoretical study of this question may be, a working formula should contain only those essential factors which can be readily obtained with reasonable correctness in the case of any pile, and it is not worth while or sensible to waste time refining a result beyond the refinement of the data. The Trautwine Formula takes no account of compressibility, weight of pile, or directly of frictional resistance to fall of ram, but considers the work done by the ram to vary as the cube root of the fall. While there is justification for this assumption in dealing with average falls based upon air resistance and greater impact losses, the allowance would appear to give too low values for higher falls and excessive results for low ones.

Owing to the necessity of treating piles individually in order to obtain the same bearing power for each pile in a group under varying conditions, the form of the working formulae, to obtain rapid and accurate results should be simple and involve only such data as may be easily and correctly obtained from each pile, so that it may be applied without delay to the driving.

The only data that can be readily obtained are weight of hammer (w), height of fall (h), and penetration per blow (s).

Discarding all working formulae, excepting those envolving only the foregoing data, we may select from the list of formulae the following forms in which the notation is all the same.

w = weight of hammer in pounds.
h = height of fall in ft.
s = penetration under last blow in inches.
F = working factor.
L = load in pounds.

(1) Weisbach's formula, known in America as Sander's.

$$L = F\frac{w.h \times 12}{s} \quad F = \tfrac{1}{8} \text{ to } \tfrac{1}{5}.$$

(2) Trautwine's formula—pile assumed to sink appreciably under last blow, say a few inches.

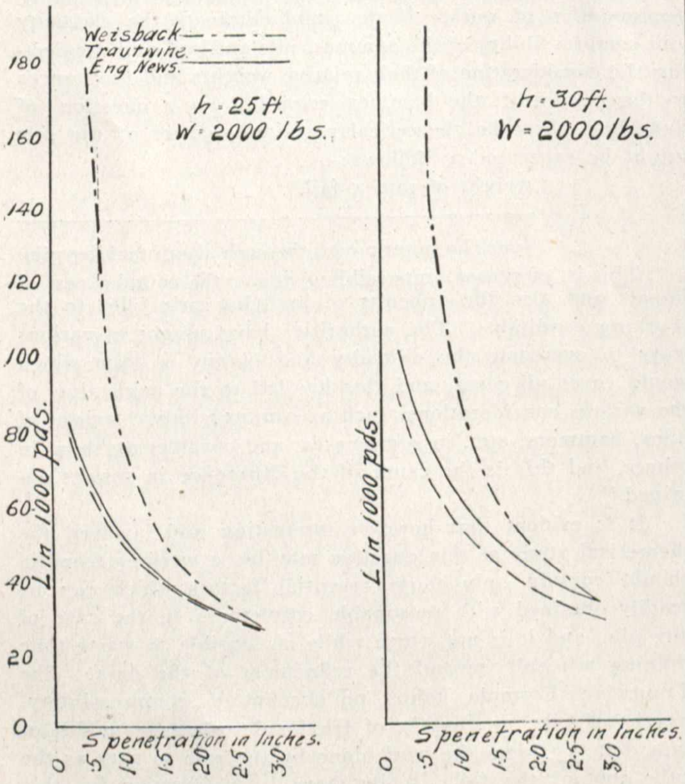
$$L = F\frac{\sqrt[3]{h} \times 50\,w}{s+1} \quad F = \tfrac{1}{3} \text{ to } 1/12.$$

(3) Engineering News—as given before.

$$L = \frac{2\ w.h}{s + 1}$$

Comparison of the Three Forms.

In order to readily compare the results obtained under varying conditions, the curves have been prepared exhibiting the respective values of safe static loads as obtained by the three formulae in four cases of varying height of fall, with penetrations ranging from ¼ inch to 3 inches under constant weight of ram. Were it not for the presence of the cube root in the Trautwine formula, one case instead of four would have been sufficient for comparison. Even within the com-



paratively limited range of fall this factor has not a small effect upon the results obtained as evidenced when the curve is plotted.

The curves are plotted to absissas of penetration in inches and ordinates of working loads. Owing to there being an earlier form for the Trautwine formula, which had a higher coefficient and a maximum factor of ½ two Trautwine curves are plotted, the lower values being obtained from the latest form.

By a comparison of these curves, which is very instructive, we are struck by two considerations, first that when the values of s are less than 1 inch there is a noticeable approach toward agreement between the three formulae; second, where the value of c in the Engineering News formula is 1, and not the proposed 0.3, which was suggested by Mr. Crowell in his discussion of this form, as the values of s become smaller and smaller the values for L obtained are more and more conservative. From an observation of the curves, one would be lead to the conclusion that the experiments governing the formation of the equations were within a narrow range of falls. Comparing the three curves thus obtained the conclusion seems fair that, in view of the simplicity of the Engineering News Formula, and its results compared with those obtained from the Trautwine formula, it is a better formula than the latter and is also quite as convenient as the Weisbach or Sanders, and gives more conservative results But where a penetration is less than 2 inches, there is little to choose between the results obtained from any one of the three.

Note:—When a steam hammer is used instead of a drop hammer 0.3 is used instead of the constant 1.0 in the formula.

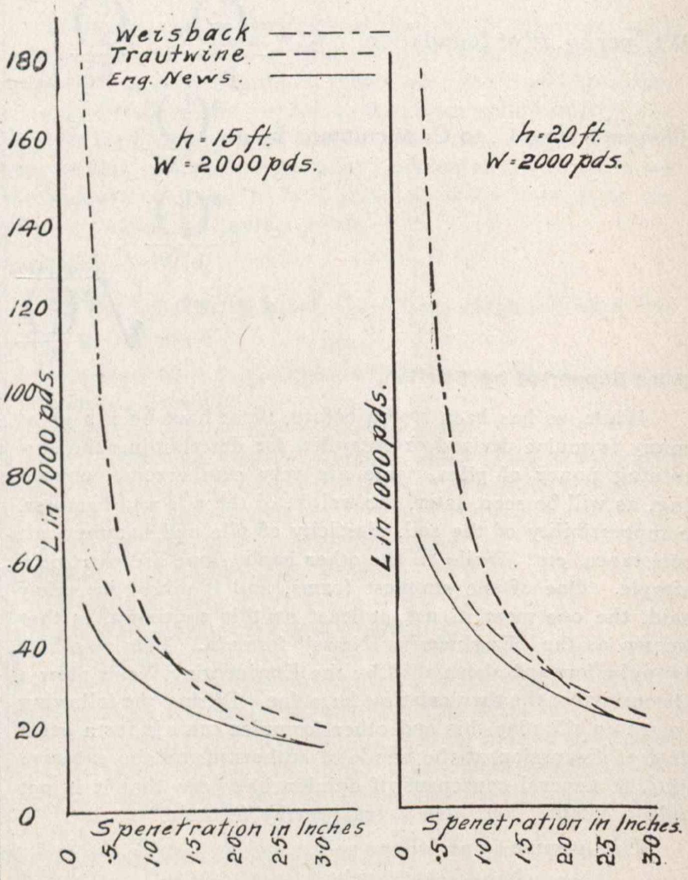
As to Application.

In applying these formulae to obtain the bearing power of a pile, care must be exercised that the conditions as represented by the data are as nearly correct as possible. For instance, as the weight of the hammer and height of fall are important factors in obtaining the result, and if in driving the hoisting line remains attached to the hammer, this has a very material effect upon the force of the blow delivered, some authorities giving it as having the same effect as reducing the free fall of the hammer by one-half.

In connection with the application of the formulae, outside of tendency to error due to bouncing, attached line, etc., which have been mentioned, there are some curious results obtained.

Cases have come under the writer's notice where piles, driving hard in clay and giving small final penetration, have failed under loads much below the calculated safe load. The only cause that could be ascribed for this was the nature of the clay, it being of a stratified nature and supposedly water had found its way between the strata to the pile and, acting as a lubricant, had destroyed its supporting value.

Driving in a mixture of clay and quicksand has brought to light some strange facts. In driving piles for the Toronto and Northern Ontario Railway roundhouse at Englehart, Ontario, quicksand was encountered. A hammer weighing 2,600 lbs. and falling 25 feet gave a penetration in this material of from 2 to 5 feet, but on raising the hammer the pile followed it up until the penetration was reduced to not more than 2 inches. Different methods were employed to keep



the pile in place after being struck by the hammer, the most satisfactory way being to chain the pile when driven to an adjacent one, which had its final set, before raising the hammer. By this means the desired penetration was obtained, and after a pile had been held in place by the chains for a period of twelve hours it was found that on releasing it, it not only showed no tendency to rise but any attempt at further driving only resulted in damage to the pile.

Brooming at Head of Pile.

The condition of the head of the pile has a very great effect upon the results obtained in driving. Owing to the repeated blows delivered upon the head of the pile it very rapidly becomes crushed or broomed as it is called. In order to overcome this effect or loss of energy, various methods are resorted to; but first of all, before driving, the head of the pile should be squared off. In the case where the steam hammer is used a cap or dolby is placed over the head of the pile after it is placed in the leads, upon which the blows of the hammer are delivered. But where the ordinary drop hammer is used, what is known as a pile ring is most frequently made use of. This is a heavy iron ring from ½ to ¾ of an inch in thickness, and from 2 to 3 inches wide, and about 12 inches in diameter. The head of the pile is trimmed down so that the ring fits snugly, when it is driven on. This prevents brooming to a large extent, and as the ring is easily removed after the pile is driven, and so may be used on a number of piles, it adds very little to the cost. That brooming has a very material effect upon the effect of the blow delivered by the hammer is readily seen by a glance at the table compiled by D. J. Whittemore, published in the transactions American Society, C.E., Volume XII., page 441, 1883. The data tabulated is that relating to the driving of a Norway Pine pile (green), driven by a Naysmith Steam Hammer. The ram weighed 2,800 pounds, and dropped 36 in. 65 times per minute. The total number of blows necessary to obtain the desired penetration for this pile was 5,228 as compared with 9,923 blows required for another pile driven at the same place and under the same conditions, but not having the head adzed or sawed off during the driving.

Brooming at Foot of Pile.

There is also brooming at the foot of a pile to be met with and, while it does not diminish the energy of the blow of the hammer as is the case in brooming at the head, yet the energy is expended without proper results. The only remedy for this is to stop the driving as soon as it is detected, which can generally be done by a skilled pile driver; and as no direct provision can be made against this in a formula, the factor of safety employed must take care of it.

Final Penetration.

Since the values for supporting power depend greatly upon s, the final penetration of the pile, in many cases, the tendency has been to make this a minimum. There are several very serious objections to this and the first is the great difficulty to accurately measure the final penetration when it is small, while some writers have called for a final set of as low as ⅛-inch, yet most authorities unite in saying that the measurement of anything less than ½-inch is so liable to error that it should be entirely disregarded and a value s = 0.5 taken. Where final penetration is specified, it is generally to be obtained by taking an average of the penetrations due to the last four or five blows.

Again, where the penetration under the last blow is small, the effect of the last blow or those giving small penetrations is to be regarded with suspicion, especially if the piles are of soft wood, because, according to a table given before, the crushing strength per square inch for ordinary pile timber is very nearly approached by the force of a blow (per square inch) necessary in most cases to give this penetration. Cases are continually coming up where, on uncovering piles, it is found they have been overdriven. One case of this came under the writer's notice, and while he cannot give the final penetration, they were driven under specifications calling for a final penetration of not more than 1 inch under a blow from 2,200 lb. hammer falling 25 feet. The piles were Tamarac and ranged from 10 to 12 inches in diameter at a point 1 foot below the point of rupture. They ranged in length from 40 to 50 feet, and were driven in clay to a depth of 30 to 35 feet.

A. M. Wellington in his pamphlet on Piles and Pile-Driving, page 115, claims that in driving in most kinds of materials a pile will drive better, truer and nearly as rapidly if merely cut off square at the lower end than if pointed, corroberating the claim of Robt. L. Hanis, Member American Society Civil Engineers.

Loss Due to Friction of Guides.

As was stated before, the loss due to friction of the hammer against the guides was neglected as being too small to materially effect the result, and also that due to air resistance which is for a fall of 30 feet calculated to be about 1/1,000 of the weight of the hammer. That the former may be safely neglected is illustrated by the accompanying table. It gives the number of blows necessary to drive each pile in four bents of a pile trestle, each bent having four piles and two piles in each bent being driven on a 2-inch batter, the guides of the driver being inclined to accomplish this. A study of the table will show that while there was an increased number of blows in the batter piles in some cases where was also quite as great a decrease in others, which would lead to the conclusion that the increase was due rather to the nature of the soil in which they were driven than to the loss of energy of the hammer due to friction in the guides; also that in all except one test that batter piles were given a greater penetration where there was an increased number of blows.

Before leaving the subject of bearing power of piles it would be well to look at one formula which, instead of using final set, weight of hammer and height of fall as elements of the formula, makes use of the superficial area of the pile, friction of soil, etc.

The formula was mentioned by R. B. Davis, Member American Society of Civil Engineers, in a discussion published by the Association of Engineering Societies, June, 1903. He ascribes it to Mr. W. M. Patton, and it is of this form:—

$$S = \frac{W - P}{F.}$$

Where S = number of sq. ft. of surface of pile in contact with soil.
W = load of pile.
P = bearing power of pile or resistance to settlement.
F = friction of soil on superficial area of pile.

He gives values for P which vary from 5,000-6,000.

For dry gravel and for silt F = 0. pounds per sq. ft.

For soft semi-liquid soils F = from 100 to 300 pounds per sq. ft.

For mixed earth and gritty soil F = from 300 to 500 pounds per sq. ft.

For clay, sand and gravel, F = 400 to 600 pounds per sq. ft.

Where such a wide range of variation is given for the different soils, and since in a great many cases soils act in a totally unexpected manner, it would seem rather a poor substitute for a formula in which some fairly reliable information obtained from driving the pile is used in determining its bearing value; for instance, where final set, fall and weight of hammer is the data upon which most formulae are based.

Observation on Driving with Steam Hammer.

The following is from a paper by J. J. Welsh, Member of Technical Society Pacific Coast, read before Association of Engineering Society, May 27th, 1904.

The test was made to determine ground liable to be encountered and results obtained. The driving took place in San Francisco at the south-east corner of Spear and Market Streets, upon ground known as made ground, this having been at one time part of the bay.

From enquiry among engineers and pile-driving firms, it became evident after six piles had been driven that in this area the ground was of a more yielding nature than that of the surrounding district, which might be explained by the manner of filling. At the time this was done the houses occupying the site were built on stilts so that in filling the material was dumped around the stilts.

Owing to the nature of the building, it was necessary to determine carefully beforehand the resistance of the piles liable to be met with so that test piles were driven in a number of places to determine the soft spots. One was driven as far as 105 feet without finding a hard resistance, while another under the last two blows given sank 1 foot. On the next day it required 16 blows to sink it 1 foot, the first three blows having no apparent effect.

A third test was then made in order that the conditions such as would exist in the case of a pier might be obtained. Eleven piles were driven in a trench, the four outer ones being left about eighteen inches above the rest. This was done in order that the load might be placed on only four piles, while at the same time obtaining the benefit of the consolidation of the surrounding ground by the rest of the piles in the group.

The piles were of Oregon pine, 70 feet long, and were from 12 to 14 inches at the butts, and 6 to 8 inches at the small ends or points. The test piles were spaced 4 feet 8 inches on centres for the short span, and 7 feet 1 inch for the long span. On top of the four piles were set four steel plates 14" x 14" x 7/8", and on top of these were placed two 15 inch I-beams weighing 1,000 pounds each, bolted together to each set of piles in the long span and upon these were placed eleven I-beams weighing 1,000 pounds each which formed the platform. On this platform pig-iron was piled. Before placing the platform and pig-iron, levels were taken and bench marks established. The pig-iron was brought to the ground in trucks, each load being weighed on public scales before being delivered.

The table gives:—(1) The conditions and results for each of the four piles (actual loads and settlements). (2) The calculated safe load for each by three well-known formulae; and (3) the extreme load by the Trautwine formula, whch is the only one giving extreme load defined by Trautwine as the load that will be just at the point of causing more sinking The three formulae are:—

Sanders—$p = \dfrac{12\ wh}{8s}$

Engineering News $p = \dfrac{2\ w\ h}{s\ c}$ where c for drop hammer = 1, and where c for steam hammer = 0.1.

Trautwine $P = \dfrac{s\ 1.\ s\ 2\quad w\ h}{s\ 1}$

Where P = the extreme load on one pile in pounds.
P = the safe load on one pile in pounds.
w = weight of the hammer in pounds.
h = fall of hammer in feet.
s = final penetration in inches.

The steam hammer used with piles No. 3 and No. 4 was known as No. 1, the heaviest made, total weight 9,850 lbs., length 12 feet, diameter of cylinder 13½ inches, normal stroke 42 inches, weight of striking part 5,000 lbs., distance between jams 20 inches, width of jaws 8¼ inches.

The machine struck between 65 and 85 blows per minute. For piles No. 1 and No. 2 a drop hammer was used weighing 3,080 pounds, the fall being varied for each of the piles. The table gives height of final fall and final penetration.

Note:—That in pile driving in places where quicksand is encountered, it is often found that the penetration of a pile under the blows of a hammer of from 2,200 to 3,000 lbs., and falling from 15 to 20 feet is practically unappreciable. In other words, if the general specifications are accepted as correct, the pile has been driven to refusal; yet, if this pile is in a structure subject to vibrations, as would be the case in a trestle for a railway, it will almost invariably sink under the load.

Again there are cases where piles have been driven where the penetration per blow has been as high as a foot to two feet for the last blows given, and yet have shown under load no apparent settlement.

Mr. James C. Haugh, in a paper read before the Association of Engineering Societies in September, 1900, cites a case where piles used in a railway trestle of lengths as great as 70 feet gave a penetration under the last blows as great as 1 foot from a hammer of 3,000 lbs. falling from 10 to 15 feet, and yet after a period of fifteen years have not settled.

The writer knows of a very similar case in Northern Ontario across a part of Redwater Lake where 60 and 65 ft. piles were used. These, according to the foreman who had charge of the driving, settled by their own weight for about three quarters of their length and for the final 10 or 15 feet were given from 5 to 7 blows with a 2,200 lb. hammer falling from 20 to 25 feet, the penetration under the last blows being nearly as great as for the first, and yet after some years' service they have settled no appreciable amount.

THE RELATIVE CORROSION OF STEEL AND WROUGHT IRON TUBING.*

By Henry M. Howe and Bradley Stoughton.

Is steel, tube steel, intrinsically and incurably materially more corrodible than wrought iron, as unprotected steel and iron are surely far more corrodible than well-painted steel and iron? Or is it merely that ill-made steel, and steel of unsuitable composition, are more corrodible than well-made wrought iron? If the former, then in each and every test which is sufficiently wide to make reasonable allowance for the usual caprices of corrosion, tube steel must necessarily corrode and pit materially more than wrought iron. If the latter, then, though in certain tests, tube steel may corrode and pit more than wrought iron, either because that steel is ill-made or of unsuitable composition, or because of the caprices of corrosion, yet in other tests tube steel should resist corrosion as well or better than wrought iron.

If the latter proves true, then has such a degree of skill in manufacture and inspection been reached that, in each lot of one hundred or one thousand or ten thousand steel tubes delivered, there need be no single tube which shall corrode or pit materially more than the worst tube in a like lot of wrought iron tubes? Is steel as trustworthy as iron?

To these questions this paper seeks an answer from the evidence at hand, in view of the existing distrust of steel—indeed, the general belief that steel is intrinsically and incurably far more corrodible than wrought iron. Where we touch on other questions, we do it to throw light on these.

The day has gone by when the Society can hear with patience that, because some steel of unknown source has misbehaved, therefore steel cannot be so made as to behave well. The serious study and great efforts made in the last decade to fit steel tubing to resist corrosion are not to be ignored. To ridicule them would be ridiculous. Have they or have they not yielded regularly a steel which resists corrosion substantially as well as wrought iron?

What we have to say is based in part on investigations which we have made on behalf of the National Tube Company, and in part on our independent inquiries along lines which suggested themselves to us while we were making those investigations. As we understand, that company is interested in overcoming what it believes to be the existing prejudice against steel tubes.

Our inquiry relates only to uncoated tubes. It does not concern itself with the relative merits of steel and iron for conduits, the life of which depends upon the integrity of their coating.

There is no reason why steel ought to corrode worse than wrought iron, at least no reason strong enough to call for unusually convincing evidence. The most marked constant difference between them, the presence of cinder in iron and its absence from steel, creates no such reason. In that the particles of cinder themselves resist corrosion they protect the metal beneath. But their distribution is such that this protective effect may be equalled, or even outweighed by their opposite effect of hastening corrosion by difference

* Read before the American Society for Testing Materials.

of potential. This distribution is shown in the accompanying micrograph (Fig. 1). To increase this mechanical protection by increasing the quantity of cinder should hardly be practicable, at least in case of tubes which need strength, because this would weaken the metal tangentially; i.e., transversely. In cases in which strength may profitably be sacrificed to gain incorrodibility, it may, perhaps, be practicable to make use of this principle. This might, perhaps, apply to the metal for certain tanks.

The evidence, which is presented and discussed in detail in an appendix, may be summarized as follows:—

Steel corrodes and pits less than wrought iron in our own tests (A) lasting seven months, on twelve pieces of steel skelp in competition with ten pieces of wrought iron skelp from the best makers, in hot aerated salt water, a medium previously found extremely unfavorable to steel; (D) in Principal T. H. Thomson's tests on three steel and three iron tubes for about a year in hot water under service conditions; (E) and (H) in simultaneous exposure of many steel and iron pipes to sulphuric acid coal mine water; (J) in the actual use of eleven steel and eight iron tubes in railroad interlocking and signal service; (K) in certain locomotive boiler service; and (N) in tests in which sixteen pieces of wrought iron and steel tubing were buried in dampened ashes for sixteen months. In cases E, H, J and K the tests were carried to destruction.

Cases KK and L, trials in locomotive and in stationary boiler tubing, tended to show that there was no material difference between steel and iron. Case O, a twenty-six-month test in the Gayley blast drying coil at the Isabella furnaces, showed no difference between steel and iron, both of which had scaled uniformly.

Five cases, C, F, G, I and Q, are more or less unfavorable to steel. Of these, C and Q relate not to modern steel, but to that of 1897 or earlier, and Q, indeed, reports a condition of affairs wholly exceptional; while the evidence under I is obscure, if not self-contradictory, and is not shown to apply to modern steel tubing. In case F, the only one of those unfavorable to steel which is known to apply to modern steel tubing, on simultaneous exposure, pushed to destruction, to sulphuric acid mine water, the average life of three steel tubes was 11 per cent. less than that of three iron ones in series with them, and the life of the shortest-lived steel tube was 14 per cent. less than that of the shortest-lived iron tube.

This is all the evidence which we have found, and received permission to cite, though we have asked manufacturers prominently and financially interested in showing that steel is worse than iron to give the addresses of those who could give us evidence. None of that which we have found, but have not yet received permission to cite, is unfavorable to steel.

To sum this up, tube steel has corroded less than wrought iron in seven distinct sets of tests, by seven different sets of observers in seven different places. In three other sets steel and iron behaved substantially alike. Eight of these ten sets were under conditions of service, and in six of them corrosion was pushed to destruction. In five cases steel corroded worse than wrought iron, but in the only one of these in which the steel tube is known to be modern the difference was moderate. Further, in our own tests (B) steel tubing of 1906 pits very much less than that of 1897 from the same makers.

The fact that steel has behaved as well and often better than wrought iron in so large a number of tests, seems to us cogent evidence that steel is not intrinsically materially more corrodible than wrought iron. The fact that in one set, F, modern tube steel has corroded a little worse than wrought iron does not conflict with this inference in the least.

Opposed to this evidence there is a very widespread and deep distrust of steel tubing; indeed, a belief that it habitually pits deeply, and that wrought iron corrodes uniformly, a belief contradicted by the evidence under V. This distrust, so far as we know, is not based on any direct competitive tests between materials known to be good modern steel and wrought iron, respectively; note that we restrict ourselves to known good modern tube steel, made specially to resist corrosion. Instead, this distrust seems to rest on the results of practical experience.

Most of this experience cannot have been with good modern steel tubing, but must have been with the older tubing which preceded it. Now, the present survival of this distrust in spite of the apparent great improvements in making tube steel resistant, and in spite of the evidence that it does resist as well as iron, need not surprise us in the least. Such a survival is always easy. It is especially easy under the unusual conditions of this case, viz., that the user has not been able to tell steel from iron by his own observation, and that in a large proportion of cases tubing sold as wrought iron has actually been steel, as shown under J and T in the Appendix. We believe that we are right in saying that, of the three great classes of users, architects, civil engineers, and plumbers, the last only have in general attempted to learn by direct personal observation whether a given tube was steel or iron. This the plumber has thought that he could do with certainty by the threading test; but the evidence under S shows that this test, at least in most hands, is useless. It is beside the mark to say that he could have distinguished steel from iron by the etching test, because, as we understand, this test has not, in fact, been used to any important extent. With the best intentions, steel and iron carried in stock are likely to get mixed up, unless special precautions are taken to keep them separate. The fact that neither dealer nor user could tell them apart has removed one usual motive for preventing errors.

This actual ignorance of users as to whether any given lot of pipe is steel or iron seems to us of value, not, of course, in showing whether steel or iron is the better, but in interpreting the existing distrist of tube steel in the face of direct cogent evidence tending strongly to show that this distrust is unjust.

The truth must fit all the facts, and no fact can be rejected simply because it does not fit our preconceived belief as to what the truth is. The truth is what the facts—all the facts—show, and not what we may in the past have thought they showed. No matter how strong we may think the presumption created against tube steel by the very existence of the present distrust, no matter how heavy the burden of proof that we may demand of the defenders of steel, we have no right to shut our eyes to the evidence. Nobody has a right to say either that defects which may in the past have lessened tube steel's resistance cannot be cured by skill and care, or, except on valid evidence, that they have not been cured. The existence of distrust calls for caution, but does not justify incredulity, especially in view of the special conditions of this case.

The theory that steel is intrinsically and incurably more corrodible than wrought iron is contradicted flatly by the evidence above. It, therefore, must be abandoned, unless resuscitated by correspondingly direct, convincing, and abundant counter-evidence, clearly relating to well-made modern tube steel. Nobody doubts that ill-made steel may misbehave. The distrust of steel may be nothing but a survival from a day when it was justified, or it may be only an unjustified inference that, because some steel corrodes badly, all must. The distrust can be explained away; the evidence cannot. Therefore, the evidence and its implications must stand till refuted.

Our second question now arises, "Have manufacture and inspection been so perfected that, reproducing continuously the conditions which have made so much of the steel of our present evidence as incorrodible as wrought iron, they may deliver only steel of like incorrodibility?" That they will be so perfected some day we can hardly doubt; but have they been already? To prove this so that the community can rely confidently on it, needs more evidence, especially of cases in which corrosion is pushed to destruction. We understand that such evidence is accumulating rapidly. But though not proved, it is made easily credible, indeed, to our minds on the whole probable, (1) by the very fair degree of harmony among the large number of tests of modern steel reported; and (2) by the fact that out of the nineteen pieces of modern steel tubing represented in cases A, D, and E, not a single one shows any abnormal pitting, nor behaves materially worse than the worst of its iron competitors, of which those in test A at least were from the best makers. This probability is somewhat strengthened by the many cases summarized under P.

CONCRETE AND MASONRY DAM CONSTRUCTION IN NEW SOUTH WALES.*

By L. A. Burton Wade, M. Inst. C.E.

In thirteen cases concrete walls curved in plan have been built for the storage of town water supplies, the resistance of the material in the wall and the sides of the valley being relied upon for stability, and complex questions of stresses being disregarded. The formula used for determining the thickness of a wall at any level below the highest water surface was

$$T = \frac{RP}{S},$$

in which

T denotes the thickness at any level in feet;
R " " radius in feet;
P " " water pressure in tons per square foot;
S " " stress in tons per square foot.

These vary as under for different materials, where D is the depth of water in feet:

$T = RD \times 0.0014$ when S is equal to 20 tons;
$T = RD \times 0.0018$ " " " 15 "
$T = RD \times 0.0023$ " " " 12 "
$T = RD \times 0.0027$ " " " 10 "

The cross-section would be a triangle, but in practice it is advisable to make the top not less than 3 feet 6 inches wide, increased according to the depth of water and the timber passing over in flood time. The climatic conditions are against the formation of heavy ice.

Nine of the thirteen walls are curved for the whole of their length; of the rest, the Cootamundra has two tangents of gravity cross-section, and the Tamworth, Parkes and Woolongong walls each have one tangent of gravity cross-section. In all cases they abut against the rock sides of the gorges to their top levels. The gravity tangent at Parkes is constructed on a flat bench of rock at a level about 13 feet below the top of the wall, the thrust of the arched length being taken by the gravity length, assisted by an anchorage of steel rails placed vertically, and connecting the wall to the rock foundation.

The horns of the curve are more or less fixed by local conditions, and a radius giving a versed sine of about one-third forms the most economical location between those points. When this rule will not apply, the radius may be advantageously altered to suit the configuration of the valley.

In two cases pressures of 24 and 25 tons per square foot have been allowed on hard granite, but, later, these limits have been reduced to 20 tons. Hard slate, sandstones, conglomerates and ironstones are limited to 15 or 12 tons per square foot, according to quality; and softer sandstones to 10 tons. These limiting pressures apply to the walls rather than the abutments, as the end of the wall can be splayed, thus reducing the pressure per unit area in the abutments. The walls in all cases are of Portland cement concrete, with plums of greater resistance than the concrete, which is, therefore, the measure of the crushing resistance of the well. The proportions of the concrete in all cases are 11½ cubic feet of sand, 10 cubic feet of shivers from ¾-inch to ⅛-inch gauge, and 13 cubic feet of metal of 1½-inch gauge. The results of tests of concrete gave a mean crushing resistance of 50 tons per square foot when mixed with soft sandstone and 100 tons with sound igneous rocks. It has been assumed that concrete in bulk offers a crushing resistance one-and-a-half times greater than that of unsupported 6-inch cubes. The maximum pressures allowed on different materials give a factor of safety of 5 on results from unsupported 6-inch cubes, which, if the assumption of increased strength be correct, will be 7½ for concrete in bulk.

The section of a wall of 500 feet radius to resist twenty tons per square ft. and of a wall of 270 ft. radius to resist 10 tons per sq. ft. closely approximates to that of a gravity wall for a similar depth of water. The author is of opinion that gravity walls should be made straight, a curve having no advantage as regards strength or adaptability to meet contraction sufficient to justify the increased quantities. The economical limit justifying substitution of curved for gravity walls is with radii somewhat less than the foregoing, bearing in mind the greater length of a curved as compared with a straight wall; thus the use of curved walls is restricted to comparatively narrow valleys and gorges.

Igneous rocks as foundations proved the most impervious media against leakage. In the case of granite, all soft seams were followed up. In sandstones and conglomerates, the weaknesses were found along horizontal beds and in cases leakage occurred under the flanks of walls, water entering some distance up-stream, the exit being some distance down-stream. In two instances short drives were carried under the flank of a wall to cut out weak places, being filled again with concrete and grouted through drill-holes under pressure. The worst leakages have been experienced in shale and slate.

The proportions of material used in concrete are sufficient for the required resistance at a minimum cost, but are not sufficiently impervious for a thin wall. In earlier walls a 6-inch facing of special concrete was placed on the up-stream side, for water-tightness. Subsequently it was found that by working the sloppy concrete in situ against the mould boards a skin was formed on the surface and a practically impervious wall was obtained. When, however, surplus water dried out, vertical cracks developed. Further experience showed that longitudinal contraction was less in a wall of concrete placed in situ fairly dry and well rammed, and that cracks either do not occur or occur only to a much less extent; but a skin could not be obtained, and thin walls leaked excessively. It was found that two coats of neat cement applied as the timber was stripped gave good results and did not scale, owing to the absence of frosts.

Cracks have appeared more or less in the Parkes, Cootamundra, Tamworth, Wellington and Mudgee dams, but no failures have resulted. No cracks have appeared in any of the other dams.

The cracks in the Mudgee dam are more open than are those in dams constructed of dry concrete. Vertical cracks in all cases twist in their course, inwardly as well as vertically, and open and close with change of temperature; they almost disappear with high temperature and low-water level and cold temperature and high-water level, and open most with cold temperature and low-water level. They occur as a rule at quick changes of foundation level.

The author is of opinion that such vertical cracks, as they occur naturally, do not endanger the stability of the walls; but as they are likely to develop, it is better to provide parting joints to allow of the cracks forming on radial lines, spaced at intervals, than to allow them to occur naturally. Iron built horizontally into the top levels of walls has been suggested to prevent vertical cracks, but the author thinks this would lead to horizontal cracks. Iron might be built in if the parting joints were provided, and if it did not cross the joints.

In the opinion of the author, the experience gained of these structures since the first was completed in 1895 shows that curved walls relying for their stability on their resistance to crushing form a safe and economical means of storing large bodies of water.

Cataract Dam for Sydney Water Supply.—This dam is straight in plan and will retain about 21,500 million gallons

*Abstract of a paper read last week before the Institution of Civil Engineers.

of water, covering an area of 2,400 acres. The dimensions are:

	Feet.
Length of wall	811
Height above river bed	157
Depth below river bed	35
Total height (base to top)	192
Top width	16½
Bottom width	158
Maximum depth of water stored	150
Length of spillway, weir	715

The highest estimated flood level is 4 feet 6 inches over the spillway weir.

The material of which the dam is constructed is local Hawkesbury sandstone, and its maximum crushing stress was limited to 8½ tons per square foot. A system of 6-inch rectangular conduits filled with broken stone, parallel to and about 6 feet back from up-stream face, was constructed to drain the interior of the wall, and these conduits were again drawn into 6-inch earthenware pipes, laid at right angles to the wall, with exits on the down-stream face.

The sandstone, from experiments, gave a crushing strength of 276.3 tons per square foot on 12-inch cubes, unsupported.

Tests on concrete at ninety days gave an average of 113.5 tons, and mortar, for hearting, about 102 tons per square foot.

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ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

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

6536—March 9—Authorizing the St. Mary's and Western Ontario Railway Co. to construct and maintain a spur to and into the premises of D. Maxwell & Sons, St. Mary's, Ont.

6537—March 16—Granting leave to the C.P.R. to construct its railway across highways in the Township of Bentinck, County of Grey, Ont., at mileages 18.07, 18.40 and 22.34.

6538—March 3—Directing the V.V. & E. Railway and Navigation Company to construct suitable proper fences together with gates at farm crossings on both sides of its right off way on Lot 8 of the lands of Mrs. H. M. Milstead at Abbotsford, B.C.

6539—February 25—Dismissing complaint of A. F. Latta, of Port Moody, B.C., re damages for cow killed.

6540—March 3—Directing the G. N. Railway and V.V. & E. Railway & Navigation Company to erect crossings, gates, fences and cattle-guards on both sides of right of way where it affects the property at or near Cloverdale, Alta., of Messrs. Murphy, Mackenzie, Milton, Armstrong, and Shannon.

6541—February 25—Dismissing complaint of Fred. Allan and others regarding extension of the railway siding now terminating at the Western Boundary of the Pacific Coast Mill Company on Coal Harbor, Vancouver, B.C.

6542—February 25—Dismissing complaint of municipality of Burnaby & Coquitlam, B.C., regarding defective cattle guards on the V.W. & Y. Railway or the V.V. & E. Railway & Navigation Company.

(Continued on Page 498.)

SOME EXPERIENCES WITH TIDES AND WAVES.*

By H. A. Russell, Department of Public Works, Halifax, N.S.

In offering this paper on some experiences with tides and waves, I beg to remind you that these experiences have been acquired during so short a period as eight years, which covers the period of my work in the Department of Public Works of Canada and cannot therefore be offered as containing anything more than the ordinary experiences of a young engineer. However, as the work of the Public Works Department is of a specialized character, and the problems presented are somewhat out of the ordinary, I trust that I may be able to present some matters which may be of interest to members of the Nova Scotia Society of Engineers.

About the first work of importance which presented any features of interest came under my charge in the year 1904. It happened in this particular case that the estimates contained an item of $4,000 for the construction of a breakwater at East Chezzetcook, and the first intimation of the difficulties which the work presented came from a first hand survey of the locality after the authority had been issued for the construction of the work.

The lusty habitant who rowed "de Eng'eneer" to the mouth of the harbor, pointed to the partially submerged sandbar which had formed between the tide of the harbor and the wash of the sea, and in a manner which seemed to indicate the complete absence of any thought of difficulties, said: "dere w'ar we wants de breakwater."

Further enquiry brought out the fact that it was not merely the problem of constructing a breakwater which was presented. The breakwater was for a specific purpose, and that purpose was by no means the usual one for which breakwaters are constructed.

At the mouth of Chezzetcook Harbor, as happens in many places where there is much sand or loose material which can be carried about by tides, there had formed a bar, and at both the east and west entrances of the harbor (the harbor mouth is divided by an island) navigation had been greatly hindered from this cause. There was at the time mentioned a depth of about four feet of water at the east entrance at L. W. O. S. T., in what they called the channel. Indeed, though vessels pursued a long and circuitous route in entering and leaving the channel, accurate soundings indicated the entire absence of anything that might be called a channel.

The purpose for which the breakwater was to be built was that of narrowing the entrance of the harbor in order to confine the current of the ebb and flow of the tide, and thereby create a scour which would deepen a channel through the bar.

From the accompanying plan, which was made while the work was in progress, it may be readily seen that such results were, to say the least, doubtful, and adding to this the failure of a similar attempt at the western entrance of the harbor, there was very little in the situation to inspire confidence on the part of an engineer who was facing his first difficult problem.

It is perhaps fortunate for the people of East Chezzetcook that the matter should not have been reported upon before the money was voted, otherwise I suspect there would never have been a breakwater at East Chezzetcook. But they had turned the problem over in their minds and had decided that they would have a breakwater first and decide afterwards whether or not it would do the work. I had, therefore, no further responsibility than to put the breakwater there and make it stay there. Of course I had also to decide upon the proper course of the work from a certain point. The eastern end was practically fixed by a shoal of rocks covered at high water; at this point the sand was dry at low water, but for the greater part of its length the breakwater had to be founded beneath the water.

Remembering the parable of the foolish man who founded his house upon the sands, and knowing from others the difficulties of building in such places, the problem naturally demanded serious consideration. The appropriation was limited also to the amount of $4,000, which was obviously insufficient for the work and it therefore became necessary to exercise the strictest economy in designing the work.

Having decided that 16 feet was the least width which could safely be given to the work, it was found that just 400 feet in length could be built for the amount of the appropriation. The best protection which could be provided against settlement would be brush and stone.

The work was begun in October, 1904, and completed in July, 1905, work having been discontinued from November, 1904, to May, 1905.

The work is of the ordinary type of round-log cribwork, filled solid with stone, built plumb on both sides and without sheathing. The brush mattresses upon which the work rests were formed of small spruce trees laid upon transverse poles, about five feet apart, and secured by a second set of poles on top of the brush, securely lashed to those beneath. These mattresses were built about two feet thick and about five feet wider than the work, they were floated into position and sunk with ballast. Separate cribs, 30 feet in length, and of a height equal to two feet above low water were placed and sunk on top of the brush foundation, the remainder of the work being in continuous work throughout. The completed work was 420 feet in length. Before the completion of this portion of the work, a further sum of $4,000 was voted on the recommendation of the engineer, and an additional 450 feet was completed in September of the same year, making a total length of work of 840 feet.

No results, however, were apparent during the following winter, but in the summer of 1906, about one year after its completion, I was informed by an acquaintance from the district, that they "had a great channel dere now." "Yes," continued my informant, "we can go cross de bar one hour before dey can go in on de wes' side. Abe Young pass out las' week when der w'ernt more an one foot of risin' tide an' she go right straight out pass de end de breakwater."

I regret I have not had the opportunity to make new soundings, so that I am unable to say just what the improvement amounts to.

The breakwater, as it is called (perhaps it should be called a shear dam) has not settled perceptibly except at the outer end where the scour created by the ebb and flow of the tides has undermined it for a distance of thirty or forty feet.

The sand has collected along the seaward side through the action of the waves, and the probabilities are that before it has rotted down there will be the inner end and perhaps two or three hundred feet in length of the work buried in the sand.

The second experience in building upon the sands which I propose to relate, occurred at Petite Riviere, in the County of Lunenburg, and, I regret to say, was not in all respects as successful as the first.

Here, however, the course was not so conveniently marked out by others, and the responsibility rested solely upon the engineer.

Petite Riviere flows into Green Bay, upon the Atlantic Coast, through a low flat beach of sand. The bay itself is shallow, and for some distance from the shore line the sea breaks at low water, and during the summer months, when the water was low in the river, a sandbar formed across its mouth, making it impossible for boats to leave or enter the river except at high water.

Petite Riviere is a prosperous farming settlement and situated some miles from the railroad, most of the trade of the place (which is by no means small in amount) is done by water. Schooners carry practically all the freight which is transhipped into larger boats while the vessels lie at anchor some distance from the mouth of the river. Very often boats are swamped in attempting to enter the river, and boatloads of valuable goods often lost in this way. The problem presented therefore was, first, the preventing of the accumulation of sand at the mouth of the river, and second, that of protecting the boats from the wash of the sea. To the eastward of

*Read before the Nova Scotia Society of Engineers.

the work there lay a beach of sand about half a mile in length, the litter of drift being from east to west. It was evident, therefore, that the only means of preventing the sand from accumulating was to build some form of work along the east side of the river. At the same time, it was necessary to confine the flow of the river so as to create a scour and deepen the water at the bar. And the construction of a work in this position served this dual purpose.

Encouraged by the success of the work at Chezzetcook, the same form of structure was adopted and the same method of construction adhered to.

The accompanying plan shows the position in which the work was built and the total length of work built.

The work was commenced in 1906, and continued to October of the same year. At this date 1,220 feet in length had been completed, 900 feet in length being 16 feet wide, and the remaining portion, owing to the increasing height of the work, 20 feet wide.

During the construction of the work, the sand had accumulated to such an extent on the east side of the shoreward end of the work that over 200 feet in length of the work was practically buried. During the following winter a great improvement was noted in the channel.

At this date $9,681 had been expended of a total of $12,000 estimated for the work. The balance being held in reserve until it had been decided whether it would be best to expend it in constructing a detached breakwater some distance from the end of the completed work, running in an east and west direction, as indicated by the dotted line on the accompanying plan, or in continuing the main work.

It was finally decided to continue the main portion of the work, and during the summer of 1907 an additional 150 feet was constructed. This, however, appears now to have been a mistake, for, though it has effected further improvement in the channel, it has also been productive of unforseen results, much to the detriment of the general purpose of the work. Owing to the increasing current at the end of the completed work which had scoured a channel in a southeasterly direction across its head, it was not thought safe to continue the work in the same direction; the direction was therefore changed slightly to the eastward as indicated by the plan.

Up to the time of the completion of this block no serious settlement was noticed throughout the length of the work, but shortly after its completion a severe storm proved the folly of the undertaking. The action of the waves as they were narrowed up by the decreasing distance between the shore and the work apparently backed up the water in the confined space inside the breakwater, creating pressure which was only relieved when the water began finding its way out underneath the breakwater. There may be some doubt as to the correctness of this theory, but the fact that the scour occurred in the shoreward portion of the work which had not been previously affected seems to confirm it. At any rate, it is evident that had the addition been built detached from the main work and in the position indicated, it would have protected the main portion of the work and possibly have had equally good effects in increasing the depth of water in the channel. At the same time it would have afforded better protection for boats entering the channel of the river. It would be a mistake, however, to assume that the work as a whole has been a failure. There is still the opportunity of building a transverse detached work, though this would cost much more in the position in which it would now have to be built. The channel has been greatly improved through the construction of the work, there being a depth of from four to five feet of water where formerly the sand was almost bare at low water. Beyond the unsightly appearance of the work, which looks from a distance like an elongated caterpillar, with several humps and hollows, there is little fault to be found with it. When the work has found its permanent level and a new top is required these kinks will be taken out. The total length of the work is 1,370 feet and the cost $11,500. Spring tides rise seven and a half feet, neaps six feet.

But if there are difficulties in building upon the sands there are others sometimes equally as great in building upon the rocks, for on the Atlantic coast of Nova Scotia there are many places where the rocks alone are capable of resisting the force of the seas, and though it is seldom in such exposed places that works of protection are required, there are, nevertheless, many places along the coast where the best judgment possible is required in the designing of harbor protection works. The engineer may come to his task armed with all the theories which he can absorb, but without that instinctive judgment which can alone be acquired by familiarity with the ways of the sea, he would be absolutely and hopelessly astray. The principle theory upon which all calculations are based is that the height of the wave varies one and one-half times the square root of the distance of the greatest wind reach, or,

$$h = 1.5\sqrt{d}$$

d being the distance of unobstructed water in miles to windward of the work and h the height of the wave in feet.

Were we to apply this theory to any existing works along the Atlantic coast there are few indeed which would be adjudged of sufficient strength to withstand the force of the sea which must accumulate between them and the originating point of the storms which periodically sweep along our shores, and the reason of this is that the ideal conditions which would make the application of this theory possible nowhere exist except in such places as are not used by fishermen or as harbors of refuge and which therefore do not require works of protection. Islands, shoals, headlands, etc., almost invariably intervene and make such calculations absolutely useless.

To the student who had accepted this formula as his criterion, the little breakwater which juts out into the Atlantic in an easterly direction at Cow Bay, Halifax County, would be an utter impossibility. Such a structure of native cribwork, only 16 feet in width, could not possibly live in the sea which would accumulate in the unobstructed sheet of water lying to the east and southeast of the work.

I have said unobstructed, and to the casual observer this would appear to be a correct statement of fact, since there is no visible obstruction, but in applying our wave formation theory it must not be forgotten that a wave such as that which would accumulate in the unobstructed stretches of the Atlantic would begin to break in perhaps forty or fifty feet of water. (Waves have been known to break at the mouth of Halifax harbor in fourteen fathoms of water), and as the bay for some distance from the breakwater is very shoal it can be readily seen that the full impact of the Atlantic wave can never reach it, whereupon, as in ninety-nine cases out of a hundred, our theory goes by the board and together with it go all the calculations based upon it. The engineer is therefore dependent solely upon his judgment in the designing of his work.

In designing breakwaters for the protection of boat harbors, etc., practically the same form of structure has been adhered to by the Halifax branch of the Public Works Department, the variation being merely in the width of the work and in such details as may require changes to fit different localities.

As an example of the general practice I cite the Devils Island breakwater. The shoreward 250 feet in length, of which was constructed during the summer of 1907. The outer portion of the stem, together with the ell, being now under contract. Here it was found that native timber was destroyed by the limnoria in about thirteen years. The department having constructed a small breakwater in 1892 of native timber which in 1905 was found to be beyond repair. The bottom logs and ballast floors had been so completely destroyed by the limnoria that the ballast was being washed out to such an extent that there was danger of the work being destroyed by the sea.

The form of work adopted in the new breakwater, as may be seen from the plans and sections submitted herewith is that of a continuous stone-filled crib, built plumb on the seaward face, with a break three and a half feet in height, supported by boulsters in counter-fenders opposite each set of main fenders to which they are bolted top, middle and bottom. The work is built of creosoted South Carolina Pine, to a height of three feet above low water.

There are, of course, differences of opinion regarding the efficiency of the plumb face, which I will not here attempt to discuss, beyond pointing out the obvious advantage over the sloping face which allows a greater quantity of water to flow over the break, making it impossible during rough weather for persons to use the breakwater as a landing pier.

Regarding the strength of this break, it may be stated that I have yet to learn of an instance of failure where the work had been properly completed. Several instances, however, can be cited in which the sea, after being successfully resisted by the break had fallen in such quantities and with such force upon the floor of the work as not only to break the planking, but to carry away the guard-timber on the inner side of the work. In one instance, during a recent storm, in which the whole work was shaken out of its original position and shape so that the inner face instead of being battered one in twelve as originally built, was found to be plumb, while the outer face showed the batter, and in which the inner guard-timber together with fenders and top face-logs were all carried away, the break showed no signs of weakness.

There are also differences of opinion regarding the value of creosoted timber, but as this raises a point which would involve a rather lengthy discussion, I refrain from stating my own views, since I feel that I have already opened the discussion of a sufficient number of interesting points.

I do not pretend to offer matured judgment upon any of the subjects upon which I have touched. My aim has been to open the discussion of these subjects in order that those of us who are entrusted with such matters may be able to profit by the interchange of ideas.

My experience has taught me that as a general rule, the men who are too well informed to profit by such interchange, are generally those who are incapable of acquiring new ideas and are rapidly going to seed.

I have no desire to reach this stage in my career and I assure you that this attempt has been prompted rather by the desire to learn than by the desire to impart.

THE TELEPHONE IN TRAIN DESPATCHING.*

W. H. Harkness, Engineer Western Electric Co., New York.

It will be contended by many that the telegraph operator does his work unconsciously, and is, therefore, not subject to a mental strain. But despatchers and operators who have been using the telephone for despatching work in nearly every case speak of the reduced strain. They can do the same amount of work by telephone in one-half of the time formerly required. The abandonment of the telegraph key for calling the stations has been a great physical relief to the despatchers, and the operators have been relieved of all calling of the despatcher. The stations' answer the signal given by the selector bell much more promptly than they do the sounder. The fact that the noise of the telegraph instruments is removed will also have an effect upon the work of the despatchers and operators.

The calling of stations by the despatcher while conversation is being carried on with other stations saves time. There is greater accuracy in transmitting orders by telephone, as the despatcher writes down each word as it is spoken instead of sending it from memory by telegraph. The improved line construction and telephone apparatus available to-day is far superior to that used even five years ago. It has been stated that all voices are not transmitted equally well by telephone. This is true, but trouble from this cause is seldom experienced, and it will be possible to obtain employees with suitable voices easier than it is to get employees who can send good Morse. The telegraph operator is subject to paralysis of the arm. There is no such effect or any other physical trouble caused by the continued use of the telephone, and its introduction enables many telegraph operators already affected with paralysis, but otherwise efficient employees, to continue to carry on their work in a satisfactory manner.

The despatchers and the operators have become better acquainted since using the telephone, and this has resulted in closer co-operation in the performance of their work. The fact that they are talking with each other seems to have eliminated the caustic remarks and comments so frequently sent by telegraph. The remark of a despatcher after using the telephone for several months to the effect that he "had not been mad once since using the telephone" is well worth repeating, as it indicates an improved condition. By equipping trains with portable telephone sets the despatcher may be reached from any point between stations in case of breakdown.

The first of the present type of telephone despatching circuits was installed by the New York Central in October, 1907, between Albany and Fonda, forty miles. The Chicago, Burlington and Quincy was the next, in December, 1907. Aurora to Mendota, forty-six miles. At the present there are over twenty telephone despatching circuits in use on the C.B. and Q., covering 1,534 miles of road (1,381 miles single track).

The construction of the line is important. Hard-drawn copper wire of sufficient size to withstand wind and sleet should be used, and the line should be a metallic circuit; i.e., two wires should be used. The wires forming the circuit should be properly transposed and so located in relation to other circuits as to prevent inductive disturbance from other wires or mechanical injury. The introduction of considerable amounts of cable in the circuits should be avoided, as it reduces the volume and affects articulation. When cable must be used, lead-covered paper insulated telephone cable having the wires twisted in pairs to prevent inductive disturbances should be used, not only on account of it affecting the transmission less than the rubber insulated cable, but also on account of its lower first cost. Cable of this type can be furnished to withstand the potentials used on telegraphic circuits, and on account of its low capacity, as compared with rubber insulation, will improve the operation of telegraph service as well as that of the telephone circuits. Adjacent telegraph or telephone circuits, if used in emergency as patch circuits, should be in first-class condition. Copper wire weighing 210 pounds per mile usually has been used. This is of sufficient size to render a very high grade of telephone transmission. With from thirty-five to fifty poles per mile a circuit of this kind will, with few exceptions, withstand severe wind and sleet storms.

Circuits like those now being used will cost $85 per mile, or a division of 150 miles, $13,000. These figures do not include the telephones and selective apparatus, the prices of which vary according to the type used. The average life of the copper wire is considered to be fifty years. By applying suitable apparatus to two telegraph wires two duplex telegraph circuits and one metallic telephone circuit may be obtained which will permit of four telegraph messages and one telephone message being transmitted simultaneously. Such a circuit as this has been in use on the Union Pacific between Omaha and Cheyenne since last June and has been rendering excellent service. When the telephone circuit is not being used for official conversations between division headquarters, it is used for the transmission of messages which otherwise would be sent by telegraph. The following traffic was handled over this circuit in a month:—

Messages by telegraph	59,020
Messages by telephone	30,703
Conversations by telephone, 2,539; time consumed by conversations, 126 hours, which is equivalent in messages to	3,780
Total	93,503

* From a paper read before the St. Louis Railway Club by W. E. Harkness, Engineer Western Electric Co., New York.

The telephone messages are handled at a less expense than by telegraph. The telephone operators handle as high as 450 messages a day, and this could be increased if the line were not used so much for conversation.

For train despatching service due consideration must be given to the length of the line, the kind and size of wire, the number of stations connected to the line, the kind of telephone, transmitter, receiver, induction coil and circuit, together with the kind and amount of current supplied. The number of stations connected to lines now in service varies from ten to forty-four. In regular commercial telephone service there are usually but two people talking or listening on the line at a time, while in despatching service it is customary to have from three to five operators in addition to the despatcher all connected to the line at the same time, and in addition an unknown number of other stations listening to their conversation. Various methods of rendering efficient service under these severe conditions have been proposed and tried. Some have attempted to equalize the telephonic current passing through the receivers at the various stations, others have increased the volume of transmission, and still others by a combination of the two have attempted to secure more satisfactory results. In some cases increased volume of transmission has been accomplished at an increase in battery consumption and a decrease in the clearness of articulation. In others, the volume of transmission has been decreased to obtain clearer articulation. The great difficulty is that there is no standard. No two users of a telephone will agree as to the relative volume of articulation obtained on two different circuits. Even with skilled observers differences in volume of transmission are often taken for differences in quality of articulation, and vice versa, or the amount of difference when judged in per cent. will vary within a wide range. A comparison of a laboratory standard and a working line is a physical impossibility if the tests are to be made by the same parties and under the same conditions. Comparisons made by observing the service on one line and then several days later observing the service on the same or a different line cannot be considered fair. Further, changes in atmospheric or physical conditions may occur in an instant.

The limit of commercial transmission is taken as that obtained over a 1,000 mile circuit of No. 8 BWG copper, using standard telephone sets and circuits. It is, of course, impossible to make tests over an actual line of this kind, so artificial lines have been constructed and comparisons are made with these as a basis. To reduce the chances of error still further these artificial lines have been compared with standard No. 19 gauge paper-insulated telephone cable and reduced to terms of miles of No. 19 gauge cable. This establishes a unit of comparison, and all comparisons are expressed in these units. In this way, it has been determined that transmission over 1,000 miles of No. 8 BWG copper circuit is equivalent to that obtained through thirty miles of standard No. 19 gauge paper-insulated cable. . . . Numerous attempts have been made to measure the relative transmission obtained from telephone instruments, but no instrument has yet been devised which will distinguish between good and bad articulation as accurately as the human ear. For a number of months' work has been carried on with the idea of developing apparatus which will transmit with sufficient volume and clear articulation and at a minimum consumption of battery to satisfy the most critical. It is expected that this apparatus will be available for use within a short time.

Various types of telephone sets are being used at the stations. The New York Central and the Canadian Pacific are using a special transmitter arm so arranged that the transmitter and receiver are fixed on the arm, and the operator upon placing his ear to the receiver has his mouth in line with the transmitter. This arrangement permits an operator to have the use of both hands. A foot-switch is used to close the transmitter battery. This is used to prevent a waste of battery and the introduction of noise on the line when an operator is listening on the circuit. The Burlington and a number of other roads have been using a simple form of transmitter with which a head telephone is used, thus giving the operator considerable freedom of movement. The telephone equipment is connected to the circuit by moving the head telephone from a switch-hook upon which it is hung when not in use.

A key, operated by hand, is provided to close the transmitter battery during conversation. This key is arranged to open the transmitter circuit when released by the operator, thus permitting him to listen on the circuit without a waste of battery or causing a noise on the circuit. A foot-switch could be used with this equipment if desired. The use of the transmitter key has not been found objectionable, as it is not necessary to hold the key when receiving, thus having both hands free for writing. When talking the operator is not required to write, so there is no necessity for him to have both hands free. With this apparatus the operator is not compelled to speak directly into the transmitter, but this apparently has not caused serious trouble.

The desk stand arranged for a head telephone has also been used, principally on account of its low price. On the D.L. and W. this is now standard. It is liable to injury by being knocked off the desk, but has the advantage of being located so as to be convenient to several people.

The Santa Fe and Union Pacific have used a set between the transmitter arm and the desk stand, or what is commonly called a "flexiphone." This consists of a desk stand stem attached to an arm, which can be raised or lowered so that it can be used while seated or standing, and in addition can be rotated in a horizontal plane. The despatcher's equipment is practically the same on all of the railroads, and consists of a chest transmitter, supported by a band passing around the despatcher's neck, and a head telephone.

It has been suggested that a loud-speaking receiver be used by the despatcher. This arrangement, while available and capable of giving a large volume of sound, is not satisfactory on account of the quality of the sound rendered being less distinct than that obtained from a regular receiver held close to the ear. This is largely due to the reflection of the sound waves in the horn, which must be used to amplify the sound. Another objection to this device is that noise in the room or from outside will prevent the despatcher hearing distinctly. A device of this kind is to be tried on one of the eastern roads for use in block towers in connection with the reporting of trains from tower to tower. Another design is being prepared for one of the western roads for trial on a despatching circuit. The use of a double head telephone has been considered, and should be of benefit where the despatchers or operators are located in noisy locations. The use of a transmitter which could be mounted on the despatcher's desk which could be spoken to in place of having to speak directly into the mouthpiece as at present has also been suggested. This arrangement, while possible, would be found unsatisfactory for two reasons. First: It would render a poor quality of transmission; and second: it would necessarily have to be very sensitive to transmit the voice from a distance, and it would, therefore, pick up other sounds in the room which, when transmitted on the circuit, would affect the service.

The cost of the telephone apparatus depends largely upon the type used, and will vary from $17 to $36 per station. An average of $25 per station may be used for rough estimates. The selective apparatus in general use may be divided into two classes, electromechanical and mechanical, the Gill representing the electromechanical type, and the Wray-Cummings the mechanical.*

The selector when operated closes a bell circuit and causes the bell at the station to ring until stopped by the operator answering the call. Where the bell at a station rings continuously until the call is answered and a station is called by mistake and the call is not answered for hours owing to the absence of the operator, there is a waste of battery, and one arrangement permits the despatcher to stop the ringing of the bell at any time after it has started. Another arrange-

*The Wray-Cummings apparatus was described in the "Railroad Age Gazette," February 19, page 359.

ment permits the bell to ring for a certain length of time and then automatically causes it to cease. One of the selective systems has what is known as an "Answer-back," an audible signal received by the despatcher when he has called a station and the bell has started to ring.

The cost of the total station equipment, including telephones, selectors, test panels and installation will vary according to the apparatus used from $60 to $96 per station. Combining these figures with those covering the cost of the despatcher's equipment and the line construction a despatching circuit of 150 miles, to which is connected thirty stations, will cost approximately $15,000, or at the rate of $100 per mile.

(Continued from Page 493.)

6543—February 25—Dismissing application of the Vancouver Board of Trade for refund under Order of the Board dated August 11th, 1907, in what is known as the "Transcontinental rate case."

6544—February 23—Dismissing application of the V.V. & Y. Railway for authority to construct branch line within the City of Vancouver, B.C., from a point on the main line north of False Creek, B.C.

6545—February 25—Directing the V.W. & Y Railway to join its tracks with the tracks of the C.P.R. operated by the B.C. Electric Railway Company at, or near, the junction of Columbia and Front Streets, Vancouver, B.C., within two months from the 25th of February, 1909.

6546—February 25—Dismissing complaint of Trades and Labor Council of Vancouver, B.C., that the C.P.R. is running its trains from Vancouver without proper inspection.

6547—February 25—Dismissing complaint of R. Robertson & Company, of Vancouver, B.C., respecting rates of the C.P.R. to Ladysmith, B.C.

6548—February 25—Authorizing the Vancouver Power Company to erect and maintain a line of wires for the conveyance of electric power across the tracks of the C.P.R. Company at the Second Narrows, Burrard Inlet, Vancouver, B.C.

6549—February 23—Dismissing application of the V.W & Y. Railway for authority to cross by its branch line from False Creek to Burrard Inlet, in the City of Vancouver, across the tracks of the C.P.R.

6550—February 23—Dismissing application of the V.W. & Y. Railway for authority to cross with its branch line No. 2 from False Creek to Burrard Inlet over the lane between Parker and Napier Streets in the City of Vancouver, B.C.

6551—March 18—Extending until May 18th, 1909, time during which the C.N.O. Railway may use for construction purposes the crossing of the G.T.R. spur line to Edwards' Mills, Rockland, Ont.

6552 to 6577, inclusive—February 23—Dismissing 26 applications of the V.W. & Y. Railway for authority to cross with branch line over various lanes and streets in the City of Vancouver, B.C.

6578—March 20—Authorizing the Sunderland Telephone Company to carry its wires across tracks of the G.T.R. at 5th Concession, Township of Brock, Ont.

6579—March 18—Authorizing the Bell Telephone Company to lay two conduits containing cable or cables, along and under Fortification Lane, from the end of its present underground system in the said lane to Victoria Square, a distance of about 200 feet and thence along and under Victoria Square in a southerly direction for about 100 feet and thereafter maintain and operate its telephone lines by means of such cables or conduits.

6580—March 18—Authorizing the C.P.R. to use and operate bridge on its Guelph branch at mileage 4.2.

6581—March 18—Authorizing the C.P.R. to use and operate bridges on the Havelock section of its line at mileages 77.7, 99.3 and 99.4.

6582—March 23—Granting leave to the rural municipality of Hamiota to erect, place, and maintain its wires across the track of the C.P.R. at P.C., 2¼ miles south-east Hamiota, Man.

6583—March 18—Authorizing the G.T.R. to construct a spur to the premises of the Stratford Mill Bld. Company and Ballantyne's Cheese Warehouse, Stratford, Ontario.

6584—February 25—Dismissing application of the Vancouver and Lulu Island Railway Company for Order authorizing a proposed deviation from plan of branch line on the south side of False Creek.

6585—March 15—Dismissing application of the Canada West Coal Company, Limited, for authority to construct tunnels and necessary work in connection therewith under the tracks of the C.P.R. Crow's Nest branch, south half of Section 31, Township 9, Range 16, west of the 4th meridian at Taber, Alta.

6586—February 18—Authorizing the C.P.R. to open for the carriage of passenger traffic its Moose Jaw branch from mileage 14.5 to mileage 118.75 and to operate its trains over mileage 14.5 to 113.0, a distance of 95.5 miles, at a speed of 25 miles per hour.

6587—February 25—Authorizing the City of Vancouver to construct a bridge for highway purposes over the C.P.R. tracks at the intersection of the northerly shore of False Creek and Granville Street and at the intersection of False Creek and Fourth Avenue.

6588—March 19—Directing the C.N.R. to properly fence its right-of-way where the same crosses the south-east ¼ of Section 21, Township 19, Range 21, west of the 2nd meridian.

6589—March 16—Refusing petition of the residents of Sinclair, Man., for Order directing the C.P.R. to provide a side track between Reston and Sinclair, Man.

6590—March 22—Granting leave to the Cardoc-Ekfrid Telephone Company, Limited, to erect telephone wires across the C.P.R. tracks at 1¼ miles north of Appin, Ont.

6591—March 22—Authorizing the Canadian Northern Telephone Company to erect its wires across the tracks and the telegraph wires of the C.P.R. Wolseley-Reston branch, and the Brandon-Regina branch at Kaiser, Man.

6592—March 22—Authorizing the Bell Telephone Company to erect its wires over the tracks of the G.T.R. 2 yards east of Sprucedale Station, Ontario.

6593 to 6596, inclusive—Authorizing the rural municipalities of Hamiota and Miniota, Man., to erect telephone wires across the tracks of the C.P.R. at four points in the Province of Manitoba.

6597—March 10—Dismissing application of E. D. Coffey, of Dauphin, Man., and F. L. Merritt, of Winnipegosis, Man., and the Canadian Lakes Fishing Company for Order directing the C.N.R. to put into immediate and continuous operation its line of railway now constructed from Etoimami to the Pas, Sask.

6598—March 15—Dismissing application of M. McGregor, of Tilston, Man., and residents of the Town of Tilston, against the unsatisfactory trains service furnished by the Canadian Pacific Railway between Lauder and Tilston, Man.

6599—March 15—Authorizing the C.N. Railway to operate temporarily, until further ordered by the Board, its spur from the connection of the C.N. Railway near Smith's Packing Company at Edmonton, to the Clover Bar Coal Company's property.

6600—March 22—Dismissing application of the Nipigon Bay Fish Company complaining of refusal by the C.P.R. to receive and carry, on passenger trains, fish offered for carriage at Rossport, Hackfish, and Coldwell, Ontario.

6601—March 22—Dismissing complaint of C. N. Cobett, Edmonton, Alta., alleging exorbitant rates in the West charged by express companies.

6602—March 12—Amending Order No. 6320, dated February 13th, 1909, in the complaint of the Nelson-Ford Lumber Company and the International Elevator Company, as to the service furnished to them by the Canadian Pacific Railway over a spur track built across blocks 7 and 11, in the Townsite of Estevan, Sask.

ENGINEER'S LIBRARY

MACHINERY FOR THE MAIN.ENANCE OF STREET PAVEMENT IN PARIS.*

Those engineers whose charge it is to see that the streets of Paris are kept in good condition have discovered that their task grows more difficult from day to day. The citizens of "la ville Lumière" demand that their public ways shall be most carefully maintained and kept clean, for this seems to

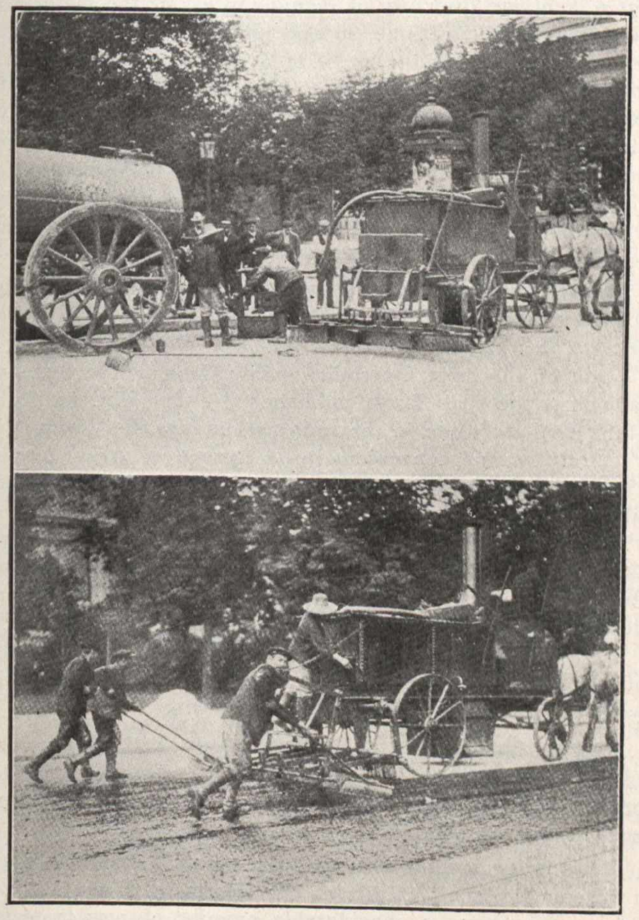


Fig. 1—Melting Tank, Portable Spreader and Operation of Tarring a Roadway.

them but child's play. Nevertheless, very difficult problems must be solved to satisfy the taste of the householders, to conform to the laws of modern hygiene, and to preserve good living conditions over a total area of 16,913,250 square metres, of which 7,198,160 square metres are sidewalks and alleys. Beyond this, reckoning must be made with the new "autobuses" now running in the Paris streets which wear the pavement as much as three or four old-style buses; in fact, it has been calculated that a line of these automobile vehicles, each weighing 6 to 7 metric tons when fully loaded, running at 20 to 25 kilometres an hour under a 3-minute headway, is equivalent from the point of view of road wear to an unbroken procession of horse-drawn omnibuses filled with passengers and moving at a walking pace.

Many types of pavement are to be found in Paris, but the principal ones are macadam, stone block, asphalt, and wooden pavement. Although macadam or metaled pavements appear now to be rejected for corresponding situations elsewhere and although the engineers of Paris endeavor to reduce the extent of this pavement year by year, there were still in 1906 1,178,710 square metres of macadam streets in the entire city.* Furthermore, effort is constantly made to improve the quality of the construction employed.

The most interesting innovation in recent years, however, so far as concerns the metaled streets of Paris, is the tarring, which, among other advantages, makes them easier for haulage and suppresses almost entirely the dust clouds which formerly were raised by every passing automobile. Many products were tried; first came petroleum, but this has an unpleasant odor, is expensive in France, and gives only short-lived results; therefore it has been abandoned. Next followed divers compositions (westrumite, pulveranto, asphaltine, rapidite, injectoline, odocreol, etc.), of formulæ kept secret by their inventors, but composed for the most part of the heavy oils of coal tar or of oil residues rendered miscible by some saponifying agent. These solutions check evaporation more or less and no dust will show for a number of days. Thus they are often serviceable to the municipal administration of Paris on special occasions, as on race days, reviews and other fêtes during which, on account of the crowds in the streets, it is necessary to suspend for some hours the ordinary sprinkling.

Of all these many products tar alone (suppressing dust and consequently mud) has given good results. Let us review rapidly the technical operations of tarring. First of all it is necessary to prepare the pavement carefully, to submit it to vigorous sweeping to remove every trace of dust, and to clear the joints of the metaling in order to allow the tar to penetrate as far as possible. For this purpose, use is made either of mechanical sweepers or of very stiff brooms. The tar is then brought conveniently near in wheeled tanks containing about 3,500 kilos. (Fig. 1). From these it is transferred to heaters, for when cold it is too viscid to spread easily, while at a temperature near its boiling point (80 to 85 degrees C.) it is almost as fluid as water. Nevertheless, certain precautions are necessary, for it foams like milk, froths and overflows the receptacle; furthermore, it takes fire on contact with flame. Therefore, attentive oversight of the heating is imposed upon the operatives. In the apparatus

Fig. 2—New Horse-Drawn Sweeper in the Paris Streets.

shown in Fig. 1, 2,000 to 3,000 kilos. of tar may be brought up to the desired temperature. A spraying device and a train of brooms secure a good distribution, which is further perfected, especially on the sides, by sweepers. These latter, with hand brooms, follow a tarring tank whenever it is in motion.

The methods adopted for cleaning Paris streets are many, and the provisions made by the administration for the comfort of citizens and for conformity to the modern standards of hygiene are of a high order. The brief summary will deal particularly with new ideas of special interest to engineers.

* Abstract of an article in The Engineering Magazine, by Jacques Boyer.

*All statistics given in this article refer to the year 1906, the administration not having yet published the figures for 1907.

The sweeping of the Paris streets is done either with a hand scraper fitted with a rubber strip, or by large horse-drawn or mechanically propelled sweepers. M. Mazerolle conceived the idea of combining the ordinary broom sweeper with a scraper fitted to the same machine. (Fig. 2.) The idea seems simple, but a slight mechanical difficulty was encountered. The scraper does not actually give satisfactory results except when it is pushed by the hand of the workman. If it is dragged, the least obstacle raises it and it jumps, unless it is very heavily loaded, and in this case the rubber quickly wears out. If, on the contrary, it is pushed, its adhesion to the ground is assured. M. Mazerolle, therefore, arranged in the rear of the machine three scrapers operated not by traction but by propulsion. For this purpose he added a special frame supported by a friction roller, and the motive force is thus transmitted to the scrapers from the rear forward, so that each one acts as if it were pushed by hand. Further, the three scrapers are set at different angles so that they correspond to the ground of the roadway. They are controlled by a special lever convenient to the hand of the driver, who raises them when, for example, the machine leaves a wood to work upon a stone-paved surface where the rubber scrapers would be of no effect.

The new automobile sweeper and sprinkler recently put into service, shows important progress in the same line of ideas. The reservoir has a capacity of 2,670 litres. It is equipped with a de Dion-Bouton two-cylinder combustion motor of 15 to 17 horse-power, with radiator, circulation pump, and a six-vaned ventilating fan, belt-driven, and magneto-ignition. In order to reduce the length of the vehicle

Fig. 3—Iron Wheelbarrow for Removing Sweepings.

to the minimum, the revolving brushes are installed between the axles. The chassis, 4.37 metres long, is built of steel sections, and to save space the driver's seat is placed between the motor and the tonneau. Besides the ordinary levers and pedals, the operator has close to his hand a handle for control of the sprinklers or sprays, and a wheel operating the distributing cock.

Mechanical sweeping is employed in almost all the Paris streets, whatever their type of pavement, but it renders the greatest service on macadamized or stone-paved surfaces. On the other hand, the rubber scraper effects a more thorough cleansing of smooth pavements and sidewalks. Furthermore. street cleaners sweep up the leavings by hand. For gathering up and removing all these sweepings, a little iron wheelbarrow with a tipping bucket filler has recently been devised as shown in Fig. 3.

BOOK REVIEWS.

Chadwick Lectures.—University of London; author, Mr. W. D. Scott-Moncrieff. Published by St. Bride's Press, Limited, Fleet Street, London, E.C. Price, 50 cents.

This publication, issued in the form of a brochure, comprises four lectures, delivered last year in connection with the London University on the subject of "The Engineering Aspect of Recent Advances in Connection with Sewering."

The Chadwick lectures receive their title from Sir Edwin Chadwick, an enthusiastic sanitarian, born in 1800, died in 1890. By his will and codicil he bequeathed investments to the university producing annually about $4,500 in trust for purposes connected with the promotion of sanitary science and the provision of annual lectures on this subject. In 1899 a Chadwick Scholarship in Hygienic Engineering was also established at University College. The lectures form an interesting synopsis of the present position of "Sewerage and Sewage Disposal," the author being well known in the sanitary world as one of the early pioneers of the bacterial methods of sewage disposal. They are further referred to in the Sanitary Review.—T. A. M.

Cement Manufacturers.—A directory of Portland cement manufacturers, together with gypsum and lime. Published by the "Cement Age," Chicago. Pages 200; price, $1.

The purpose of the directory is twofold. First, to present a complete directory of manufacturers of the materials, cement, gypsum and lime, so that any prospective purchaser of these products might locate at a glance any nearby mill from which he can obtain these materials; and second, to present as complete a directory as possible of all machinery and supply manufacturers who can supply the products used in the construction or operation of cement mills, as well as gypsum or lime plants. The names of officers of each company, the brand of cement, capacity of plant and process of manufacture is given.

American Street Railway Investments.—Published by the McGraw Publishing Co., 239 West 39th Street, New York. Size, 9 x 14; pages 500; price, $5.

One of the most creditable publications in the form of manuals is the Red Book, published by the McGraw Publishing Co. Accurate in the information furnished, complete in its returns and convenient in its method of arrangement, it is a useful publication to those who have to do with street railways.

Every street railway operating in Canada and the United States is listed, and the information given is just what one interested in the road as an investment would desire to know: the population of the district served, the capital stock of the road, funded debt, franchise, plant and equipment, and the officers of the company. Insert maps, giving the layout of the larger systems are also given.

Steam Boilers.—By Cecil H. Peabody and Edward F. Miller. Published by John Wiley & Sons, New York. One hundred and seventy-five illustrations, five plates, and 434 pages; price, $4 net.

This is the second edition of the author's excellent work on "Steam Boilers." Although the treatment of the subject remains the same, a considerable amount of new material has been added and the other parts revised. The book was primarily intended for students, but it will be found a source of useful information to all engineers. The various types of boilers in common use are described, with a new chapter on superheaters. Following this is a discussion on fuels, describing their composition, heat and chemistry of combustion, with a calculation from a gas analysis. Chapter IV. treats with the corrosion and incrustation of boilers, with a statement of the most recent investigations and conclusions on these important subjects. Boiler settings, furnaces and the various types of stokers are discussed in detail under Chapter V., with a short discussion on chimneys. Chapter VI., power of boilers, study of the value of coal, equivalent evaporation, rates of combustion, and the relative value of heating surfaces. Chapters VII to IX. deal with the construction and strength of boilers in detail, studying the types of furnaces, staying rivetted joints, tubes, etc.; also discussing hydraulic tests and boiler explosions, with a report on a hydraulic test of a boiler to destruction. Chapter IX—Boiler accessories, under which valves, steam traps, separators and steam piping is fully discussed. Chapter X.—Shop practice, describing tools, etc. A complete description of boiler-testing is given under Chapter XI., and under the heading, "Boiler Design," in Chapter XII. The principles and methods set forth in the previous chapters are brought together and illustrated by applying them to the design of a boiler of common type. The appendix contains various useful tables, a number of which give the dimensions and floor space occupied by several types of boilers and economizers. The book contains a considerable amount of useful information, is well illustrated, many of which illustrations are new.—F. A. G.

Heat for Engineers.—A treatise on heat, with special regard to its practical application. By Chas. R. Dorling. Published by E & F. N. Spon, Limited, 57 Haymarket, London, and Spon & Chamberlain, 123 Liberty Street, New York. Pages 430, illustrations 110; price, $3.50.

This book deals with the numerous applications of heat in modern industrial processes, and furnishes useful information and reliable data on the thermal phenomena involved. The general procedure followed in the various chapters has been to first explain thoroughly the fundamental principles and theory of the matter dealt with; second, to describe methods of measurement, and finally to give its practical applications. The use of various formulæ given has been illustrated by examples embodied in the text. The author deals with the following: Heat as a form of energy; methods of producing heat; the expansion of solids; gases, and its practical applications and measurement; general property of gases; explaining the principles of the barometer; Boyle & Charles' law; adiabatic and isothermal changes and a perfect gas. Measurement of temperatures under which the various types of thermometers and pyrometers are described. Under heading, Change of State, fusion, critical points of steel, freezing and melting points of liquids, fusible alloys and their practical applications to water sprinklers, furnace linings, freezing machines, etc., are fully explained. Under chapter on Refrigerating Machinery the following subjects are discussed: Ice manufacture, illustrating the various methods of manufacture; cold storage, describing the various types of refrigerating machinery in common use, with discussions on the relative advantages and drawbacks of air expansion, compression and absorption machines for producing cold, giving working data and energy ratio of the machines. The transfer of heat is treated under chapters on Conduction, Convection and Radiation, giving the fundamental principles and their practical application to the heating and ventilating of buildings, chimney draft, etc., with useful data and coefficients of conduction, etc., for different substances. The use and advantages of insulating materials is fully described, with tables and curves of test data. The book ends with chapters on the conversion of heat into work, explaining the two fundamental laws of thermo dynamics and the consideration of the disposal of heat in actual engines in conjunction with these laws.—F. A. G.

Railway Working and Appliances.—By Edward S. Hadley. Size, 6 x 9; pages 120. London, E.C.: Longmans, Green & Co., 39 Paternoster Row. Price, 40 cents.

To those anxious to acquire a practical knowledge of the rules, methods and appliances used for the safe working of railways this volume will strongly appeal. It contains a series of interesting articles which describe in non-technical language the methods and mechanism by which railways in Great Britain are operated with the remarkable safety that characterizes them.

A portion of the first chapter is devoted to a description of the uses of fixed signals and the positions they occupy. Following this is a complete account of the block telegraph instrument, by means of which communications are made between the signalmen concerning the movements of trains. The tail-lamp and its functions and the object of the catch-points or derailing switch are dealt with in Chapter III., while the methods adopted for the protection of trains in case of accidents and obstructions on the lines or in the event of the block telegraph instruments failing to work properly are referred to in the next chapter. A section that will be of particular interest to the railway men of Canada is one that describes at some length the British system of operating trains on single lines and single line working when one road of the double line is obstructed. Chapter VII. deals concisely with the permanent way, including facing-points, trailing-points and the locking apparatuts connected with them—factors of vital importance in the safe operation of every railroad. The next section is devoted entirely to a description of the uses of signals, in which is included brief mention of the ingenious mechanism known as "interlocking," which makes it impossible to exhibit at the same moment any two signals that can lead to a collision. As the author points out: "The degree of perfection attained by a railway company in its signalling arrangements practically represents the degree of safety with which its train-working is conducted. Signals and other appliances that are connected with signalling have undoubtedly more to do with the prevention of accidents than has anything else." The remaining chapters, seven in number, are devoted almost exclusively to the various appliances connected with rolling stock, one of the more interesting features of which is a description of brakes. The automatic vacuum and the Westinghouse automatic brakes are described here. Another portion tells of the preparation for accidents, the break-down van, the equipment it contains, and its uses. The concluding chapter, dealing with railway sketching, is intended to be of assistance to those who frequently have occasion to make a descriptive report in which suggested structural alterations are practically unintelligible unless accompanied by a sketch.

The volume is profusely illustrated, and an ample index is also provided.

Railway working and appliances is a subject upon which there is not a superabundance of literature, and the mass of valuable information contained in this book makes it one of the foremost works of its kind. To railway men it will undoubtedly be of especial interest.—W. M.

Malleable Cast-iron.—By S. Jones Parsons, M.E., Leicester, Eng. Published by Archibald Constable & Co., Limited, 10 Orange Street, Leicester Square, W.C. XI.-171 pages; size, 5 x 8, with 86 cuts and six full-page plates; price, $2.25 net.

Treats of the "hitherto neglected" subject of malleable cast-iron very fully and from many view-points, being an elaboration of several articles appearing in English technical journals under the nom de plume, P. I. Giron, with many additions.

In the introduction an effort is made to remove that objectional confusion of terms which arises when information on a subject comes from so many original sources. Considerable history of "annealing" is given, as well as an idea of direct annealing in future, of which we may shortly hear something in this country.

Under melting the first chapter makes several references to the difference in impurities content of Canadian and English pig and coke; yet a great part of this chapter would not apply here. The crucible, cupalo, and air furnace are described in detail.

Moulding in the second chapter gives many opportunities for discussion from members of that trade. For instance, raming, spinners, spray moulding and pouring.

Annealing is thoroughly written up in some thirty pages. Temperatures, packing, kind of ore and furnace used and pan design are principal items. Chapters on methods of cleaning and straightening and on core-making follow.

Engineers will be interested in a practical treatment of the subject design, the tables on tensile strength and elongation may be compared with present practice, while the discussion fillets carries ideas new to many. This chapter and that on inspection and testing, where some excellent ideas are thrown out, gives the engineer, who has not been in touch with the manufacture of this product, considerable information regarding its possibilities, as well as limitations.

Under supplementary processes, case-hardening, pickling, galvanizing, brazing, and that difficult operation, machining, are dealt with.

A list of the uses of malleable cast-iron follows, and lastly, attention is given malleable cast-iron, or "semi-steel," which, with its high ultimate strengths, the writer has seen used in the United States to great advantage.

Economy in production is referred to several times, although the book is not written from this viewpoint.

The work is thoroughly indexed, and will be of interest to the trades affected in this country, and particularly in England, where the men requiring such materials can turn with some confidence to a man who has given the matter much thought..

We hope, in this connection, that those men in Canada who are familiar with such somewhat restricted trades will make the appearance of this book an opportunity for discussion, and give, through the technical press, to those interested avenues of choice in materials other than that of trial and risk, which obtains to a great extent to-day.

The engineer is always anxious to locate that manufacturer who is giving some thought to his product other than the ever-present "returns."—A. E. D.

PUBLICATIONS RECEIVED.

Proceedings of the American Society for Testing Materials, eleventh annual meeting, held at Atlantic City, N.J., June 23-27, 1908; 700 pages, 6 x 9; edited by the Secretary, University of Pennsylvania, Philadelphia, Pa.

Water and Sewage Purification in Ohio.—Report of an investigation by the Ohio State Board of Health; 900 pages, 6 x 9; secretary, C. O. Probst, M.D., Columbus, Ohio.

Proceedings of the thirty-fourth annual meeting of the New Jersey Sanitary Association, held December 4th and 5th, 1908, at Lakewood, N.J. Secretary, James A. Exton, M.D., Arlington, N.J.

Seventh Report of the Geographic Board of Canada, containing all decisions to June 30th, 1908. Deputy Minister of Marine and Fisheries, Ottawa.

Proceedings of the American Society of Mechanical Engineers, entitled "The Journal," March, 1909, 150 pp., 6 x 9.

Proceedings of the 18th annual convention of the American Railway Bridge Building Association, held in Washington, D.C., 325 pp., 6 x 9.

Annual Report of the Superintendent of the Montreal Waterworks for year ending December 31st, 1907. Geo. Janin, Superintendent.

Report of the subsidized railways and other public works in Nova Scotia for year ended September 30th, 1908, by Roderick McColl, M. Can. Soc. C.E., Provincial Government Engineer, Halifax, N.S.

Translation of papers by M. P. Tur, chief engineer of bridges and roads of Paris, on asphalt and wood pavements in Paris, and by M. Louis Mazerolle, engineer of bridges and roads of Paris, on the requisite qualities of wood for pavements, from the Chief Engineer, Board of Estimate and Apportionment, New York City.

Annual Report, Town of Truro, Nova Scotia, 1908, G. C. McDawell, Superintendent and Engineer.

Mixing and Placing Concrete by Hand, Bulletin No 20.—The Association of American Portland Cement Manufacturers, Land Title Building, Philadelphia, Pa.

A Manual of Corporate Management, containing forms, directions and information for the use of lawyers and corporate officials, by Thomas Conyngton; 420 pp., size, 6 x 9. Ronald Press Co., 229 Broadway, New York City.

We are in receipt of a telephone book holder issued by A. C. Leslie & Company, of Montreal. The cover is strong and durable, and will be found serviceable alike in the office and the workshop. The pages of a telephone directory will be kept in good shape by its stiff covers, while a strong wire hanger makes it still more useful. On the cover appears a list of some lines handled by this firm, including iron, steel and metals of many kinds.

CATALOGUES

Underfeed Stoker.—The Taylor Gravity Underfeed Stoker, manufactured by the American Ship Windlass Company, Providence, R.I., is described in a booklet just to hand.

Surveying Instruments.—The 33rd edition of the catalogue of Keuffel & Esser Company, Hoboken, N.J., just published, is the largest yet issued by this well-known firm, and will be of great interest to engineers and architects. It is handsomely bound, and contains many fine illustrations and descriptions of surveying instruments, drafting instruments, and drafting office furniture of all kinds. For the first time, illustrations are included showing the interiors of the general office and factory buildings. The fact that prices are quoted for the various articles makes the volume especially valuable. It comprises some 540 pages, well indexed, and may be obtained from the Montreal office, 252 Notre Dame Street West.

Engines and Boilers.—An elaborate volume has just been issued by the Atlas Engine Works, Indianapolis, Ind. It is profusely illustrated, and contains good descriptions of Corliss engines, high-speed engines, fire fronts and boilers of many kinds as well as other machinery along those lines. One section gives interesting information regarding steam engineering and the generation and transmission of steam power, while another contains valuable statistics. The book is well indexed.

Reinforced Concrete.—A pamphlet illustrating the unit system of reinforcing has just been issued by the Clinton Fireproofing Company, of Canada, Eastern Townships Bank Building, Montreal.

Municipal Supplies.—A most complete range of municipal equipment, including road building and maintaining machinery, is described and illustrated in a catalogue just issued by Mussens, Limited, of Montreal. It will be found useful by municipal officials who are interested in such machinery, and will be kept for reference, since it is the only publication of its kind. Copies may be obtained free of charge from Mussens, Limited, Montreal, Toronto, Cobalt, Winnipeg or Vancouver.

Malleable Iron Sundries for electric light construction are quoted in a pocket-size edition of Catalogue No. 562, issued by the Canadian General Electric Company, Toronto.

Chimney Construction.—The Weber Company, of Chicago, specialists for chimney construction, send an interesting booklet which contains a partial list of their customers. Many Canadian firms are included, as well as a number in the British Isles and Europe. We also received from them a booklet devoted to a review of concrete chimneys which includes much of interest.

Sewer Pipes.—An illustrated catalogue and price list comes from the Standard Drain Pipe Company of St. Johns, Quebec, manufacturers of all kinds of sewer pipes. Prices are quoted for pipes and connections, inverts, flue linings, chimney tops, and so on. It is a catalogue that should be filed for reference.

Electric Motors.—Two booklets are sent by Laurence, Scott & Company, Limited, of Norwich, England. Some interesting notes on continuous current electric motors, by W. H. Scott, M.I.E.E., are given and will be appreciated alike by the professional electrician and the user of dynamos and motors. Electric driving of rotary presses is also discussed in an intelligent manner.

Milling Machines.—From the Niles-Bement-Pond Company, of New York City, comes a handsome catalogue which is devoted exclusively to the many kinds of heavy milling machinery manufactured by this well-known firm. The aim of his book is to present descriptions of the more regular types and sizes of milling machines used by the trade. Many excellent illustrations are also included.

Belting.—F. Reddaway & Company, 56 St. Francois Xavier Street, Montreal, send a leaflet which gives a list of prices for their "Camel Hair" belting in various sizes.

Thermit Welding.—Two interesting pamphlets are to hand from the Goldschmidt Thermit Company, of 90 West Street, New York, and 103 Richmond Street West, Toronto. One is devoted to thermit welding of castings and forgings, while the other contains instructions for the use of thermit in railroad shops.

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.

Newfoundland.

ST. JOHN'S.—Tenders will be received until the 1st May, 1909, for a suitable steamer for the postal service in the district of Fortune Bay. The boat for this service must be from 100 to 130 tons nett measurement, fitted with all modern improvements, and to have accommodation for about twenty cabin and about forty steerage passengers. Further particulars may be obtained on application. R. Watson, Acting Colonial Secretary.

Quebec.

KNOWLTON.—Tenders for fittings for Post Office will be received until Tuesday, April 13, 1909. Plans and specifications may be seen on application to Mr. H. Hunt, Clerk of Works, Public Building, Knowlton, Que., and at the Department of Public Works, Ottawa. Napoleon Tessier, secretary, Department of Public Works.

QUEBEC.—Tenders will be received up to the 12th of April for iron castings, brass castings, lead pipe and pig lead, cement, brick and drain pipes, required by this department for the years 1909-1910. Jer. Gallagher, W. W. Engineer.

Ontario.

CORNWALL.—Tenders will be received until May 15th, 1909, for steel spans and concrete abutments for bridges. Address—Township Clerk of Charlottenburg, Cornwall, Ont.

FONTHILL.—For erecting church of brick, with stone basement. Address George C. Brown, clerk, up to Monday, April 12th.

GUELPH.—Tenders will be received until April 24th for the construction of a steel bridge and concrete abutments for same. James Hutcheon, engineer. (Advertised in The Canadian Engineer.)

GUELPH.—The Boards of Works will shortly call for tenders for paving materials required in connection with the improvements that will be made to a number of streets this season.

NEW LISKEARD.—Tenders will be received until May 1st: 1. For trenching and back-filling necessary to be done from the main to the street line as required for making house connections. 2. For tapping the mains, supplying all necessary material (except brass supplies), making connections, etc., as required for making house connections. F. W. Ferguson, secretary-treasurer, New Liskeard Water Commission.

NORTH BAY.—Tenders addressed to the undersigned for additions to fittings, North Bay Post-office, will be received until Tuesday, April 13, 1909. Plans and specifications may be seen on application to Mr. L. A. Gauthier, caretaker, Public Building, North Bay, Ont., and at the Department of Public Works, Ottawa, where all necessary information can be obtained. Napoleon Tessier, Secretary, Department of Public Works, Ottawa.

OWEN SOUND.—Tenders addressed to the undersigned for fittings, post-office customs and inland revenue offices at Owen Sound will be received until Tuesday, April 13, 1909. Plans and specifications may be seen on application to Messrs. Forster and Clark, architects, Owen Sound, and at the Department of Public Works, Ottawa, where all necessary information can be obtained. Napoleon Tessier, Secretary, Department of Public Works, Ottawa.

OTTAWA.—Tenders will be received until the 13th April, 1909, for 5,154 gross tons of eighty-pound steel rails (open hearth or Bessemer, at the option of the Commissioners), and the necessary fastenings, for delivery at West Fort William by the 15th June, 1909. Specifications may be obtained on application to Hugh D. Lumsden, chief engineer, Ottawa. P. E. Ryan, secretary, Commissioners of the Transcontinental Railway.

OTTAWA.—Tenders will be received up to the 15th of April for supplying and delivering the coal required for the Dominion Government steamers at St. John, Halifax, Pictou, Sydney, and Louisburg, and also the coal for the Sorel Shipyard and certain fog alarm stations in the Strait of Belle Isle, Gulf of St. Lawrence, River St. Lawrence, Nova Scotia, and New Brunswick, all in accordance with specifications prepared by the Department. Specifications and detailed information can be obtained here and from the agents of this department at Montreal, Quebec, St. John, Halifax, Pictou and Charlottetown. G. J. Desbarats, Acting Deputy Minister of Marine and Fisheries.

OTTAWA.—Tenders will be received until the 27th April, 1909, for the construction and erection complete of station buildings, section and tool houses, etc., as follows: —Section No. 1: From Lake Superior Junction to mile 1,629 (near Wabigoon River); Section No. 4, No. 2 station buildings; Section No. 2, No 3 station buildings, Section No. 5, section houses. Section No. 2: From mile 1,629 to mile 1,729 (N.E. of Rennie); Section No. 1, No. 1 station building; Section No. 2, No. 2 station building; Section No. 3, No. 3 station building; Section No. 4, section houses. Section No. 3: From mile 1,729 to St. Boniface; Section No. 2, No. 1 station buildings; Section No. 2, No. 2 station buildings; Section No. 4, No. 3 station buildings; Section No. 3, section houses. The work on each section must be completed on or before October 1st, 1909. Plans and specifications may be seen, and full information obtained, at the office of Mr. Hugh D. Lumsden, chief engineer, Ottawa, Ont., and Mr. S. R. Poulin, district engineer, Winnipeg, Man. P. E. Ryan, secretary, Commissioner of the Transcontinental Railway.

ST. CATHARINES.—The City of St. Catharines intends paving certain streets and invites final tenders for paving one or more of same either in vitrified brick, asphalt block, sheet asphalt, bitulithic or westrumite. Sealed tenders addressed to the Chairman of the Committee of Works will be received by the City Clerk until 15th April, 1909. D. Benzie, C.E., city engineer.

TORONTO.—Tenders will be received up to noon on April 30th, 1909, for supply of Underground Cable. Address, Joseph Oliver, (Mayor), Chairman, Board of Control.

TORONTO.—Mr. C. H. Rust, city engineer, is advertising for a dredge. Full particulars are given in advertisement, which appears elsewhere in this issue.

TORONTO.—Tenders will be received until April 14th for the construction of pavements, concrete walks, sewers, and the dredging of slips. Address—Joseph Oliver (Mayor), Chairman, Board of Control.

WATERLOO.—Tenders will be received until April 15th by A. E. Devitt, secretary, Public School Board, for the erection and completion of a two-storey brick schoolhouse to to be built in the town of Waterloo.

Manitoba.

BRANDON.—Tenders for cement will be received until April 16th for the supply of one thousand to two thousand barrels of Portland cement. W. H. Shillinglaw, City Engineer; Harry Brown, City Clerk. (Advertised in the Canadian Engineer.)

BRANDON.—Tenders for cement will be received until Friday, April 16, 1909, for the supply of one thousand to two thousand barrels of Portland cement, for the City of Brandon for the coming season. Specifications and form of tender may be obtained on application to W. H. Shillinglaw, city engineer, Brandon. Harry Brown, city clerk.

MEDICINE HAT.—Tenders for drilling a gas well will be received until April 30th. W. P. Morrison, City Engineer. (Advertised in the Canadian Engineer.)

WINNIPEG.—Tenders will be received for the following sub-contracts in connection with the erection of a transmission electric power system between Point du Bois and Winnipeg. Clearing, piling, ditches, bridges and culverts, complete footings and corduroy. Hunt, Noble & Card, 611 McIntyre Block.

Saskatchewan.

SASKATOON.—Tenders will be immediately asked for the construction of the new Canadian Northern passenger depot, and the work proceeded with and completed at the earliest possible moment. The station will be of brick and stone, and will be one of the handsomest in the system, and will cost $40,000.

SASKATOON.—Tenders will be received until Wednesday, April 28th, 1909, for smokestack of brick, steel or concrete, and for bricking in boilers. J. H. Trusdale, city clerk. (Advertised in The Canadian Engineer.)

British Columbia.

PRINCE RUPERT.—Tenders will be received up to the 27th April, 1909, for the erection and completion of a reinforced concrete wharf with timber superstructure at Prince Rupert, B.C. Plans at the offices of the Government agent, Prince Rupert; of the Government agent, New Westminister; of the provincial timber inspector, Vancouver, and at the Public Works Department, Victoria, B.C. Edward Mohun, Assistant Engineer, Public Works Department, Victoria, B.C.

VICTORIA.—Tenders will be received up to Monday, the 26th of April, for the erection and completion of a land registry office at New Westminster, B.C. Specifications may be seen at the office of the Public Works Engineer, Victoria, B.C.; at the office of the Government Agent, at New Westminster; and at the office of the Provincial Timber Inspector, Vancouver, B.C. F. C. Gamble, Public Works Engineer.

VANCOUVER.—Mr. G. A. McNichol, purchasing agent of the G.T.P., is calling for tenders for the construction of concrete abutments, piers and pedestals for six steel bridges that will be built this summer on the 100-mile section of the main line between Prince Rupert and Copper River. Tenders must be in before April 24th.

CONTRACTS AWARDED.

Nova Scotia.

SYDNEY.—The contract for the construction of Ice Piers at Annapolis has been awarded by the Department of Public Works, Ottawa, to the Nova Scotia Construction Company, recently formed in this city, of which Thomas Cozzolino is president, and A. A. McIntyre secretary. The contract is about $50,000.

New Brunswick.

FREDERICTON.—The contract for building the two masonry piers and two concrete abutments for the Hartt's Island Bridge at Fredericton Junction, Sunbury Company, has been awarded to Albert Brewer, of Woodstock. The contract price is about $3,600.

MONCTON.—At a recent meeting of the Water and Light Committee, Engineer Edington submitted a report on the various tenders for turbo-electric pumps, and said he had carefully examined and analysed them. He found that three firms had tendered practically according to the terms of specifications, viz., The John McDougall Caledonian Iron Works Company, Ltd., The Canada Foundry Company, and the Drummond McCall Company. After adding cost of erection, etc., to all the tenders, the engineer summarized the tenders as follows:—Drummond McCall Company, $5,799; Canadian Fairbanks Company, $5,488; John McDougall Iron Works, $5,440; Can. Crocker Wheeler Company, $4,980; Gould Pump Company, $4,920; Canada Foundry Company, $4,750; Peacock Brothers, $4,750; R. H. Buchanan, $4,713; Can. Buffalo Forge Company, $4,590; Canada Foundry Company, $4,377. After considerable discussion Alderman Martin moved that the matter be referred back to the engineer to communicate with the three different companies for further details in reference to their tenders, each company to give a guarantee.

Quebec.

MONTREAL.—Vice-President McNicoll, of the C.P.R., has just given out a contract to the Dominion Car & Foundry Company for the supply of five hundred 50-ton steel cars for delivery during the summer. The cars will be used to carry the coal traffic from the coal mines in Alberta and the Crow's Nest Pass district to the prairie cities and towns.

MONTREAL.—The Grand Trund Pacific have just given out several big orders for locomotives. The Montreal Locomotive Works, Longue Pointe, have received an order for twenty-five eight-wheel engines, to be delivered next July. An order has also been placed with the Algoma Sault Ste. Marie Steel Company, for 22,000 tons of eighty-pound steel for rails. These rails are intended for the prairie section of the line and are to be delivered at Fort William on the opening of navigation this spring.

In addition to this the G.T.P. have ordered from the Dominion Steel & Iron Company Sydney, N.S., 13,000 tons of eighty-pound steel rails, and 2,000 tons of sixty-pouna rails, sufficient to lay 21 miles of track, intended for sidings. This shipment will be moved entirely by boat around Cape Horn from Sydney to Prince Rupert. The Grand Trunk Pacific are now building for service on the Skeena River, B.C., two new steamers similar to the steamer "Distributor" built last fall. These steamers will ply between Prince Rupert and the head of navigation on the Skeena River, and will be ready for service in June. The 25 mogul engines, ordered by the G.T.P. from the Canadian Locomotive Company, of Kingston, are well under way. Delivery will be completed by July this year.

Ontario.

INGERSOLL.—At a recent meeting of the Property Committee the tender of P. H. Secord & Sons, of Brantford, amounting to $11,311, for the erection of a school, was recommended for acceptance.

OTTAWA.—It is stated on high authority that the contract for building the National Transcontinental Railway's shops at Winnipeg has been awarded to M. J. Haney & Quinlan & Robertson, of Toronto. The estimated cost is $863,000.

OTTAWA.—The Department of Public Works has awarded the following contracts:—For supply of electric fixtures for Guelph Armoury, F. R. J. McPherson Company, Ltd., Peterborough, Ont. For electric wiring of Dauphin public building, the town of Dauphin electric lighting department.

WATERLOO.—The following tenders were submitted for flushing sewers:—Paul Bergman $102, Ed. Dermul $105. The tender of Paul Bergman was accepted. For house connection: Paul Bergman, ¼-inch pipe,; 35c. ½-inch pipe, 44c.; ⅙-inch pipe, 38c.; ⅓-inch pipe 50c. Ed. Dermul, ¼-inch pipe, 30c.; ½-inch pipe, 38c.; ⅙-inch pipe, 38c.; ⅓-inch pipe, 50c. The tender of Ed. Dermul for house connections was accepted.

Manitoba.

WINNIPEG.—At a recent meeting of the Board of Control tenders were recommended for the construction of sewers as follows, each being the lowest for the work specified: Birds Hill Road. Poplar to north city limits, Thomas Jackson & Sons, $5,380.56; Hespeler Avenue, from Birds Hill Road to Glenwood Crescent, Thomas Jackson, $2,433.50; Brant Street, Elgin to Alexander, engineer of construction, $1,226.45; Glenwood Crescent, Hespeler to Hart, engineer of construction, $548.97; Crawford Avenue, from Mack to Scotia, $1,251.75; Arlington, from Yarwood to Notre Dame, engineer of construction, $737.50.

Alberta.

CALGARY.—The City Commissioners have decided to accept the following tenders in connection with pavements and sidewalks:—Blome Granatoid Concrete Paving Company, $2.50 a square yard; Winnipeg Bitulithic & Contracting Company, bitulithic pavement, $3.20 a square yard; Kettle River Quarry Company, Minneapolis, block pavement, $3.50 a square yard; the Calgary Paving Company, of Calgary, asphalt, $2 per square yard upon a bituminous base, and $2.85 on a concrete base. Batchelor, Marshall & Skarin, Calgary, cement, at $1.92 per square yard. The sidewalk contracts are divided up between McKibbon Bros, Calgary, tendering at 8.75 per square foot, and Forest City Paving Company, London, Ont., at 9.1 per square yard. Batchelor, Marshall & Skarin will get the contract for the catch basins. Some of the bids were: Creosote wood block, $3.28, $3.50, $3.70 per yard; bitulithic, $3.20, $3.05 per yard; asphalt, $2.25 per yard; concrete for streets and lanes, $1.92, $2.50, $2.72 per yard; granolithic sidewalks, 9 1-9c., 8 8-9c., 11c. per yard.

EDMONTON.—The City Council awarded the contract for the supply of the piping for the new power plant to the Babcock and Wilcox Company at $6,770 for the piping complete and erected. The contract for the supply of induced draught fans was awarded German, Clancey & Grindley at $3,400.

British Columbia.

VANCOUVER.—A contract for the supply of 390 miles of aluminium wire has been awarded by the British Columbia Electric Railway to the Great Northern Aluminium Company of Montreal.

VANCOUVER.—Tenders for sewer pipe were opened and the following are the figures: Evans, Coleman & Evans, $43,620.19 for material delivered; William O'Neil & Company, $44,615.25 for pipe f.o.b. The latter firm had tendered on a small part of the contract on Old Country types of fittings, but even deducting these totals Evans, Coleman & Evans were ahead in the bidding, and they received the award.

RAILWAYS—STEAM AND ELECTRIC.

New Brunswick.

MONCTON.—The Salisbury & Harvey Railway Bridge across the Shepody River, about seven miles from Albert, was washed away by the high tides last week, and as a result railway communication has been shut off from Riverside and Albert. It is expected to take about ten days to effect repairs to the bridge.

Quebec.

MONTREAL.—Mr. E. J. Chamberlin, vice-president and general manager of the Grand Trunk Pacific, is making his initial tour of the new transcontinental in the West, making arrangements for the opening of the spring construction campaign. Mr. Chamberlain is paying particular attention to the completion of the line from the big Battle River Bridge through to Edmonton, where it is hoped to complete the line from Winnipeg to Edmonton this summer. The grading has been completed from Battle River to Edmonton, and work will be hastened as much as possible in laying rails so as to get a through train service.

Ontario.

PORT ARTHUR.—Davis Bros., who have a contract to build 200 miles of the Grand Trunk Pacific, got a bill passed by the Railway Committee of the Legislature this week, authorizing them to build a 60-mile road from Lake Superior north, over which to take their supplies.

Manitoba.

WINNIPEG.—One of the important works along the line of the G.T.P. this summer will be the erection of passenger depots. They have already been built at the divisional points, but the next move will be to supply all the towns that have shown reasonable development. This work will be started in a few weeks.

Alberta.

EDMONTON.—Work is now in full swing on the completion of the last stretch of grading of the Edmonton-Macleod section of the Grand Trunk Pacific between the Pembina and the Macleod Rivers, 75 miles, the contract for which is held by Foley, Welsh and Stewart. It is the intention of the railway company, it is understood, to have this last strip of grading completed and to have the steel head at the Pembina before midsummer, and both steel bridges at the Pembina and the Macleod well under way before fall, in order that construction may proceed as rapidly as possible on the mountain section west of Wolf section, which is the last gap on the transcontinental to be completed. It is possible that work on this section may not be proceeded with until next year.

MACLEOD.—There is much activity in railway circles here. Work is being rushed on the cut off between Macleod and Lethbridge. Twenty car loads of bridge material left for a railway bridge over the Old Man River, ten miles east of here, and a force of 100 men is expected by the middle of the week to ballast the new road between Macleod and the river. A steam shovel was sent down to open up the gravel pit a mile east of Macleod, where there is an unlimited quantity of the finest material for ballasting purposes. It is expected the cut off will be completed by August.

British Columbia.

VANCOUVER.—Mr. E. J. Chamberlin, general manager of the G.T.P., told the News-Advertiser that the railway would come by the shortest feasible route to Vancouver. The contract for rails for the first hundred miles east from Prince Rupert had been let to the Dominion Iron & Steel Company and laying would begin not later than August. The contract would be let for the next one hundred miles in September.

LIGHT, HEAT, AND POWER.

Nova Scotia.

NEW GLASGOW.—A Bill has been introduced into the local Legislature to confirm an agreement by which all the plant, property, franchises, privileges and good-will of the New Glasgow Electric Light Company, Limited, are to be transferred to the Egerton Tramway Company, Limited.

Ontario.

WINDSOR.—D. A. Coste, representing the Volcanic Oil & Gas Company, has applied to the city for a franchise to supply Windsor with natural gas from the Tilbury field. He claims there is an abundant supply and plenty of capital to provide for expenditure of piping.

Saskatchewan.

NORTH BATTLEFORD.—The town of North Battleford will have electric lights installed this year.

Alberta.

EDMONTON.—Good progress is being made upon the construction of the new intake at the power house. Two of the five lengths of pipe have already been placed in position, and the work completed is the most difficult part, as the pipe is under about eight feet of water in the centre of the river.

TELEPHONY.

Ontario.

GUELPH.—Steps will at once be taken for the erection of a telephone line along the route of the transmission line from Hamilton to this city. This will be a private telephone of the Niagara Power Commission, and it will mark the route where, immediately after, the towers will be erected for the carrying of the big electric cables. In connection with the erection of the telephone line, Mr. Thomas R. Allison, mechanical engineer, is in the city as representative of J. F. H. Wyse, the contractor, who holds a sub-contract.

TILLSONBURG.—At a meeting of the provisional directors of the Tilbury Telephone Company last week, an order was placed for six carloads of telephone poles for their rural line. It is planned to have about thirty-five miles in operation within the next three months.

Manitoba.

PIPESTONE.—The telephone line is nearly completed and will be in working order in a few days. A petition is being largely signed by the ratepayers in Albert municipality to have the telephone extended there this summer.

Saskatchewan.

GOVAN.—The Govan Rural Telephone Company has been organized and will apply for incorporation at once. It is the intention of the company to put up about 60 miles of line this summer.

REGINA.—The latest issue of the Saskatchewan Gazette contains a notice of the incorporation of the North Regina Rural Telephone Company, Limited, of Regina.

FINANCING PUBLIC WORKS.

Nova Scotia.

YARMOUTH.—At a special meeting, held last Friday, the Town Council decided to borrow $12,000 for the extension of the town water main and $6,000 for the completion of the Milton engine house.

Saskatchewan.

GOVAN.—The ratepayers have endorsed the Council's action in calling for $4,000 debentures. It is the intention to try for a sufficient supply of water for the town.

MOOSE JAW.—On March 29th the citizens voted in favor of a by-law to raise $8,000 for sewer and waterworks extensions.

MISCELLANEOUS.

Quebec.

MONTREAL.—Steven Lund, of Chicago, who is interested in the California Construction Company of San Francisco, is at Montreal to build a seven million dollar bridge across the St. Lawrence. The bridge is to run from Montreal to St. Helen's Island, and from there to Longueuil. It is to carry eight tracks for all the railways that enter Montreal, and room for a car line and a driveway underneath. He guarantees to construct it in two years, but wants either the Provincial or Dominion Governments to guarantee five hundred thousand dollars for bonds covering the cost of the bridge.

Ontario.

LONG BRANCH.—Long Branch cottagers on Saturday authorized the construction of a wharf 65 feet in length, to be finished by May 1st.

FORT WILLIAM.—The work of laying the concrete foundations for the G.T.P. elevators will commence in a few days. The basement has been excavated and pile driving will be continued during the next week. The work of erecting machinery for the construction of the mammoth elevator is going steadily on.

PORT ARTHUR.—City Engineer Antonisen recently paid a visit to Onion Lake to inspect the dam. The work is progressing favorably, the cribbing being completed and filling in well under way.

Alberta.

EDMONTON.—John Galt, C.E., of Galt & Smith, Toronto, has been engaged to report on the gravity of the water supply system for this city.

EDMONTON.—Premier Rutherford made the statement recently that the new Parliament Buildings, upon which an outlay of over $1,250,000 will be made, will stand completed by the close of 1910. He said that the full amount of $300,000, voted by the Legislature for the construction of the building this year, will be expended and that the work would be proceeded with as rapidly as possible.

British Columbia.

VANCOUVER.—The Stewart River Gold Dredging Co. will install a dredge this season. The plant will have the capacity of handling 5,000 cubic yards daily. The company will make extensive tests of the ground with Keystone drills. Surveys will be made this season in connection with plans for the development of five thousand horse-power of electrical energy for operating the additional dredges the company intends to install each year during the next five years.

CURRENT NEWS

Ontario.

HAMILTON.—Until May 4th, Lees, Hobson & Stephens, solicitors, will receive tenders for timber berths in the Algoma district and along the Spanish River.

OTTAWA.—The Royal Trust Company will sell at the Russell House, Ottawa, on September 30th, a number of timber limits situated in Block A, Upper Ottawa, in the Province of Quebec. Further particulars may be obtained from the Ottawa branch of the Trust Company.

OTTAWA.—Hon. Geo. P. Graham, in reply to a question by Mr. Perley in the Commons last Friday, said that up to the end of February the building and equipment of the National Transcontinental Railway, from Winnipeg to Moncton, had cost $48,372,560. The Government estimate of the further amount required to complete the railway is $66,021,206, exclusive of the Quebec Bridge and terminals and the Winnipeg terminals.

Manitoba.

WINNIPEG.—Hudson Bay Railway survey party No. 2 has finished the work on the second of the four sections of the proposed railway line, and returned to Winnipeg. The party consisted of fourteen men in charge of J. J. Murphy, and left Winnipeg on September 1st, starting its work at the junction of the Goose and Grass Rivers, and finishing at the ending point of survey party No. 1, under Mr. Low.

Alberta.

CALGARY.—Seventy-five members of the engineering staff of the Canadian Pacific Irrigation Colonization Company take the field this week. Twelve camps will be established at once, and, in addition to doing work incidental to the completion of 600 miles of canals and ditches now under contract, work started last year will be finished.

MACLEOD.—Work on the last pier of the Government Bridge over the Old Man River, is being pushed forward vigorously. The steel work will probably be commenced during the present week.

MEDICINE HAT.—The Southern Alberta Land Company has started out its first survey party of the season under Superintending Engineer A. M. Grace and Assistant Engineers McIntosh, Wallace and Putman. The party went to Lethbridge by train, and will work out north to the Bow River surveying land in that district. This first party consists of ten members, but it is the intention to break it up shortly into three, each of which will be under the respective direction of one of the assistant engineers, when the staff will be largely increased.

Quebec.

QUEBEC.—The lease of "Kai-Kai-Ke" and the "Island Rapids" groups of water-powers will be offered for sale at public auction in the sales room of the Department of Lands and Forests on the 11th May. The "Kai-Kai-Ke" group is situated in the County of Pontiac and its power at low water is 32,980 horse-power. The "Island Rapids" group, whose power is 32,000 horse-power, is situated in the same county. For further particulars, address: Jules Allard, Minister of Lands and Forests, Quebec.

British Columbia.

VANCOUVER.—Wynn Meredith, who acted as consulting electrical engineer for the British Columbia Electric Railway Company at the time its plant on the North Arm of the inlet was installed, is again in the city consulting with the management of the company regarding the extension of its plant and improvement at Lake Buntzen.

Yukon.

DAWSON.—Not for several years has there been such activity in this city as is witnessed each day now. All the dredge and hydraulic companies are rushing the work of getting their fuel and other necessities in place and preparing to operate on an extensive scale. The Guggenheims are putting big crews to work. Twelve miles of new ditch will be built by them on Bonanza Creek this summer. Several power schemes are under way and one or more dredging companies will get into the field the coming season.

PERSONAL.

The firm of FETHERSTONHAUGH, BLACKMORE & DENNISON, patent solicitors, have changed the firm name to Fetherstonhaugh, Dennison & Company. Their Ottawa office will be removed to 25 Spark Street, while the other offices will remain the same.

MR. W. E. WATSON, managing director of the Atlas Metal & Alloys Company, Limited, London, Eng., has just returned to the Old Country after having spent some time here appointing sales agents. Messrs. Baines and Peckover, of Toronto, will look after the Ontario territory.

MR. C. G. HAFLEY, formerly advertising manager for the Buffalo Forge Company, Buffalo, N.Y., and more recently with Keuffel & Esser Company, Hoboken, N.J., has taken a position with the Vechten Waring Company, 92 John Street, New York, as assistant to Mr. Waring in the advertising service department.

MR. GEO. T. CLARK, B.A., who for a number of years has been engaged with Galt & Smith, consulting engineers, Toronto, Ont., has been appointed city engineer of Saskatoon, Sask. Mr. Clark was born at Campbellford, Ont., and after completing a course in the public and high schools of the Province entered Toronto University, taking his degree in mathematics. Later he graduated with honors from the School of Practical Science. In practical work Mr. Clark has had splendid experience, having had charge of the municipal work in Indian Head, Maple Creek, Sask., and Palmerston, Ont. Mr. Clark enters upon his new duties at once.

MR. Z. A. LASH, K.C., who as general counsel of the Canadian Northern Railway Company was responsible for all the legal details in connection with that corporation, has appointed Mr. F. H. Phippen, of Winnipeg, to take up his work, and the appointment will take effect about the middle of this month. Mr. Lash is a director of the C.N.R. and Mackenzie-Mann Companies, and the burden of detail work has been pressing heavily upon him for a long time. He will now be free to act as a director in the various fields where the companies' interests lie, and he will thus be able to relieve Messrs. Mackenzie & Mann of a great deal of work. Mr. Phippen, who was one of the judges in the Manitoba Court of Appeals, resigned that position about a week ago to allow of his taking up his new work.

MR. L. A. HERDT, who has just been made a full professor of electrical engineering in the Faculty of Applied Science at McGill University, is a McGill man, having graduated from the department of mechanical engineering here in 1896. On leaving McGill, Professor Herdt went to Paris to pursue research work at the Laboratoire Centrale. Next he took a course in electrical engineering at the Montefiore Electro-Technical Institute at Liege, Belgium, where he obtained the degree of E.E., with honors. This was followed by his appointment to the staff of the Thomson-Houston Electrical Company of France. In 1899 Professor Herdt returned to Montreal and was appointed demonstrator in electrical engineering, and rose to be lecturer, assistant professor, and last year associate professor of electrical engineering. Two years ago he was appointed by the Canadian Engineering Societies as Canadian delegate to the International Electro-Technical Commission which met in London, to study the question of the standardization of electrical machinery. In 1905 Professor Herdt was appointed Officer d'Academie by the Government of France. He is the author of a number of articles which have appeared in technical publications, and in connection with the transactions of the American Institute of Electrical Engineers and the Canadian Society of Civil Engineers. He has carried on a great deal of research work and his services as consulting engineer are much sought after. He is at the present time a member of a board of consulting engineers engaged on hydro-electrical works for the city of Winnipeg.

MARKET CONDITIONS.

Montreal, April 6th, 1909.

Advices from the Pittsburg district are to the effect that although reductions in wages have not all been accepted it is not expected that any trouble will arise over them. Employment is scarce and under such circumstances workmen are not so likely to resist decreases as when the opposite is the case. Further wage reductions are being quietly put into force in other sections also. Purchasing of pig-iron is being delayed and no trouble is anticipated by buyers, as the most of them are considerably overbought. This applies particularly to steel works. There has been a decided decrease in unfilled tonnage and an increase in stocks, although such increase is not so large as anticipated. There seems to be a feeling that the Payne Bill is now dead, as a practical issue. It was expected all along that it would be subjected to alterations, but it now looks as though it might be thrown out altogether. It is so shaped as to invite opposition and criticism from industries affected and in addition is not well adapted to the raising of revenue, so it is claimed. The fact that it was proposed to accept some 250 amendments to it is significant.

The English market is showing a slightly upward tendency. This is a little difficult to account for, in view of the fact that the home demand is poor and stocks are on the increase. However, the market is irregular and easily influenced, and at present shows a rise of fully a shilling from the low point, notwithstanding continued bad reports from the United States, and also from Germany. The advance in price seems to be due, as much as anything else, to the settlement of the Balkan crisis, this having eliminated the danger of trouble for the time being, at least. The position with regard to finished material has not shown improvement during the past week, save in the case of rails, which are in better demand. At the same time, English merchants are pleased to know that the market is not going from bad to worse, the tendency towards improvement giving rise to hope of a better development later on.

In the local market, matters are progressing favorably. Consumers have pretty well covered their requirements for the next three or four months to come, and are deferring purchases for later delivery, owing to the impression that lower prices may yet be made a little later on. In this, however, they are very apt to meet disappointment, particularly in English or Scotch metals. In fact, purchasers of these, to-day, would have to pay about 25c. per ton over recent prices. Even United States prices appear to have about reached bottom, although these have little effect upon the Canadian market.

It is a very long time since the local market for finished or semi-finished material has shown so little tendency to alter in the matter of prices. Once more, quotations are repeated without so much as an alteration in the more permanent lines, fluctuations in certain metals, however, being constantly in progress without altering the general level one way or the other.

Antimony.—The market is steady at 9 to 9½.

Bar Iron and Steel.—Prices are steady all round, and trade is dull. Bar iron, $1.90 per 100 pounds; best refined horseshoe, $2.15; forged iron, $2.05; mild steel, $2.00; 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, $7.10; smooth finish, $2.75.

Boiler Tubes.—The market is steady, quotations being as follows:— 2-inch tubes, 8½c.; 2½-inch, 10c.; 3-inch, 11½c.; 3½-inch, 14¾c.; 4-inch, 19c.

Building Paper.—Tar paper, 7, 10, or 16 ounces, $1.60 per 100 pounds; felt paper, $2.40 per 100 pounds; tar sheathing, No. 1, 35c. per roll of 400 square feet; No. 2, 35c.; dry sheathing, No. 1, 45c. per roll of 400 square feet, No. 2, 28c. (See Roofing; also Tar and Pitch).

Cement.—Quotations are for car lots, f.o.b., Montreal. Canadian cement is $1.55 to $1.65 per 350-lb. bbl., in 4 cotton bags, adding 10c. for each bag. Good bags re-purchased at 10c. each. Paper bags cost 2½c. extra, or 10c. per bbl. weight. English cement is $1.65 to $1.85 per 350-lb. bbl. in 4 jute sacks (for which add 8c. each) and $2.20 to $2.40 in wood. Begian cement is $1.60 to $1.65 in bags—bags extra—and $2.10 in wood.

Chain.—The market is steady as follows:—¼-inch, $5.30; 5-16-inch, $4.05; ⅜-inch, $3.65; 7-16-inch, $3.45; ½-inch, $3.20; 9-16-inch, $3.15; ⅝-inch, $3.05; ¾-inch. $3; ⅞-inch, $2.95; 1 inch, $2.95.

Copper.—The market is about steady at 14½ to 15c. per lb. 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 strentgh, 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.

Galvanized Iron.—The market is steady. Prices, basis, 28-gauge, are:— Queen's eHad, $4.40; Comet, $4.25; Gorbal's Best, $4.25; Apollo, 10¾ oz., $4.35. Add 25c. to above figures for less than case lots; 26-gauge is 25c. less than 28-gauge. American 28-gauge and English 26 are equivalents, as are American 10¾ oz., and English 28-gauge.

Galvanized Pipe.—(See Pipe, Wrought and Galvanized).

Iron.—Prices are rather higher, and the outlook is steady. The following prices are ex-store: Canadian pig, $18.50 to $19.50 per ton; No. 1 Summerlee, $21 to $22; No. 2 selected Summerlee, $20.50 to $21.50; Carron soft, $20.25 to $20.75; No. 3 Clarence, $19 to $20 per ton.

Laths.—See Lumber, etc.

Lead.—Trail lead is firmer, at $3.75 to $3.85 per 100 pounds, ex-store.

Lead Wool.—$10.50 per hundred, $200 per ton, f.o.b., factory.

NEW INCORPORATIONS.

Montreal.—Mines Power, $3,000,000; E. C. Warren, E. A. Wallberg, J. P. Nicholas. Starlight Mining Smelting & Developing Co., $20,000; I. E. Hyman, H. J. Hyman, H. M. Levine. Cobalt Island Co., $1,000,000; G. R. Lightall, F. Bacon, T. Bacon. C. Meredith & Co., $300,000; J. J. Reed, H. B. MacDougall, W. F. Daniels.

TENDERS CALLED FOR

CITY OF SASKATOON

PROVINCE OF SASKATCHEWAN.

TENDERS FOR EXCAVATING AND PIPELAYING.

Sealed Tenders will be received by the City Clerk until 8 p.m. on Tuesday, April 13, 1909, for all labour necessary for laying water mains and sewer pipes, and furnishing certain materials therefor according to plans and profiles dated April 1st, 1909.

Plans and specifications may be seen at the office of the Chief Engineer, 103 Bay Street, Toronto, or at the office of the City Clerk, Saskatoon, on and after April 1st, 1909.

WILLIAM HOPKINS, Esq.,
Mayor, Saskatoon.
J. H. TRUESDALE, Esq.,
City Clerk, Saskatoon.
WILLIS CHIPMAN, C.E.,
103 Bay Street, Toronto, Ont.

TENDERS FOR BRIDGE

Tenders will be received by the undersigned up till noon on Saturday, April 24th, for the construction of a steel bridge of 82½ feet span over the River Speed, in the Township of Puslinch, and also for the construction of concrete abutments for the same bridge.

Plans and specifications may been seen at my office or at the residence of any member of the Township Council.

JAMES HUTCHEON,
Engineer, Guelph.

April 5th, 1909.

Lumber, Etc.—Prices on lumber are for car lots, to contractors, at mill points, carrying a freight rate of $1.50. At the moment, the market is exceptionally irregular and prices are uncertain. Red pine, mill culls out, $18 to $22 per 1,000 feet; white pine, mill culls, $22 to $25. Spruce, 1-in. by 4-in. and up, $16 to $18 per 1,000 ft.; mill culls, $14 to $16. Hemlock, log run, culls out, $14 to $16. Railway Ties; Standard Railway ties, hemlock or cedar, 35 to 45c. each, on a 5c. rate to Montreal. Telegraph Poles: Seven-inch top, cedar poles, 25-ft. poles, $1.35 to $1.50 each; 30-ft., $1.75 to $2; 35-ft.., $2.75 to $3.25 each, at manufacturers' points, with 5c. freight rate to Montreal. Laths: Quotations per 1,000 laths, at points carrying $1.50 freight rate to Montreal, $2 to $3. Shingles: Cedar shingles, same conditions as laths, X, $1.50; XX, $2.50; XXX, $3.

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.—The market continues steady at $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, $3.10 per 100 pounds. Gas pipe is quoted at about $1 more than the above.

Pipe.—Wrought and Galvanized.—The market is steady, moderate-sized lots being: ¼-inch, $5.50 with 63 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 50 per cent. off for galvanized; ½-inch, $8.50; ¾-inch, $11.50; 1-inch, $16.50; 1¼-inch, $22.50; 1½-nch, $27; 2-inch, $36; 2½-inch, $57.50; 3-inch, $75.50; 3½-inch, $95; 4-inch, $108.

Rails.—Quotations on steel rails are necessarily only approximate and depend upon specification, quantity and delivery required. A range of $31.50 to $32.50 is given for 60-lb., 70-lb., 80-lb., 85-lb., 90-lb., and 100-lb. rails, per gross ton of 2,240 lbs., f.o.b. mill. Re-laying rails are quoted at $27 to $29 per ton, according to condition of rail and location.

TENDERS WANTED

CITY OF SASKATOON

Sealed Tenders addressed to the undersigned will be received until 5 o'clock p.m., Wednesday, April the 28th, 1909, for the following:—

(a) One Brick, Steel or Concrete Smokestack with a height of 100 feet and inside diameter of 66 inches, together with corresponding smoke connection to boilers.

(b) Bricking in two 250 horse-power Robb Mumford water tube boilers.

Plans and specifications may be seen at the office of the Electrical Superintendent.

A marked cheque for $100 must accompany tender.

The lowest or any tender not necessarily accepted.

E. L. WHITE, Electrical Superintendent.
J. H. TRUSDALE, City Clerk.

DREDGE WANTED

The purchase or rental of a clam-shell or orange-peel dredge with boom of about one hundred feet, for work near Toronto is contemplated.

Dredge owners are recommended to communicate forthwith with the City Engineer, Toronto, describing plant of such nature, which they may wish to rent or sell.

C. H. RUST, City Engineer.

Railway Ties.—See lumber, etc.

Roofing.—Ready roofing, two-ply, 64c. per roll; three-ply, 86c. per roll of 100 square feet. (See Building Paper; also Tar and Pitch).

Rope.—Prices are steady, at 9½c. per lb. for sisal, and 12c. for Manila. Wire rope, crucible steel, six-strands, nineteen wires; ¼-in., $2.75; 5-16, $3.75; ⅜, $4.75; ½, $6; ⅝, $7.25; ¾, $8.50; ⅞, $10; 1-in., $12 per 100 feet.

Spikes.—Railway spikes are in dull demand and prices are steady at $2.30 per 100 pounds, base of 5½ x 9-16. Ship spikes are also dull and steady at $2.85 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.—The market is steady. Quotations are: $2.15 for 3-16; $2.25 for ⅛, and $2.15 for ¼ andthicker; 12-gauge being $2.30; 14-gauge, $2.15; and 16-gauge, $2.10.

Telegraph Poles.—See lumber, etc.

Tar and Pitch.—Coal tar, $4 per barrel of 40 gallons, weighing about 500 pounds, roofing tar, $3.15 per barrel; roofing pitch, No. 1, $1 per 100 pounds; and No. 2, 50c. per 100 pounds; pine tar, $8.50 per barrel of 40 gallons, and $4.75 per half-barrel; pine pitch, $4 per barrel of 180 to 200 pound. (See building paper; also roofing.

Tin.—Prices are 32c. to 32½c.

Zinc.—The market is steady at 5½ to 5¾c.

(Continued on Page 46.)

Water Supply—Young Man, University Technical Training, experienced water filtration, desires position with engineer engaged in water supply and sanitary engineering. At present employed. Box 20, Canadian Engineer.

THREE APPOINTMENTS TO BE MADE.

Professors of Civil, Mechanical and Electrical Engineering. The Government of Nova Scotia will appoint men to above three chairs in its Technical College during June or July. Applicants must have college degree and also practical experience. Address:

NOVA SCOTIA TECHNICAL COLLEGE,
Halifax, N.S.

AMONG THE MANUFACTURERS

A department for the benefit of all readers to contain news from the manufacturer and inventor to the profession.

STEEL BUSINESS OF WESTERN CANADA.

The enormous and rapid development of Winnipeg and Western Canada during the past few years has been remarkable not only for the number of buildings erected, their value as indicated by increased city building records, but more particularly by the marked improvement in the class of structures designed and erected, in which steel forms a prominent structural feature. The ever-increasing demand for better construction, more durable, lasting and fire resisting materials as entering into the construction of the highest type of buildings, is demanding of Western manufacturers large extensions of plant and equipment with which to meet the increased business in this class of materials.

Owing to the very large demand for structural steel throughout Western Canada, the Dominion Bridge Company, Limited, the largest Canadian manufacturers of bridge and structural materials, will make extensive additions to their shops at Winnipeg.

Their present plant in Winnipeg, which is the largest structural steel shop in Western Canada, now having a capacity of 400 tons' output of steel per month, will this summer be enlarged by a 400 foot addition to the present buildings, and fully equipped with the most modern machinery. When completed, this plant will be in a position to turn out per month one thousand tons of structural steel and bridge material. The Winnipeg works now carry in stock from 1,500 to 2,000 tons of raw material, which stock will be increased to 4,000 tons, including all sizes of beams, channels, plates, angles, tees, and other structural shapes.

The Dominion Bridge Company have within the past few years furnished and erected the structural steel for the majority of the largest steel buildings in Winnipeg and Western Canada, notable amongst which are the following Winnipeg buildings in which over 15,000 tons of structural steel was supplied and erected:—Canadian Pacific depot and train shed, Royal Alexandra Hotel, Union Bank building, Fort Garry Station, Fort Garry freight sheds, St. Boniface Cathedral, Bank of Nova Scotia, Walker Theatre, Osler, Hammond and Nanton building, Pilkington Bros. warehouse, Canadian Pacific Railway shops, Canadian Northern Railway shops, North Western Bronze Company, Bon Accord Block, Bell Telephone buildings, Maw's garage, Gardner building, Kennedy building, Kensington Block.

This company also supplied all the structural steel for Regina Post Office, Regina Legislative Buildings, Regina Collegiate Institute. All the Western Canadian Pacific engine houses, Canadian Pacific Railway station at Calgary, Canadian Pacific 30-stall engine house at Kenora, Canadian Pacific Western hotels. In which buildings a further tonnage of over 10,000 tons was supplied.

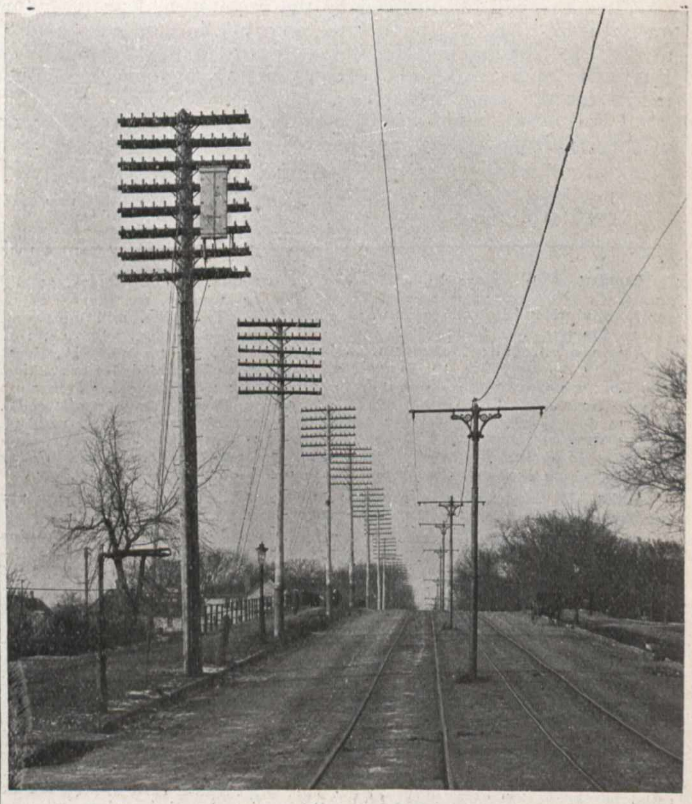
Very extensive works were carried through during the past winter in Winnipeg, such as the new Fort Garry station, terminals, and freight shed works, Bank of Nova Scotia building and Redwood Avenue bridge, calling for the erection of over 3,000 tons of steel. This work was completed in record time, and erection work was maintained throughout the heaviest winter weather, by a force of over one hundred bridge and structural iron workers.

The Western representative of the company, Mr. E. E. Sheppard, informs your correspondent that this coming building season promises unusual activity and phenomenal development in the structural steel business of the West, the local plant having now on hand a large number of orders for immediate delivery with further bookings called for a very heavy addition on the season's output.

It is the intention of the company that all of the structural steel supplied by them to buildings in Winnipeg and the West will be fabricated in their Winnipeg plant, and the heaviest class of bridge and building steel will be furnished from material carried in stock at Winnipeg.

BRITISH COLUMBIA'S CEDAR MAKES SPLENDID POLES.

British Columbia is known for its splendid forest trees, probably as much as for any of its natural products. The British Columbia cedar, from which splendid telephone poles are made, grows straight and round to a great height. The Lindsley Brothers Company, a registered Canadian corporation with head offices in Spokane, Wash., are now going into the market with a larger stock of telephone poles than they ever carried before, the total being nearly 150,000 poles. In Canada they direct their operations from Nakusp, B.C., where they have a large yard stocked with about 20,000 poles. At Summit Lake they have 15,000 poles and as many more are now arriving. The company claim to be the only pole "specialists" doing business in British Columbia timber, and they name delivered prices to any point, making a



specialty of seasoning their poles throughout before shipment. They keep in stock poles of all sizes from five-inch, twenty-five feet to eighty feet. The company claim that the western pole is capable of being shipped into the eastern market in competition with eastern prices and that the buyers obtain a superior pole. They have been in operation now for fifteen years, and with a manager in charge of every yard, inspecting the poles when they arrive and when they are shipped, they are able to produce splendid poles. They also are equipped to furnish cross arms from their factory in Portland, Oregon, the heart of the Douglas fir country. This factory is equipped entirely with modern machinery and manufactures only Douglas, red fir cross arms. Mr. G. L. Lindsley represents the company at Chicago, where their eastern sales office is located in the Monadnock Block.

Idaho and British Columbia cedar, the company claim, are identically alike in quality and appearance. They state that it is a misnomer to refer to "western cedar" as "red cedar," because the timber is not red and the odor is radi-

cally different from the Tennessee red cedar. It is also darker in color than Michigan or Ontario cedar. Western or British Columbia cedar is noted for its great height, straightness and roundness. In some cases although the butts do not equal in size, those of eastern cedar, the company state that they make up in strength what they lack in girth.

The Lindsley Company claim to be the originators of the term "Western Cedar," having adopted it in their advertisements eight years ago, and also to be the original shippers and introducers of western poles to the east, having been carrying on this class of business for nearly ten years. They state that the western pole has withstood the test of strength everywhere, and that it is being specified for its durability and strength in preference to other classes, particularly in the United States where Michigan white cedar and western cedar have been put to a comparative test, with the following results: Two samples of Michigan white cedar both cracked and broke at a pressure of 900 for the first sample and 800 for the second. Four samples of western cedar cracked and broke at the following pressures: No. 1, 1,600; No. 2, 1,100; No. 3, 1,400; No. 4, 1,100. The tests were made at the Pittsburg testing laboratory. Sections number one in both Michigan and western cedar were cut from the butts of the poles after being seasoned at the point, six feet from the butt, so as to get ground line resistance. The No. 2 samples were taken five feet from the top so as to get resistance at cross arms.

MARKET CONDITIONS—Continued from Page 43.

Winnipeg, April 6th, 1909.

With spring-like weather during the past week the building situation in Winnipeg and Western Canada has pushed ahead very rapidly, and nearly all the proposed structures have been started. Dealers report that orders are coming in very well from the country and they are busier at this season of the year than they have been for some years past.

The factories engaged in making builders' wood-work supplies are exceptionally busy. One manager of a wood-work factory stated that they would very soon have as many men employed as they had during the busy times of two years' ago, and he added that the quality of the work called for is improving.

The work on the Union Depot is progressing very satisfactorily, and the structural steel work on this will soon be completed.

Winnipeg quotations remain steady and the demand is steadily increasing.

Winnipeg quotations are as follows:—

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.—$3 to $3.25 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 M, three grades.

Cement.—$2.25 to $2.50 per barrel, in cotton bags.

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.

Dynamite.—$11 to $13 per case.

Hair.—Plaster's, 80 to 90 cents per bale.

Hinges.—Heavy T and strap, per 100 lbs., $6 to $7.50; light, do., 65 per cent.; screw hook and hinge, 6 to 10 inches, 5¼c. per lb.; 12 inches up, per lb., 4¼c.

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.

Lead Wool.—$10.50 per hundred, $200 per ton, f.o.b., Toronto.

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.

Picks.—Clay, $5 dozen; pick mattocks, $6 per dozen; clevishes, 7c. per lb.

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

Plaster.—Per barrel, $3.

Roofing Paper.—60 to 67½c. per roll.

Lumber.—No. 1 pine, spruce, tamarac, British Columbia fir and cedar—

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

Tool Steel.—8½ to 15c. per pound.

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, $24.50; No. 1 clear cedar, 6-inch, 8 to 16 ft., $60; Nos. 1 and 2 British Columbia spruce, 6-inch, $55; No. 3, $45.

WHERE TO BUY

An Engineering Trades Directory.

FOR INDEX TO ADVERTISERS SEE PAGE 3.

Air Compressors
Mussens Limited, Montreal, Que.
Reavell & Co., Ltd., Ipswich, Eng.

Anvils
Leslie & Co., A. C., Montreal, Que.

Automatic Railways
Babcock & Wilcox, Ltd., Montreal,

Bars, Steel.
Priddle, Arthur San Francisco, Cal.

Batteries, Storage
D. P. Battery Co., Ltd., Bakewell, Derbyshire, England.

Belting
McLaren, D. K., Ltd., Montreal, Que.
McLaren Belting Co., J. C., Montreal,

Boilers, Marine, Stationary and Water Tube
Babcock & Wilcox, Ltd., Montreal,
Petrie, H. W., Ltd., Toronto, Montreal, Vancouver.

Bonding for Concrete.
Canada Wire Goods Mfg. Company, Hamilton, Ont.
Priddle, Arthur San Francisco, Cal.

Books, Technical
John A. Hart & Co.,

Boring Tools
Armstrong Bros. Tool Co., Chicago, Ill., U. S. A.
Mussens Limited, Montreal, Que.

Bridges, Roof Trusses, etc.
Canadian Bridge Co., Ltd., Walkerville, Ont.
Cleveland Bridge & Engineering Co., Ltd., Darlington, England.
Dominion Bridge Co., Ltd., Montreal,
Hamilton Bridge Works Co., Ltd., Hamilton.
Pennsylvania Steel Co., Steelton, Pa.
Structural Steel Co., Ltd., Montreal Que.

Buckets (Clam Shell, Coal and Concrete)
Mussens Limited, Montreal, Que.

Cableways
Mussens Limited, Montreal, Que.

Car Hauls (Wire Cable and Chain).
Jeffrey Mfg. Co., Montreal, Que.

Cement, Machinery
Mussens Limited, Montreal, Que.

Coal Cutters.
Jeffrey Mfg. Co., Montreal, Que.

Coal Crushers
Babcock & Wilcox, Ltd., Montreal,

Coal Handling Machinery
Northern Engineering Works, Detroit, Mich.

Coal Tipples and Screenes.
Jeffrey Mfg. Co., Montreal, Que.

Contractors
Cleveland Bridge & Engineering Co., Ltd., Darlington, England.

Concrete Mixers
Mussens Ltd., Montreal, Que.
Rogers Supply Co., Toronto.

Converters, Rotary
Toronto & Hamilton Electric Co., Hamilton, Ont.

Conveyors
Babcock & Wilcox. Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

(Continued on page 50.)

WHERE TO BUY.

(Continued from Page 48).

Cranes
Advance Machine Works, Ltd., Walkerville, Ont.
Dominion Bridge Co., Ltd., Montreal.
Mussens Limited, Montreal, Que.
Northern Engineering Works, Detroit, Mich.
Pennsylvania Steel Co., Steelton, Pa.
Structural Steel Co., Ltd., Montreal, Que.

Damper, Regulators
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.

Derricks
Dominion Bridge Co., Ltd., Montreal,
Mussens Limited, Montreal, Que.
Northern Engineering Works, Detroit, Mich.
Structural Steel Co., Ltd., Montreal, Que.

Draughting Supplies
Berger & Sons, C. L., Boston, Mass.,
Hart Co., John A., Winnipeg, Man.

Drawing Material.
Keuffel & Esser Co., Hoboken, N. J.

Drills
Canadian Buffalo Forge Co., Montreal and Toronto.
Mussens Limited, Montreal, Que.

Dust Separators.
Canadian Buffalo Forge Co., Montreal and Toronto.

Drying Apparatus.
Canadian Buffalo Forge Co., Montreal and Toronto.

Dynamos and Motors
Laurence Scott & Co., Ltd., Norwich, England.
Toronto & Hamilton Electric Co., Hamilton, Ont.

Economizers
Babcock & Wilcox, Ltd., Montreal.

Electric Apparatus
Hill Electric Mfg. Co., Montreal, Que.
Toronto and Hamilton Electric Co., Hamilton, Ont.

Electrical Supplies
Hill Electric Mfg. Co., Montreal, Que.
Phillips, Eugene F., Electrical Works, Ltd., Montreal, Canada.

Elevators
Jeffrey Mfg. Co., Montreal, Que.
Northern Engineering Works, Detroit, Mich.

Engineers, Consulting
Barber F.
Beaubien, Gaspe de, Montreal.
Cleveland & Dutcher, Vancouver, B.C.
Francis, W. J. Montreal, Que.
Fuce, Ed. O., Galt.
Gagne & Jennings, Toronto, Ont.
Haffner, H. J., Calgary, Alta.
Metcalf Engineering Co., Ltd., Montreal, Que.
Mitchell, C. H., C.E., Toronto, Ont.
Nold, Henry N., Hamilton.
Rebbeck, J. R., Victoria, B.C.
Richmond, J. Stanley, Toronto.
Standard Inspection Bureau, Limited, Toronto, Ont.

Engineering Instruments.
Keuffel & Esser Co., Hoboken, N. J

Engines
Canadian Buffalo Forge Co., Montreal and Toronto.
Mussens Limited. Montreal, Que.
Northern Engineering Works, Detroit, Mich.
Reavell & Co., Ltd., Ipswich, Eng.
Petrie, H. W., Ltd., Toronto, Montreal, Vancouver.

Fans and Blowing Apparatus
Canadian Buffalo Forge Co., Montreal and Toronto.

Feed Water Heaters and Purifiers
Babcock & Wilcox, Ltd., Montreal.

Fence, Fencing, Wire
Owen Sound Wire Fence Co.

Fire Brick and Clay
Leslie & Co., A. C., Montreal.

Forgings, Drop
Coghlin & Co., B. J. Montreal, Que.

Foundry Supplies
Mussens Limited, Montreal, Que.

Generators, Alternating and Direct Current
Toronto & Hamilton Electric Co., Hamilton, Ont.

Heating and Ventilating Machinery.
Canadian Buffalo Forge Co., Montreal and Toronto.

Hoists, Electric and Pneumatic
Northern Engineering Works, Detroit, Mich.

Hydraulic Machinery.
Canadian Buffalo Forge Co., Montreal and Toronto.

Iron Bar, etc.
Leslie & Co., A. C., Montreal

Inspections
Standard Inspection Bureau, Limited, Toronto, Ont.
Dominion Bureau, Montreal, Que.

Ladles
Northern Engineering Works, Detroit, Mich.

Locomotives (Electric).
Jeffrey Mfg. Co., Montreal, Que.

Mechanical Draft Motors.
Canadian Buffalo Forge Co., Montreal and Toronto.

Motors
Laurence Scott & Co., Ltd., Norwich, England.
Mussens Limited, Montreal, Que.
Toronto & Hamilton Electric Co., Hamilton, Ont.

Patent Attorneys
Budden, Hanbury A., Montreal, Que.
Ridout & Maybee, Toronto, Ont.

Planer Tools
Armstrong Bros. Tool Co., Chicago, Ill., U. S. A.
Mussens Limited, Montreal, Que.

Poles, Telegraph and Telephone.
Lindsley Bros. Co., Spokane, Wash.
Sterling, W. C. & Son Co., Monroe, Mich.

Portland Cement
Hartranft Cement Co., Wm., Montreal, Que.

Posts
Lindsley Bros. Co., Spokane, Wash.

Presses, Hydraulic and Power
Mussens Limited, Montreal, Que.
Wood & Co., R. D., Philadelphia, Pa.

Pressure Regulators
D'Este Co., Julian, Boston, Mass.

Prison Work.
Canada Wire Goods Mfg. Company, Hamilton, Ont.

Pulleys
Mussens Limited, Montreal, Que.

Pumps—Steam and Power.
Canadian Buffalo Forge Co., Montreal and Toronto.
Mussens Limited, Montreal, Que.
Petrie, H. W., Ltd., Toronto, Montreal, Vancouver.
Reavell & Co., Ltd., Ipswich, Eng.
Wood & Co., R. D., Philadelphia, Pa.

Purifiers
Babcock & Wilcox, Ltd., Montreal,
Wood & Co., R. D., Philadelphia, Pa.

Railway Supplies
Coghlin & Co., B. J. Montreal, Que.
Mussens Limited, Montreal, Que.
Koppel Co., Arthur, New York City.

Railways, Industrial and Portable
Koppel Co., Arthur, New York City.

Ratchet Drills, Universal
Armstrong Bros. Tool Co., Chicago, Ill., U.S.A.
Mussens Limited, Montreal, Que.

Reinforcing Materials.
Canada Wire Goods Mfg. Company, Hamilton, Ont.
Priddle, Arthur San Francisco, Cal.

Rock Crushers
Mussens Limited, Montreal, Que.

Rope, Manilla and Wire
Mussens Limited, Montreal, Que.

Screens.
Canada Wire Goods Mfg. Company, Hamilton, Ont.

Separators, Steam
Babcock & Wilcox, Ltd., Montreal.

Sewage Disposal
Cameron Septic Tank Co., Chicago, Ill., U.S.A.

Sewer Pipe
Hamilton & Toronto Sewer Pipe Co.

Sheet Metal Work.
Canadian Buffalo Forge Co., Montreal and Toronto.

Shovels, Steam
Mussens Limited, Montreal, Que.

Springs
Coghlin & Co., B. J., Montreal, Que.
Montreal Steel Works, Montreal, Que.

Steel, Speedicut High-speed
Montreal Steel Works, Montreal, Que.

Steel, Structural
Cleveland Bridge & Engineering Co., Ltd., Darlington, England.
Dominion Bridge Co., Ltd., Montreal,
Hamilton Bridge Works Co., Hamilton, Ont.
Pennsylvania Steel Co., Steelton, Pa.
Structural Steel Co., Ltd., Montreal,

Steel, Tool
Montreal Steel Works, Montreal, Que.
Mussens Limited, Montreal, Que.
Allen & Co., Edgar, Sheffield, Eng.

Stokers, Mechanical
Babcock & Wilcox, Ltd., Montreal.

Stone Crushers and Screens
Mussens Limited, Montreal, Que.

Surveying Instruments
Berger & Son, C. L., Boston, Mass.
Gurley & Co., W. & L. E., Troy, N.Y.
Hart Co., John A., Winnipeg, Man.

Tanks, Steel and Iron
Structural Steel Co., Ltd., Montreal,
Wood & Co., R. D., Philadelphia, Pa

Ties, Railroad
Lindsley Bros. Co., Spokane, Wash.

Tool Grinders
Armstrong Bros. Tool Co., Chicago, Ill., U.S.A.

Track Jacks
Montreal Steel Works, Montreal, Que.
Mussens Limited, Montreal, Que.

Transformers
Toronto and Hamilton Electric Co., Hamilton, Ont.

Transmission Machinery
Mussens Limited, Montreal, Que.
Toronto and Hamilton Electric Co., Hamilton, Ont.

Trucks
Northern Engineering Works, Detroit, Mich.

Valves
Babcock & Wilcox, Ltd., Montreal,
Wood & Co., R. D., Philadelphia, Pa.

Waterworks Supplies
Wood & Co., R. D., Philadelphia, Pa.

Wire
Coghlin & Co., B. J., Montreal, Que.

Wire Rope
Coghlin & Co., B. J., Montreal, Que.
Mussens Limited, Montreal, Que.

Wirework.
Canada Wire Goods Mfg. Company, Hamilton, Ont.