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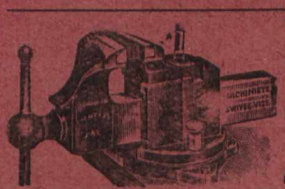

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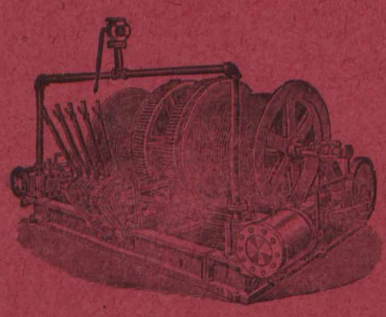

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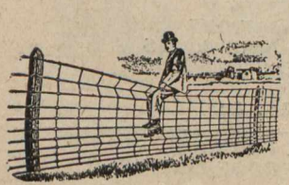

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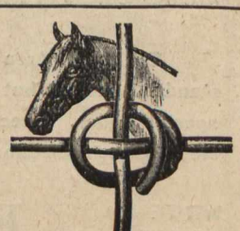

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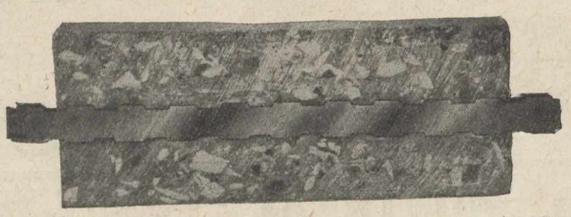

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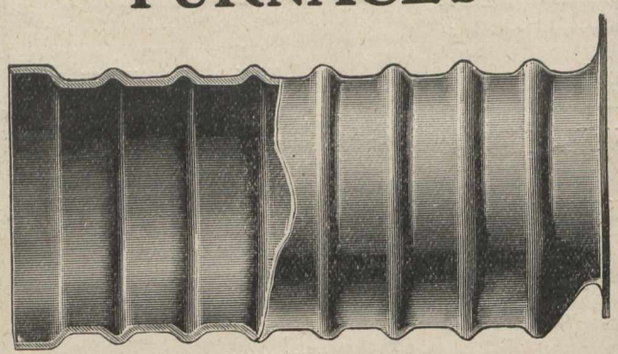

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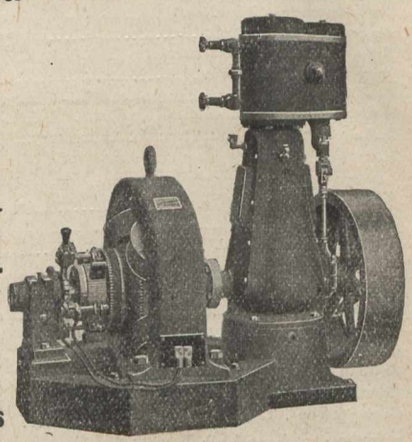

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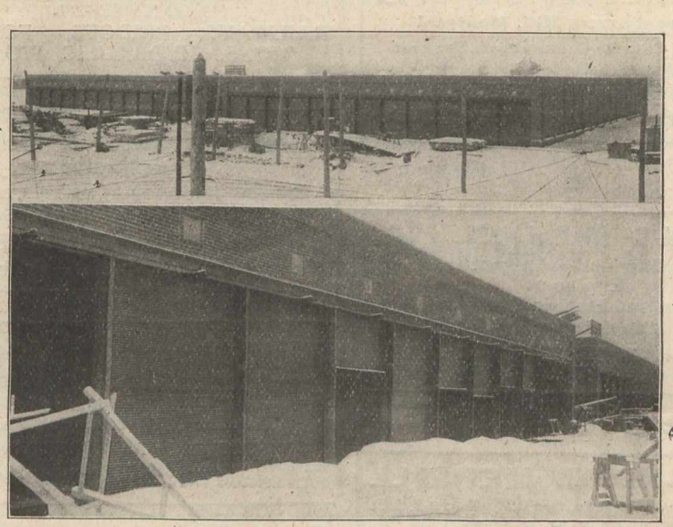

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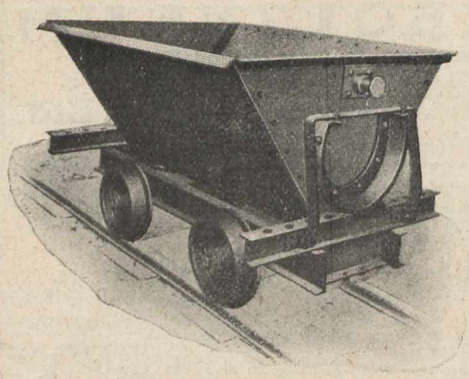

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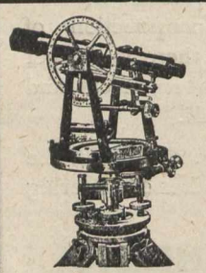

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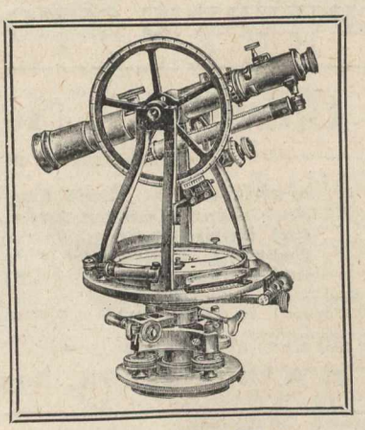

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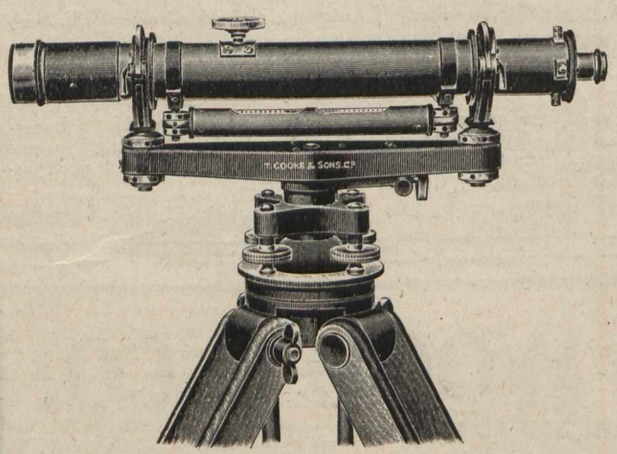

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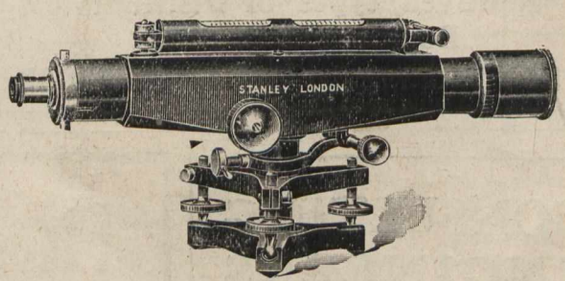

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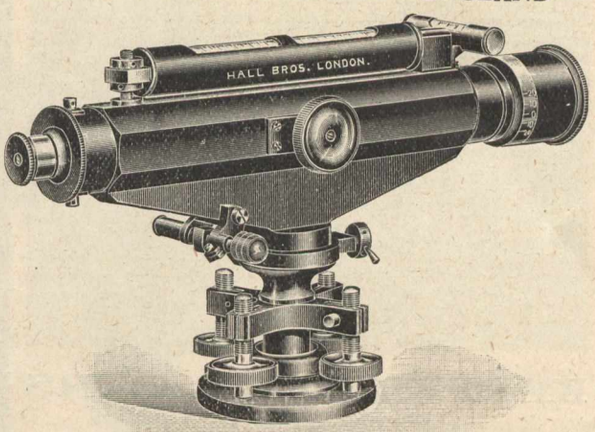

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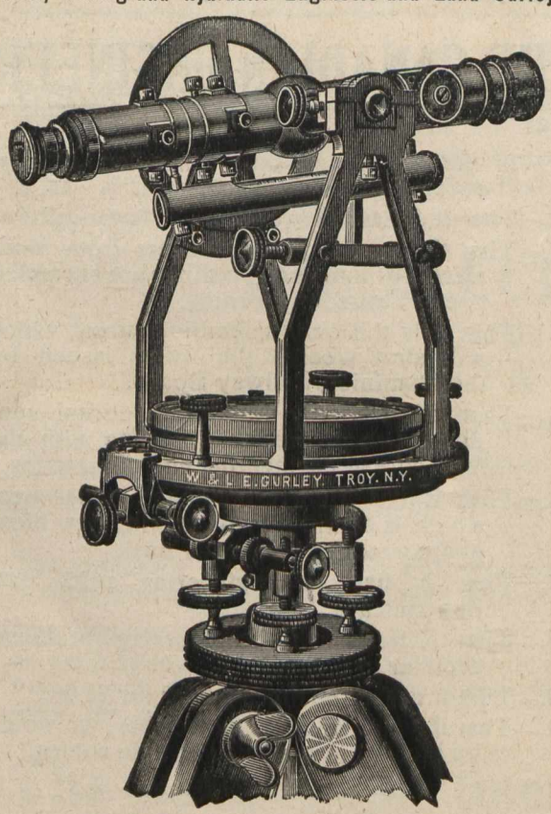

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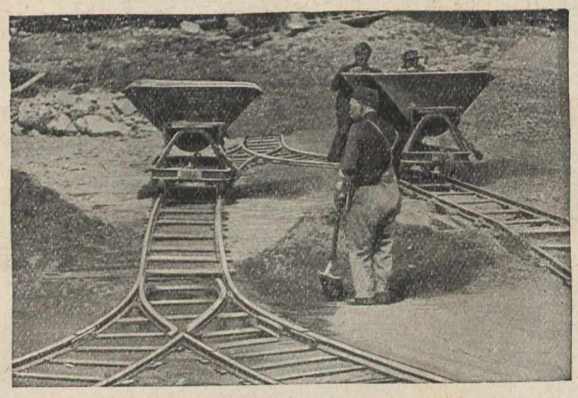

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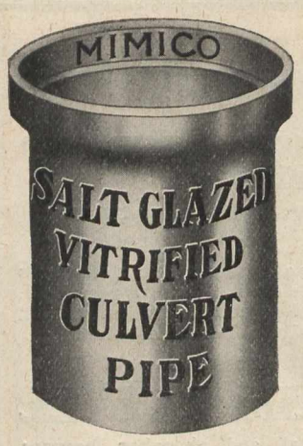

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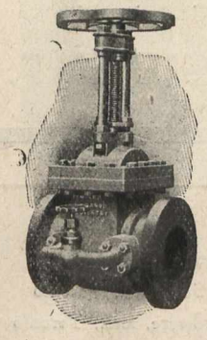

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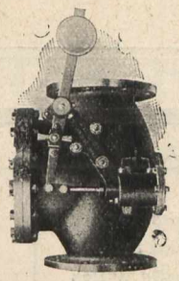

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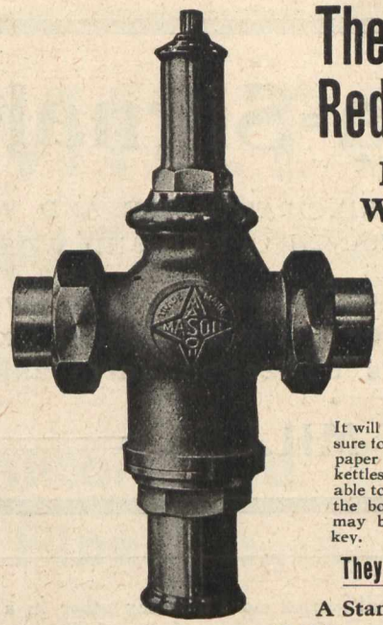

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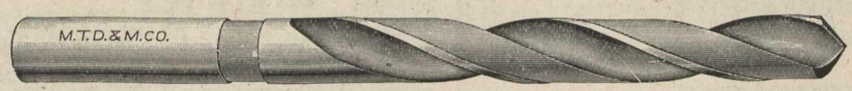

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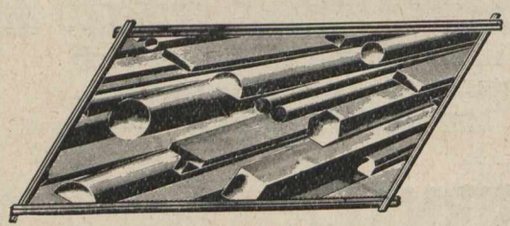

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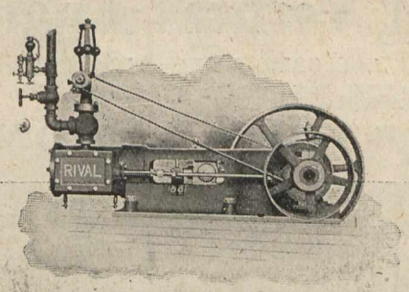

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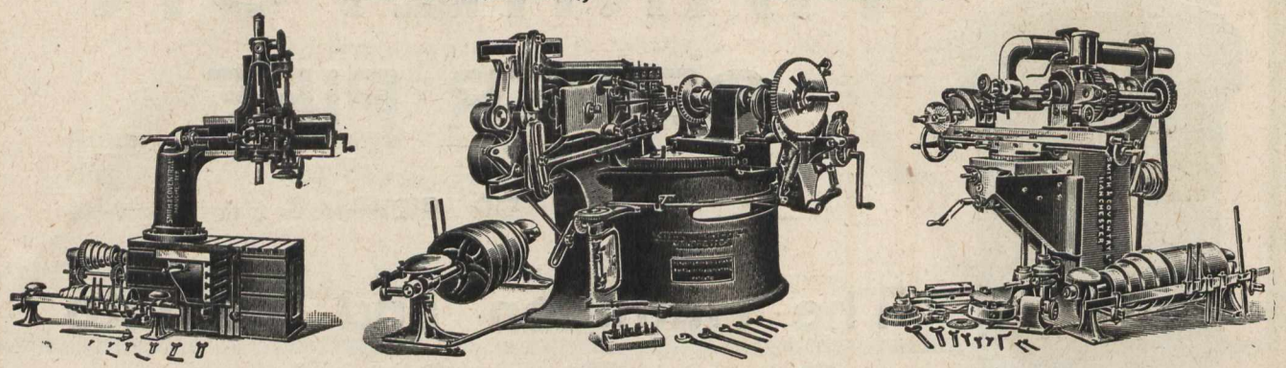

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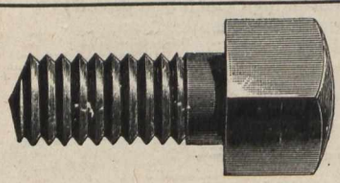

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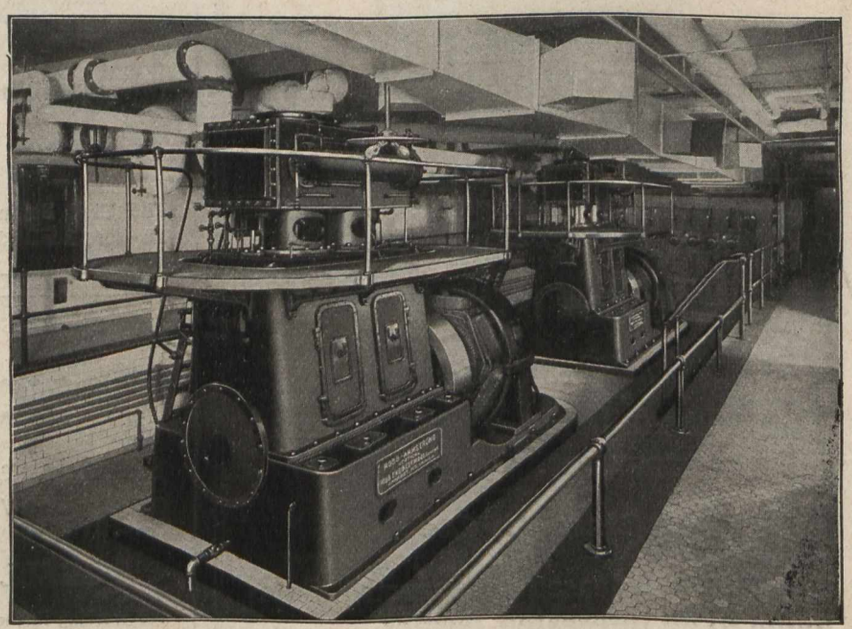

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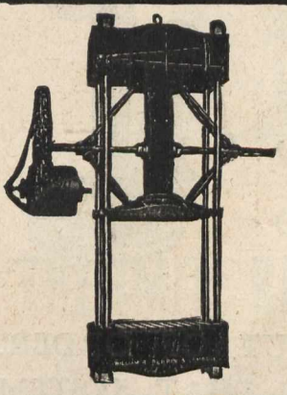

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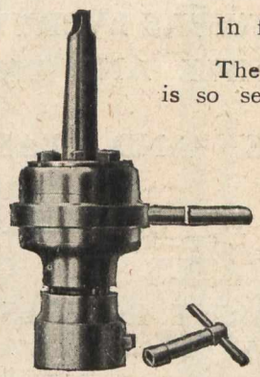

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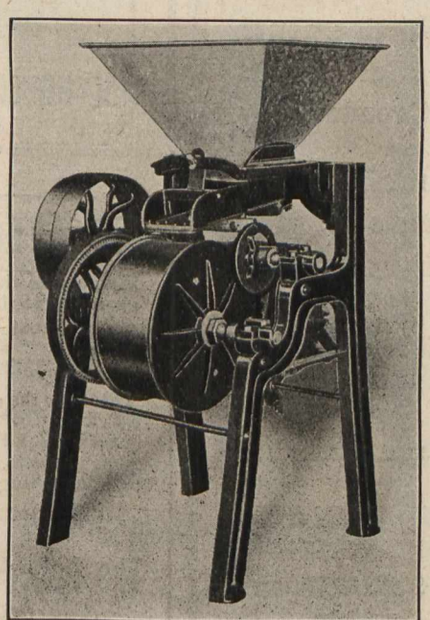

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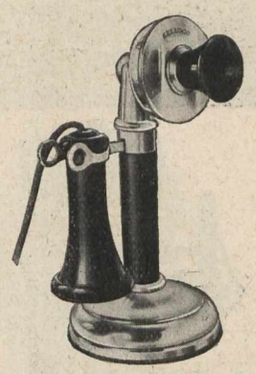

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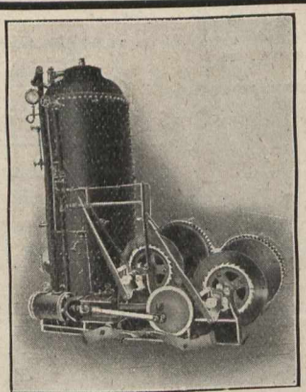

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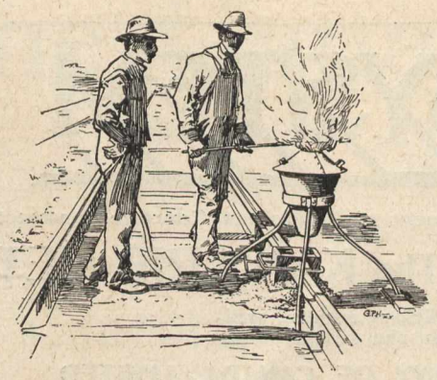

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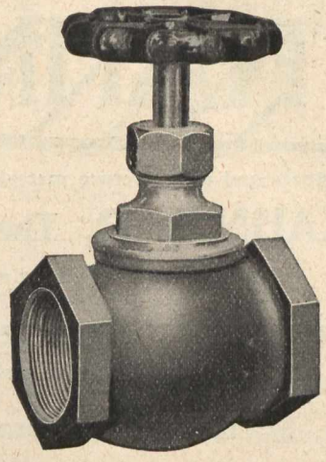

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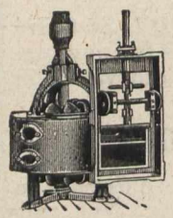

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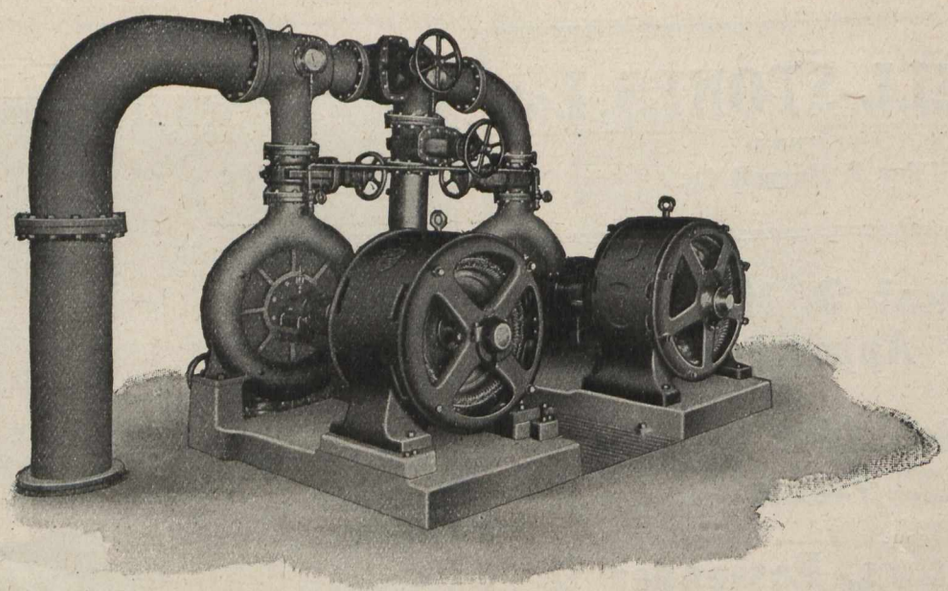

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The Canadian Engineer

WEEKLY

ESTABLISHED 1893

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The Canadian Engineer

ESTABLISHED 1893.

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

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

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TORONTO, CANADA, JANUARY 1, 1909.

CONTENTS OF THIS ISSUE.

INDEX FOR 1908.

Special care has been taken with the index of the Canadian Engineer for 1908. It has been cross-indexed, and many of the articles are classed under four heads. This index should make a valuable addition to bound volumes of the Engineer for 1908. It will be ready about January 6th 1909, and will only be sent to those applying for a copy.

THE CANADIAN SOCIETY OF CIVIL ENGINEERS' ANNUAL MEETING.

The meeting will be held at Toronto, January 28th, 29th and 30th, 1909. Mr. J. J. G. Kerry gives three good reasons why engineers should attend:—

The advancement of the profession can be secured only by hearty co-operation of the engineers resident in all parts of Canada in maintaining professional ideals.

For effective co-operation, mutual respect and confidence are necessary, and it is not the practice of a keen man to esteem and trust men whom he does not know personally.

Without annual gatherings how can a personal knowledge of men resident in other sections be gained?

THE TURN OF THE YEAR.

The week of festivity and kindly greeting has ended, and already the business world is settling down to the more serious work of building and providing for the wants of this young country.

Nineteen hundred and eight has been an uncertain year. For the business man it has been nerve wrecking. In many cases just struggling on, hoping for better things. Construction work has been fairly active, but the depression of last spring had its effect on contract prices, and in many cases work was figured so fine that there was little or no profit. The banks refused loans that a year before they would have been glad to secure. This was severe on many contractors. Municipalities and corporations had for similar reasons to allow large public works and necessary improvements to stand over. Altogether, 1908 has not been the best year for the business man, the contractor or the engineer.

What will 1909 bring?

The outlook is bright. Debentures are selling better. Credit is not so difficult to secure. Prices are firm. Both labor and material command almost the same price they did two years ago, when every industry and trade was taxed to its utmost. All this goes to show that people still have faith in Canada, her institutions and her future. The immediate future will see large schemes crystalized and dormant ventures revived, but it is not to be expected all these will be on so large a scale nor carried on with such little regard to future prossibilities as were some of the works of a few years ago. Every effective safeguard will be taken against financial loss. Business, not experiments with business, will be the keynote of 1909.

In the face of a probable revival of business it is rather discouraging to find the Minister of Public Works for Canada intimating that many Government

works will be held over because of the small revenue. In quiet times Government works should be carried forward, and we feel sure that on further consideration the Canadian Government will not curtail their work and tie up contractors' plants.

During 1909 the work on the Grand Trunk Pacific will require more men and money than any other one work in Canada, but there are a large number of other works of considerable magnitude. The Ontario Hydro-Electric Transmission Line and the Ontario Power Companies' extension; the Winnipeg Power Plant; the St. Andrew's Rapids Dam; the regulating dams at the head waters of the Ottawa; power plants and pulp mills in New Ontario and New Brunswick; irrigation works in Alberta, and hydro-electric development in British Columbia; the possibility of a third transcontinental railway line—whatever way you look large works are under way or being planned for—1909 will be a busy year.

A LARGER JOURNAL.

The success that has attended The Canadian Engineer during 1908; the kind words of our readers; the increased support of our advertisers has convinced the publishers of The Canadian Engineer that there is a field in Canada for a weekly technical journal devoted to the interests of the civil engineer. During the past year we have endeavored to cover that field, but the editorial staff, like the readers, has its limitations. That we have been in a measure successful does not satisfy, and for the coming year we are planning a larger journal and brighter and better-informed editorial work.

Commencing with this issue The Canadian Engineer will appear weekly, uniform in size with the monthly of over a year ago. This will add some eighty pages per month to the editorial section of The Canadian Engineer. We will now be in a position to handle promptly and fully any question that may interest the profession. During the year the increased readiness of engineers to contribute to the engineering literature of Canada has been noticeable. Engineers are finding, as has been found in other professions, that anything which contributes to the good of the profession helps them personally.

With a larger journal we hope to come very close to the engineer's idea of a professional paper.

STATIONARY ENGINEERS' ACT.

The Stationary Engineers' Act for Ontario comes into force January 1st, 1909. The purpose of the Act is to prevent the operation of steam plants by engineers who do not hold certificates of competency from the Government. To plants of less capacity than 50 horse-power nor of steam heating plants operating at a pressure of 20 pounds or under the Act does not apply. When the Act was passed in April, 1907, provision was made for the issuing of certificates to every engineer who at that time:—

(A) Held a certificate of qualification from any association of stationary engineers in the Province of Ontario.

(B) Held a marine or locomotive engineer's certificate.

(C) Was acually in charge of a steam plant of 25 horse-power or over in the Province of Ontario, or who, not being then in charge of such a steam plant, had had at least two years' experience in the operation of such a steam plant.

Persons qualifying as above and making application to the Board shall, upon furnishing evidence of good character and upon payment of the proper fee, be furnished with a certificate of qualification.

EDITORIAL NOTES.

Canada is acting wisely in sending a representative to the Washington conference looking towards the conservation of the natural resources of North America. The man, or body of men, representing the views of the forestry, mining and hydraulic engineer will make the ideal representative.

* * * *

A committee of ten, appointed by the National Society for the Promotion of Industrial Education of the United States, have reported in favor of industrial improvement schools. These schools are not to turn out skilled journeymen, but pupils will receive a fundamental training in those things which go to make him a skilled workman.

CURRENT NEWS

Ontario.

ST. THOMAS.—Manager Ferguson, of the Canadian Iron and Foundry Company, of this city, has been notified that the change of name to the Canadian Iron Corporation goes into effect the first of the year.

British Columbia.

NELSON.—The electric zinc smelter of the Canada Zinc Company, Limited, in this city, which has been under construction during the past year, started operation late in the autumn and is now producing spelter and lead silver bullion from mixed zinc-lead ores and complete success can be said to have crowned the efforts of the promoters. The average ore treated so far has been about 40 per cent. zinc, 10 per cent. lead and 12 ounces in silver with 1-5 per cent. copper. This new plant also saves the copper in the ore as a copper matte and is a departure in the smelting of ores in the use of a current of electricity in place of a blast. This enables the zinc to be saved in the smelting of any ore. In the blast furnace the blast burns the zinc. The plant represents the expenditure of about $125,000—and five years of experimental work in the development of the method.

PRINCE RUPERT.—The C.P.R. have appointed a freight and passenger agent at Prince Rupert. This seems to be another evidence of the correctness of the contention of Mr. C. M. Hays that Prince Rupert will command attention.

VANCOUVER.—With the object of securing new terminal facilities for one or more of the big transcontinental railways, the biggest water front deal that has been put through in the city for many days, was partially closed Dec. 23. That is the negotiations for a transfer of False Creek water front property to the value of over $350,000, was concluded, but the agent of the purchasers, who are said to be the G.N.R. and N.P.R. are still looking for more water front in that locality provided the price is right.

ROADWAYS AND PAVEMENTS.

TORONTO.—The following new roadways have been recommended by the City Engineer: Asphalt—Herrick street, from Bathurst to Euclid avenue, $4,837. Asphalt—Euclid avenue from Queen street to the north side of Robinson street, $4,079. Bitulithic—Brock avenue from the south side of Middleton street to Dundas street, $11,000. Bitulithic—Highland avenue from Schofield avenue to a point 336 ft. west, $4,054. Vitrified block—Scott St., from Front street to Esplanade street, $5,364. Vitrified block—Piper street, from a point 12 feet east of the west side of Bay street to a point 108 feet 4 inches west of Bay street, $1,370.

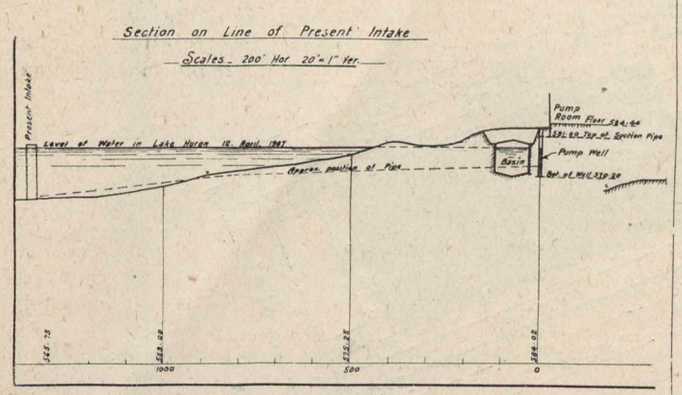
—The Canadian Forestry Association will meet in Toronto, February 11th and 12th, 1909. It is five years since this association met in Toronto, and are here this time on the invitation of the Board of Trade.

GODERICH SEDIMENTATION BASIN.

J. Grant MacGregor, Assoc. Mem. Can. Soc. C.E.

Goderich, the county town of Huron, with a population of 5,000 is advantageously situated at the confluence of the waters of the Maitland River with Lake Huron. The elevation of the plateau upon which the town stands is approximately 100 feet above lake level.

The water supply is pumped from the lake through a 10-inch main, and in addition to a direct distribution, has a standpipe with a capacity of over one million gallons.



Within the past few years the demands upon the town supply have materially increased, owing to an increased number of industries, and the advent of the Canadian Pacific Railway as a competitor to the Grand Trunk, both railways making this an important terminal point.

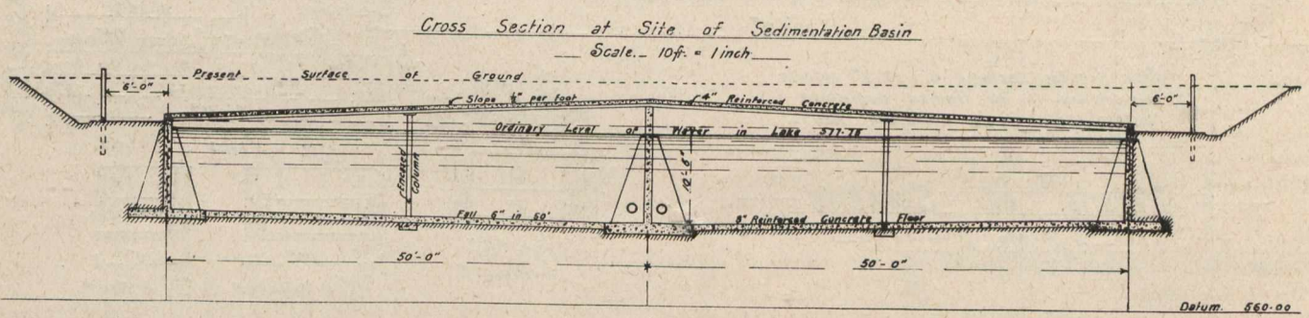
The long talked of development of the Maitland River water power and an electric interurban railway are now assuming practical form, all of which tend to stir up the more optimistic of the town's officials to the necessity of providing an edequate supply of water to meet the almost certain increased demands of the future.

The principal cause, however, of the Commissioners recent action in advocating the construction of a sedimentation basin as a first step was the almost intolerable turbid condition of the water from the present intake, and the continual increased cost of pump repairs, in consequence of having to pump sand and mud in such large quantities during a storm. The effect of a severe storm upon the lake water is noticeable for a great distance beyond the present intake which is situated not more than 2,000 feet from the margin of the lake. On account of the impossiblity of getting absolutely clear water at a reasonable outlay, by extending the pipe further into the lake, the writer in a report to the Commissioner in 1907, recommended the laying of a new 18-inch pipe to a point 2,000 feet beyond the present intake, in deeper and less turbid water, and the construction of a sedimentation basin close to the pumping station, so as to be convenient for operation by the pump attendant. A by-law for the construction of the sedimentation basin, as a first step, was carried in January 1908—the connection for the supply to be made with the present 12-inch intake until such time as the Commissioners would be in a position to carry out the improvement in its entirety. The beneficial results following the construction and successful operation of the sedimentation basin, under the existing conditions, have amply justified the Commissioners in the course they have taken, and have dispelled the fears of others who were at first in some measure opposed to the scheme.

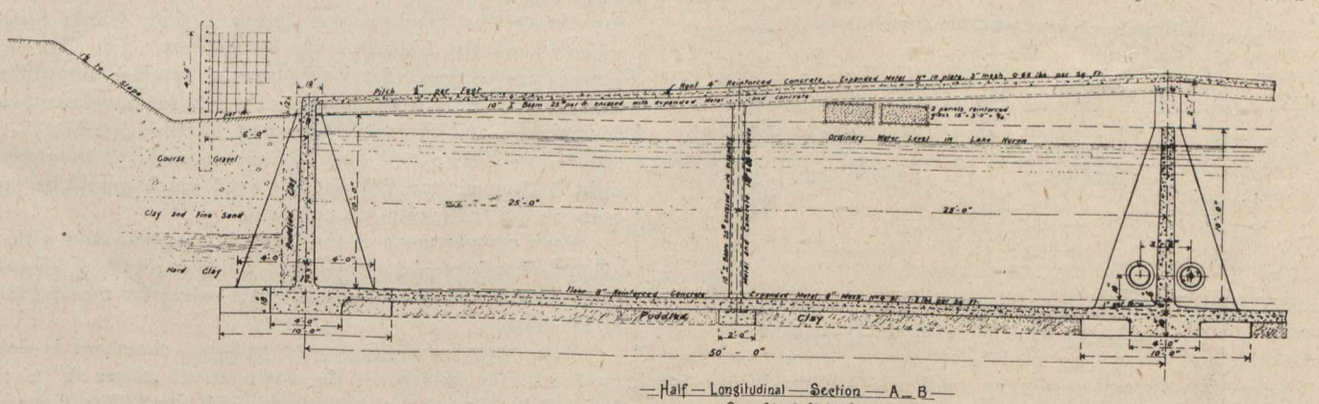
The intention of the writer in the present article is to describe the principal features of the construction of the sedimentation basin alone, in hopes of being able to show that in its design well defined practice has been followed, and deviations therefrom only introduced where circumstances demanded such improvements as it is hoped, have in the main, contributed to the efficiency of the arrangement.

The factors in the efficiency of a sedimentation basin depend on the figures representing the amount of sediment that can be got rid of in a given time, and the writer is to some extent indebted to others for much useful data already published which enabled him to design a structure as nearly efficient and economical as circumstances would permit.

The form, depth and capacity of the basin were arrived at, as the result of making a series of experiments with the muddy water to determine its rate of sedimentation. The depth, however, was to some extent governed by local conditions, and as the floor area was somewhat small in comparison with the depth, a reservoir of an intermittent type was adopted. This enables one compartment of the basin to remain perfectly still while the other is being drawn on by the pumps.



The time required for the precipitation of about 80 per cent. of the suspended matter in a depth of 9 feet was calculated to be eight hours, and each compartment has a corresponding capacity of 150,000 gallons on one-third of a day's supply.



Half Longitudinal Section A B
See Sheet "S. B. 2"

The form of construction adopted for the walls is shown as being a series of reinforced concrete panels and counter-

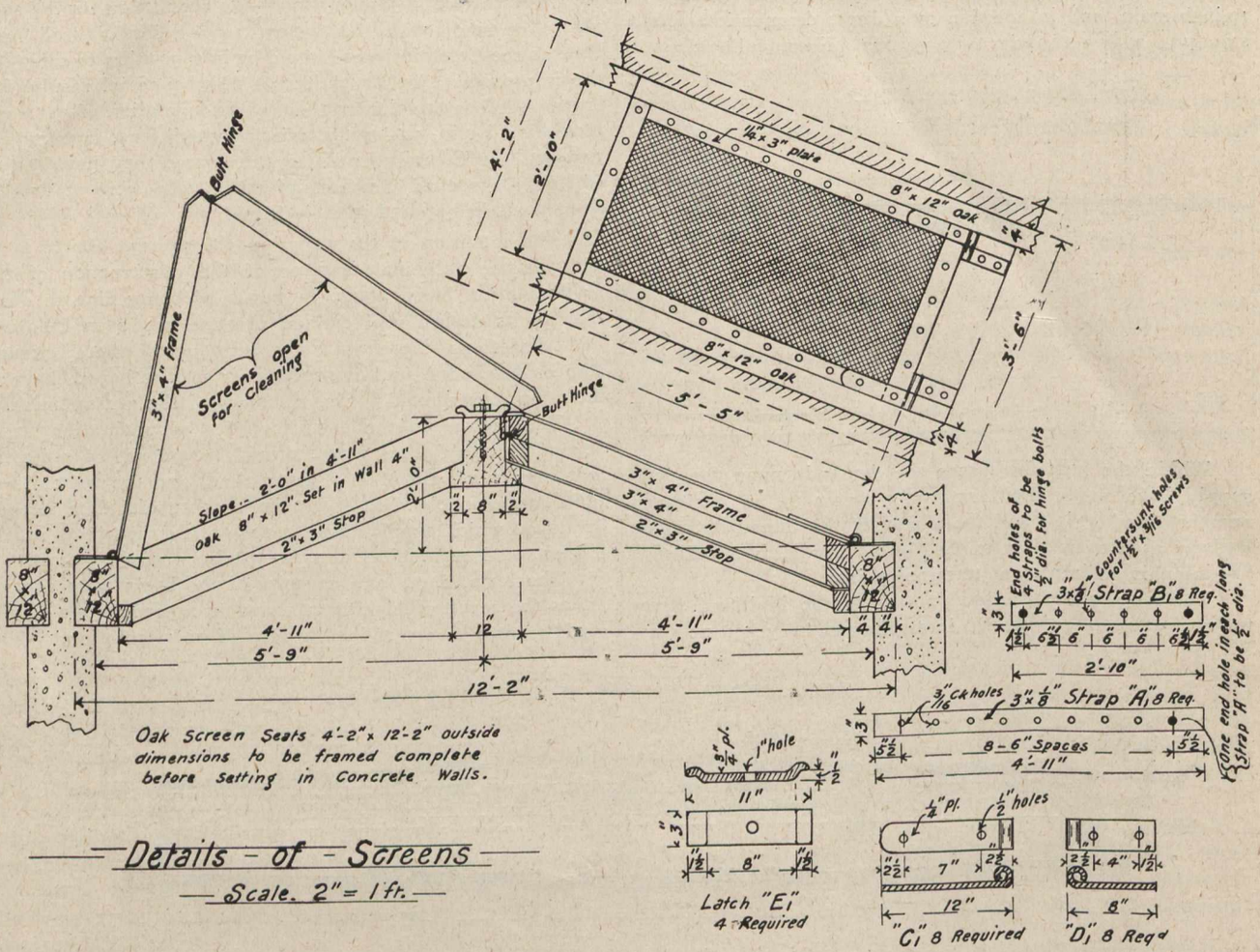
forts designed to withstand hydrostatic pressure from either side. The counterforts were designed to take the stresses transmitted to them from the panels, the bases of which are constructed in the form of reinforced girders 18 inches thick and 4 feet deep.

The floor consists of eight inches thick of concrete reinforced by a heavy grade of expanded metal calculated to resist, if necessary the static pressure from beneath, but as almost the whole area rests on a bed of clay no undue pressure

construction, rather than trust to the workmanship that could be performed in the locality on a more typical form of reinforced truss and column construction.

The roof consisted of a slab of concrete four inches thick reinforced by expanded metal laid on tie rods ¾-inch square, connecting the girders and spaced four feet apart.

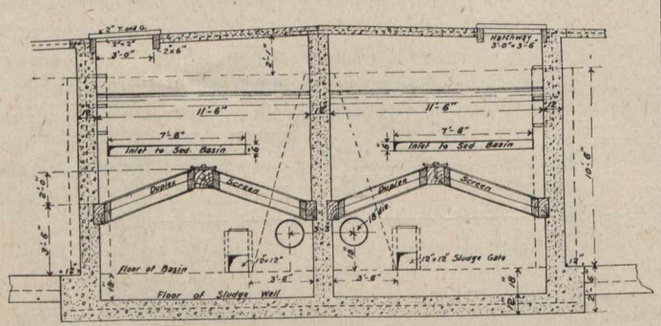
In addition to the square reinforcing bars, a diaphragm of expanded metal extended throughout all walls 12 inches thick and under.



Details of Screens

Scale. 2" = 1 ft.

from this source was anticipated. During the excavation, however, it was found that the clay had been penetrated at one time by the piling of an old wharf, and that water was flowing in under a slight head from a substratum of sand. In order that the concrete floor could be laid over these springs successfully it was necessary to lay pipes from their source to a point outside the foundation, and deposit the concrete while the pump kept the area drained to a point



Longitudinal Section J-K of Screen Chamber

below the bottom of the excavation. One ten-inch centrifugal pump driven by a 14 horse-power horizontal engine was sufficient to keep the excavation dry during the progress of the work.

The supporting girders and columns of the roof were constructed of 10-inch I beams with bolted connections, forming a skeleton framework designed mainly to facilitate the

The inlet for each compartment of the basin is in the form of a weir 6 inches deep by 7 feet long, situated in the inner wall of the screen chamber above the screens. The screen chambers are placed on the opposite side of the reservoir to the effluent chambers, and are provided with a sludge well and sluice gate for the periodical cleaning of the basin. The sloping position given to the screens was intended for the purpose of making them more effectively self cleansing and easier to handle when required to be opened for inspection. Each screen has a double frame hinged together and also hinged to the screen seat. The wire cloth screens are secured with iron straps to opposite sides of the frames, the lower one having one hundred meshes to the square inch and the upper one four hundred meshes to the square inch. The main object of these screens is to intersept light floating matter, fish and sea weed which cannot be overcome in the sedimentation process.

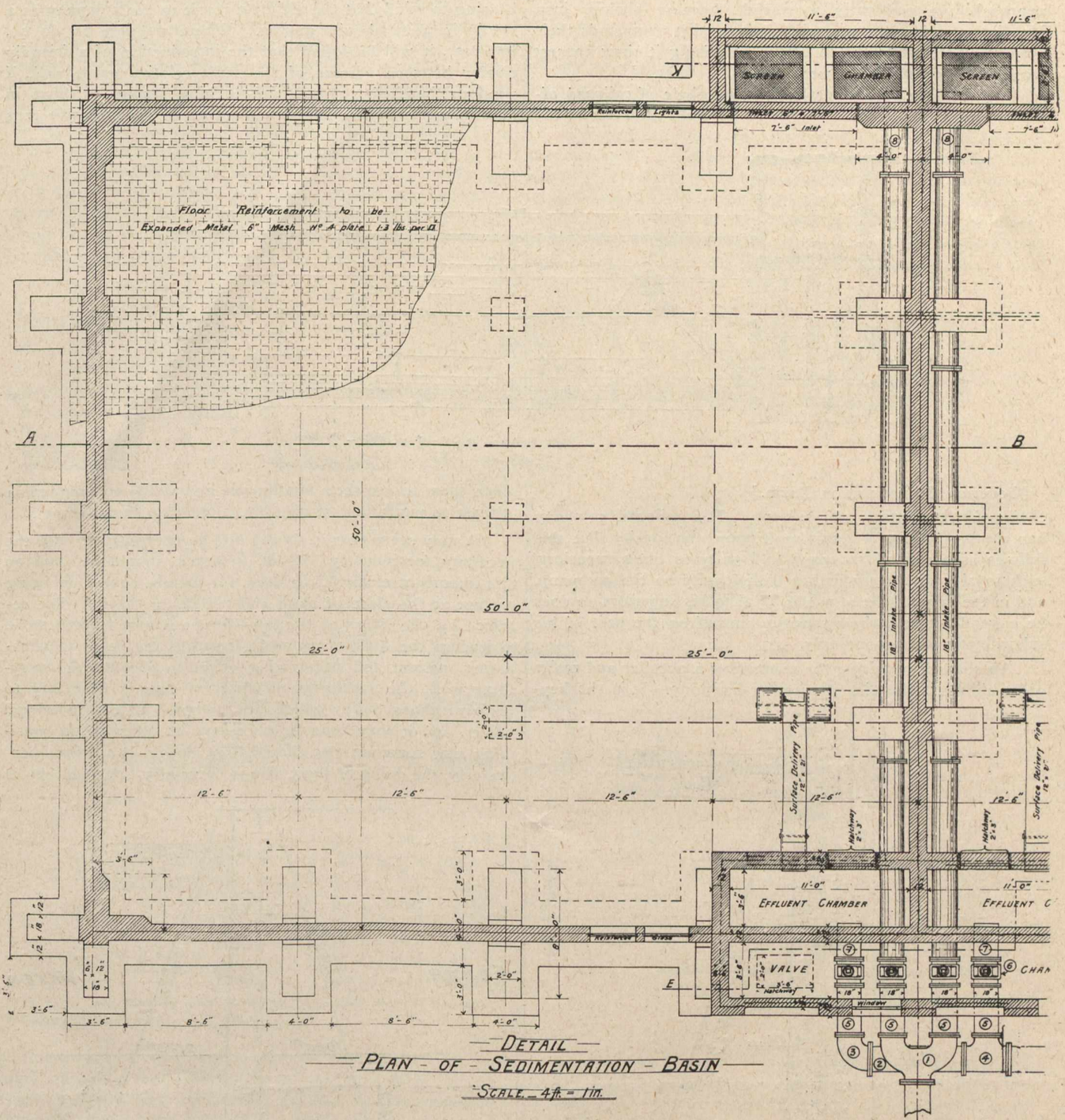
Each compartment of the basin is also provided with an effluent chamber on the outside of which is situated the valve chamber containing four 18-inch gate valves for the operation of the basin.

The water in passing to the effluent chambers is delivered from the surface of the basin at all stages in its rise and fall by means of a floating hinged pipe. The floats are in the form of two circular drums between which the hinged pipe is fastened by a bolt and sleeve, the bolt extending the whole way through the drums. The displacement of the floats was calculated to counterbalance the weight of the hinged pipe to be raised and lowered with some allowance

for friction at the hinged joint, all of which proved a success in bringing the arrangement into perfect operation. A small valve compensator is placed on each drum so that water can be admitted or drained off as the case may require in order that the top of outlet pipe may be adjusted to the level of the water.

All pipes laid in connection with the basin are of sufficient size for future requirements, but at present the basin is fed from the existing 12-inch intake.

The concrete was specified to be in the proportion of one of cement to three of sand, and five of screened gravel, passed through a one-inch screen. The contract price for concrete was $6 per cubic yard, and for the excavation 50c. per cubic yard. Common labor was paid at the rate or $1.75 per day, and the concrete was all mixed by hand. The total cost of the basin, including pipe connections did not exceed $11,000. The contractors for the work were Messrs. Nicholson & McGaw, Monkton, Ont.



ELEMENTS OF A SUCCESSFUL RAILROAD OFFICIAL.*

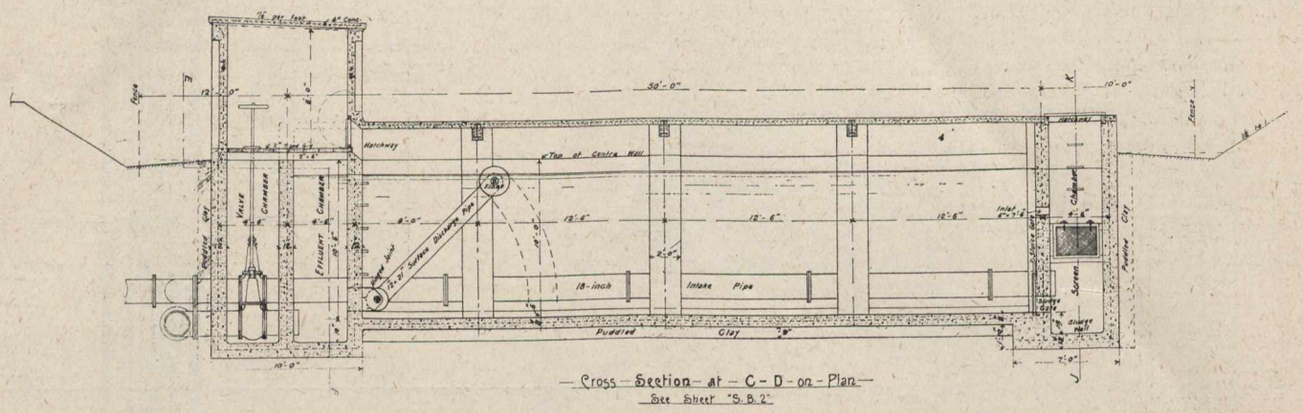
By W. J. Harahan.

What may be designated as the first element, or rather, essential of success, is common honesty. To state the old maxim: "Honesty is the best policy" is but to reiterate a truism, and to repeat parrot-like the principle that has stood the test of ages. There is, however, a broader honesty than that apparent on the surface that is a requirement. This consists not entirely in the application of the commandment, "Thou shalt not steal," but seeks also for its guiding principle the "Golden Rule." In other words, a studious and persistent effort to render just and fair treatment to all alike whether he or it be great or small. I regard this principle a most important one, and one the observance or non-observance of which surely tends to advance, or otherwise, a man's career. Temporary advantage may sometimes be obtained

*From a paper read by W. J. Harahan, assistant to the president of the Erie R. R., read before the New York Railroad Club.

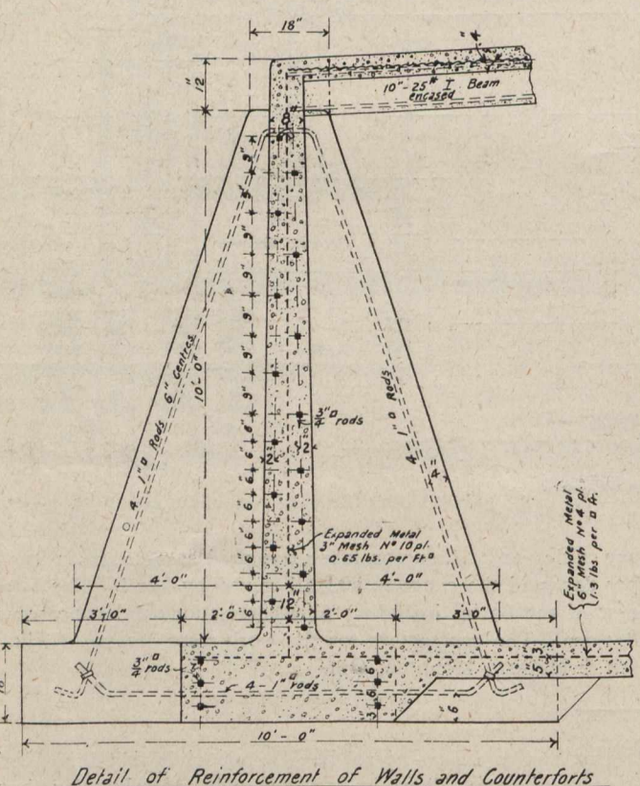
by some other course, but it is not lasting, as a day of reckoning inevitably comes. Recall to your memory those officers successful in railway work. You may remember some who have seemed a very martinet in discipline, who may have been sour of disposition, stern and exacting, hard to approach, yet eminently successful, because always just. Men know and appreciate this quality and it commands their respect and ensures to the officer exercising it their earnest work which means his success.

Loyalty is a predominating characteristic of railroad officers, and it is a necessity to perfectly weld the links of the chain of organization and system. The railroad company has the first and preferential call upon our loyalty, but this follows as a natural sequence to loyalty to one's superiors, such loyalty rarely conflicting with loyalty to the company, and in the degree that a man is loyal to his superiors so does he engender that feeling towards himself on the part of his subordinates correspondingly.



[Goderich Sedimentation Basin.]

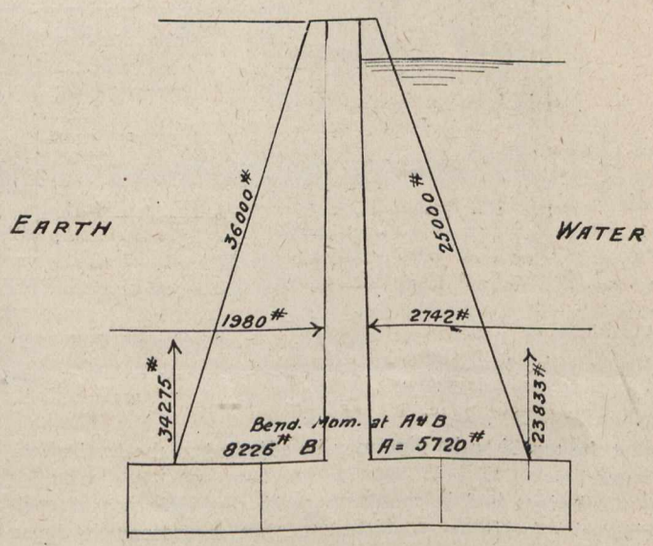
An element requiring the exercise of a peculiar and really great ability is the gift of creating harmony. It is the key-note of the arch of success, without which the structure will not sustain itself. True harmony, when carried to a finality, familiarly known as team-work, engenders enthusiasm on the part of the individuals forming the organization. An organization without harmony disintegrates and soon becomes utterly demoralized, so that a disturber should be ejected from it with little ceremony or he will prove its undoing. Departmental lines should vanish before the company's welfare. If by sustaining an expense, another department can be helped sufficiently to justify the expense assumed, there should not only be no hesitancy, but an eagerness to do so, bearing in mind that the ultimate result to the company as a whole is what should govern. Where possible to do so, however, it will be found that the introduction of a friendly rivalry between officers of the same relative grade will, if properly handled, produce far-reaching results, without in any manner affecting harmony, because of the incentive thus given them to use their intelligence and ability to accomplish at least as much, and, if possible, more than their fellows.



Detail of Reinforcement of Walls and Counterforts
Scale 2' = 1"

[Goderich Sedimentation Basin.]

It may seem that it should not be necessary to cite the necessity for industry. Much, however, should be said on this important element. It does not merely consist in being prompt at the place of work and remaining the full time required by the letter of the law—but it requires much more to lead to the highest success. It means the earnest, painstaking, patient and persevering effort to accomplish everything well; the putting in of whatever time is necessary to perform those duties which are assigned to the individual officer, and it may even be necessary at times to do something that someone else should have done. It requires particularly, the doing of these things cheerfully. A man who is truly industrious is busy in any position, whether it be high or low. He who is thus busy in the lower position will always render such high-grade service that he will be called to the higher. It will be found that he who concentrates his efforts and is the steadiest in his work accomplishes the most. As exemplified in the fable of the tortoise and the hare,



Reaction at Counterforts due to Bend. Mom at A = 102825#
Walls and Counterforts designed for Hydrostatic Stresses on both Sides of Wall.

[Goderich Sedimentation Basin.]

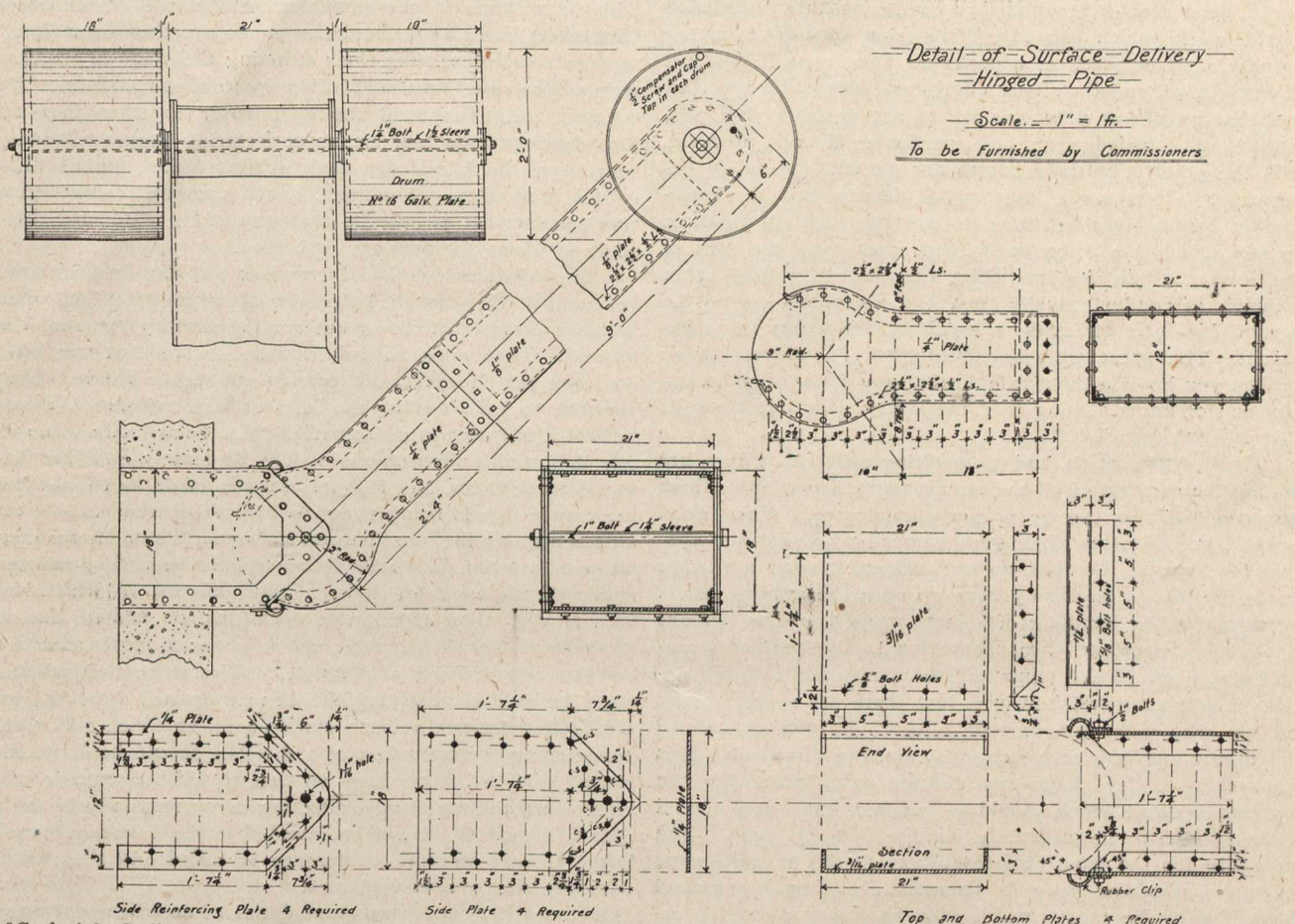
the brilliant men who are only sporadic in the application of their brilliancy do not accomplish as much as their less brilliant fellows who are continually applying what abilities they possess.

Thoroughness is an important adjunct and it is requisite to the fullest extent. Affairs should be closely analyzed. A "touch and go" method of handling matters is not conducive to success, because it invariably leads to neglect. Correspondence should not be shifted around simply to relieve desks of the presence of papers, but it should be thoroughly gone into, all questions answered, and, if an answer naturally develops another question, it should also be answered. It is exasperating to receive returned papers in which all questions are not answered, in an effort evidently to easily get rid of the correspondence, and such methods are insensibly treasured against those performing indifferent service. It should be the pride of a man conducting correspondence to feel that his superior officer did not have to return it for additional facts, if such additional facts could have been reported on in the first instance by a conclusive investigation. Where possible and consistent, definite recommendations should always be made, otherwise a man's office becomes but a clearing house for correspondence, and such clearing houses are not essential, or even desirable. When difficulties arise they should always be discussed to as absolute and as satisfactory a conclusion as the conditions will allow, otherwise half-baked measures result, causing frequently unwarranted expense, and always embarrassment. In arriving at a conclusion it should always be assured that the root of the difficulty is reached, otherwise no permanent relief is effected, as cure is applied instead of prevention. Thoroughness is one of the cardinal virtues of a successful practical business man.

As is true in all lines of work, one of the prime essentials is what I may call love of the work. There can be no success without it, as indifference is sure to result. There is no line of work more exacting than railroad work, and there is no character of work requiring a greater sustained interest. There is no line of work, either, in which indifference is more easily, or more quickly manifested. The results of such indifference immediately appear, as they cannot be concealed. For the benefit of those who are really struggling with might and main to achieve success it is well that this is true, as it serves to brush out of the path those who falter or linger by the wayside. A great deal of railroad work has to be done upon honor; that is, officers are away by themselves, and not under the direct observance of their superiors. A man is therefore necessarily judged by the results he produces. Love of work is a great incentive to spur him on to producing these results, not merely for his present, but also for his future benefit.

I regard common sense as one of the very greatest of the elements. I believe that we often fail to realize how much is expressed in these two words. It is the foundation upon which all the professions are laid. Its application is absolutely essential to the proper carrying on of business, as it is the rudder of business existence. The most gifted man but drifts upon the turbulent sea of trouble if he is not governed by its precepts, which cannot be specifically laid down, yet are as plain as the "A B C" of our childhood. On account of its evident necessity it may seem superfluous to discuss this essential to any great length, but too often there are examples which prove that it is necessary to call attention to this principle in a discussion of this subject. When in doubt, we should ask ourselves: "Are we proceeding along common sense lines?" The application of its test will invariably open a way towards the proper solution of our difficulties.

One of the elements seriously lacking in many men is originality, evidenced by their easily succumbing to difficulties, or in their inability to keep pace with progress. This is a most important attribute, and without it failure is certain. To do something a certain way because it has always been done that way is not always a good reason for so doing. A thing should be done the way best suited to the present requirements. There is, of course, a great value in precedent, if properly applied, and it would be just as much of an error to cast it to the wind as to always slavishly follow precedent. The proper mean between the two is true conservatism, avoiding, however, the type of conservatism



[Goderich Sedimentation Basin.]

that stagnates, and stops the circulation, as it were, making the body inert. Ability to adopt the proper course constitutes the successful man. This applies to very large and also very small affairs in railroad work. So far as the lack of originality is concerned the principal way in which it is manifested is that when difficulties present themselves enough effort is not made to surmount them. Situations are accepted where originality may change them to advantage, or may overcome them altogether, or probably a substitute can be made just as effective; or, at least, not as bad as total alteration. We should always ask ourselves before accepting a situation which appears to be bad, whether it is really and undoubtedly the best thing that can be done, devoting conscientious and hard thought to its proper solution. Originally is also necessary to keep abreast of the times and to make the proper expansion, so as to keep step with, or outstrip, our competitors, as business necessities may dictate.

A good deal is accomplished by an intimate knowledge of the work, which can only come from experience in the harness; that is, practical experience. Men respect this sort of knowledge, and their best efforts are obtained when they feel that an officer possesses it. If one is not in full possession of knowledge on any particular detail, however, it is the greatest mistake not to ask questions so as to become so. It is not a lowering of dignity, nor an indication of incompetency to have to ask for such information. In fact, much can often be learned, from even the men of the lowest grade, by intelligent questioning. Any other principle of conduct usually results in an ostrich act on the part of him who attempts it, his ignorance being easily apparent. The great Chinese philosopher, "Confucius" said: "When you know a thing to hold that you know it, and when you do not know a thing to allow that you do not know it; that is knowledge."

Good organization, and its resulting element, system, are among the greatest of all the requirements, for without them no large business can be properly conducted. When good organization is attained, system naturally follows, and system is essential, because no one officer, beyond a certain grade, is able to physically keep up with the infinite details occurring in the handling of a large property. The amount of detail is, necessarily, in proportion to the position occupied, the work of the minor officer being practically all detail. Let me remark, however, that there are a great many officers who make the mistake of not knowing enough of detail, although it is true that many attempt too much. It is impossible to lay down any definite rules governing the amount of detail which should be handled, but a man should know enough to be intimately familiar with his work. The necessity for the most perfect system should be uppermost in man's mind as he goes upward. He should surround himself with the most capable men he can find for the respective positions under him. Some men, by their actions, seem to feel that brilliant subordinates may detract from them. There can be no more mistaken idea, nor can there be a more short-sighted policy. A man of moderate capacity can, in a relatively high position, be successful with good and capable subordinates—but a brilliant man cannot be successful with incompetent subordinates, because of the very physical impossibility, aforementioned, of one individual knowing the details of a large business.

The ability to select capable subordinates is a most important art and most necessary to success. To do so properly requires that a man shall be somewhat of a student of human nature and be an analyst of the human character; it also requires a close and careful supervision of the work of those under him, to know their capability, because there should always be understudies who can be promoted to the various positions, otherwise the organization will become weak. Organization and system, therefore, are most vital elements; in fact, they are the very life-blood of a large corporation. Every man should be entrusted with whatever responsibility the duties of his position and the general organization of the company will allow. To deny officers' authority is to dwarf and stunt them and thus thwart their efforts. My personal opinion is, that a great deal should be entrusted to the divisional organization, so that the man on the ground could accomplish more, the idea being that the men selected for such positions should be capable of carrying out such an organization rather than to attempt to centralize, because such a localized authority means a more intimate intercourse between the men on the ground and the public; and I believe, tends to a better understanding between the railroad company and the public, because the railroad is more literally and intimately personified in the person of such a representative.

Those having to do with the line of the road should be acquainted with it from personal knowledge; that is, by getting out on the road as often as is necessary to obtain a full understanding of the characteristics producing or affecting local conditions. This brings them in contact with the public and the employees, and they ascertain many an important fact which is either not communicable in correspondence or mayhap the correspondent does not appreciate their importance to the same extent that the officer does. Oftentimes complaints from the public are thus intercepted at their root, preventing their attaining the stage of the festering sore that time and often inattention produces. In bringing the officer and the men closer together there is also developed the best means of fostering proper relations, because of the knowledge each obtains of the other's difficulties from personal contact. Such personal contact also serves somewhat to rob the company of its inanimate character so far as the men are concerned.

An important detail in the proper carrying on of a large business is the careful following up of instructions. The issuance of instructions is but the preparatory stage of the process. They must be followed up to see that not only are they put in effect, but carried out in the future. Man is prone to follow along the lines of least resistance, therefore, if it is easier to do something else he is likely to do it. For this reason instructions should be closely analyzed before issuing them, and a determination made as to whether the course that is being taken to accomplish the purpose required is along the most natural lines possible under the conditions, as when once issued they should be rigidly insisted upon. Conferences of division staff officers, to which the men should, upon appropriate occasions, be invited, should be held at stated intervals, as they are a more effective method of obtaining a complete understanding of instructions as well as obtaining the benefit derived from the interchange of views at such conferences, at which difficulties surrounding the operation of a division should be fully discussed, and the proceedings written up. When putting into effect instructions vitally affecting a system, which are a radical departure, it will be found that the best results will ensue when a general conference is called and the whole subject exhaustively explained.

One of the most important duties of an officer entrusted with it is the employment of men, and it is one which he should weigh well, and should seriously appreciate the gravity of. In hiring the inferior grade of employees he should reflect that he is hiring the future section or shop foreman, the future dispatcher, the future engineer, the future conductor, and if the true principle is carried out the future officer of whatever grade; it therefore, requires rare discrimination to do that which is the proper thing. He should know that the man hired is of proper calibre, as determined by his looks, actions and his references. When a man is employed, or promoted, he should be carefully instructed as to what his duties are. To simply drop a man into a new position and tell him to go ahead without any advice is conducive of very poor results. These instructions, in addition to the examination required in certain cases, should be exhaustive and complete and it should be the aim of the officer instructing to make it the occasion for the giving of that good advice which every man can cull from his past experience and which will enable the newcomer to avoid as many pitfalls as possible in his future career. This practice brings good results entirely disproportionate to the amount of trouble and time involved in the carrying of it out. It also makes better men and better officers and brings the officer and men closer together and puts a new employee or new officer at once on his

mettle to attempt to warrant the good opinion of his superior officer by attempting to carry out his evidently well-meant advice.

The treatment of men is a problem usually solved by the individual as his disposition seems to dictate. Its proper solution is a necessary element of success. There is no truer saying than that "familiarity breeds contempt." To become too familiar with men means a loss of their respect, yet to stand aloof and icily distant means also a loss of respect on their part, and certainly tends to prevent any enthusiasm for their work. There is a middle course which should be adopted. There should be an easy bearing between the officer and men which will beget confidence on their part and make them feel that the officer is their friend and will always do them full justice whenever anything occurs. If officers coming in contact with the men are on proper terms with them they will often be advised of things inimical to the company's or their interest, especially if the officers display interest when receiving such advice.

Proper discipline is as much of an essential in railway work as it is in army work. Most railroad officers occupy the dual position of superior and subordinate. If a man carries our carefully the principles of discipline in his capacity of subordinate it cannot but be far-reaching in influencing the conduct of his subordinates, and cannot but make easier his path so far as the proper application of discipline is concerned, as example is the most effective teacher. Implicit obedience is an essential of proper discipline. It is sometimes necessary to issue orders which cannot be explained. This, therefore, requires that all orders be carried out implicitly, unless they involve evident danger, as they may be of a very important chain in a plan of action; but if, on account of danger, deviations are necessary they must be carefully explained. It is, however, nearly always practicable to fully explain the purport and intention of orders, and when possible they should be explained to such an extent as is consistent, as it is conducive of a much more intelligent and harmonious carrying out of a plan if those who are executing orders can have some knowledge of what they are doing, as they will intuitively plan their actions so as to fit in with the following moves if they know what they are, or will be.

So far as application of discipline to men is concerned, in punishing them for not carrying out rules or instructions, they must be dealt with justly and all must be handled on the same basis. The most careful and painstaking thought should be given to this most important duty to insure that consistent treatment is given to all. Employees will render most satisfactory service to those officers who treat them with uniform justice. He who vacillates, being severe at times ,easy at other times, loses their respect. Prejudice and favoritism are fatal faults—and they should be abhorred and shunned as a disease. The officer should always take what appears to him to be the right course, for while it is not always possible to convince a man himself of the justice of a sentence imposed upon him—yet his fellows nearly always judge correctly of such action. When a man has made a mistake and it is necessary to apply discipline, he should always be told how to avoid such mistakes in the future; to simply assert to him that a mistake has been made without showing him in detail in what his fault consists, and how to avoid it, is not taking advantage of such experience as a guide for the future, either for the employee involved or for the other employees.

When possible to avoid it men should not be reprimanded within the hearing of other men, as it seems only to inflame and wound them—and such reprimand thus loses a large part of its efficiency. I cannot, even at the risk of repetition, fail to state that the ability to properly discipline is a most important element, and it is the rock on which has occurred the shipwreck of many a promising career. It would seem that no would would be purposely unjust or purposely prejudiced, so that much of it must be attributed to bad judgment, or the inability to distinguish as between right and wrong on this particular proposition. I believe it can be unquestionably stated that the more contented a body of men are the more satisfactory will be their service, and proper discipline, by which men always know where they stand and what they may expect, goes a long way towards making for contentment. Careful consideration of this most important duty also means that the higher officers will need to overrule the lower officers less and thus avoid that impairment to a man's influence which then occurs.

Railroading, as has been stated, so many times by others, is purely a commercial proposition, the same as any other kind of business. The commodity in which the railroad deals, that is, transportation, must be produced at as cheap a cost as is consistent with the conditions surrounding its production. Every railroad, no matter what its good or bad conditions are, is capable of being operated at a certain proper cost dependent upon its conditions. To produce this proper cost of operation is the problem of the railroad officer, which applies from the highest executive to the lowest subordinate officer in proportion to the responsibilities their respective positions impose upon them. The successful operation of trains, the maintenance of roadway and equipment to a proper standard, the avoidance of accidents, the proper handling of men, and, in fact, the proper solution of all the problems presenting themselves, all tend towards the successful accomplishment by a railroad officer of the purpose which is really the end for which this, and, in fact, all business, is conducted; that is, the sale of its commodity at a reasonable profit. Too many men, however, are attracted by what may be called the love of the tinsel in railroading, with its glamour and romance, so that they lose sight of its business features and necessities. The only way to insure the proper business result is to require on the part of the officers an intimate knowledge of the proper costs of the performance of service and a comprehensive planning of the future expenses based on the probable business and the railroad's policy of expenditures. Comparisons with last year are not conclusive; in fact, are misleading, unless the same conditions obtain in both years. The basis should therefore be cost of service based on units of service to be performed. To assume that expenses can be regulated without some definite planning is unbusinesslike and does not prevail in any other kind of business.

Division superintendents to-day should know as soon as possible the total expenses of the division for yesterday. If possible, labor and material will have to be separated, as the labor charge can be furnished before the material charge can. I have given this subject a great deal of thought and I do not believe that any method except the daily check is effective. At first thought it may seem that this would involve an immense amount of bookkeeping and complication of accounts, and consequently a large additional force of men. This, however, is not so. It does not involve the putting on of any additional men, as this daily check can be carried out by the present force without difficulty, as the necessary accounts are so simple and are kept by so many that it puts but little work on each; and in the larger offices, such as the division superintendents and master mechanics, it means but a consolidation of figures. This is no theoretical or fanciful scheme whatever, but is a definite practice which has been in actual operation for sufficient time to thoroughly demonstrate its practicability. It simply means system in expending the money for operating expenses and adapting to the railroad business the same rules as to knowing and watching cost that apply to all other lines of business.

An important element, which is not given the consideration it deserves, usually, is the question of intercourse with the division superintendents and master mechanics, it means colors in this respect, as his very nature solves the problem, but often there is a mistaken idea as to what is proper. Courtesy and frankness are essential in the proper dealing with the public. A railroad company always desires to have the public feel as well towards it as possible, and intends to impress the public as favorably as possible. A courteous set of officers and employees does more to impress favorably the public than any other means, as the only way a railroad meets the public is through its officers and employees, and upon their conduct depends the public's verdict as to the company they represent. Oftentimes the public is inconsiderate, finds fault without due investigation, but this should

be expected and courtesy practised nevertheless. A soft answer often turns away wrath, and this should be practised. Conciliation, not antagonism, is what is really needed. The public along the line of the railroad should be solicitously well treated, letters should be answered whether of complaint or otherwise, and if requests cannot be complied with, consistent, not childish or palpably unsatisfactory, reasons should be given. An earnest effort should always be made to remedy any reasonable complaint. It is true that under present-day practices people seem to largely run to the commissions, but the railroads are still the recipients of a volume of complaints. I am firmly convinced that a great deal of the crop of injudicious laws that have been made against the railroads in the past was caused by the treatment of the public; although I do not feel that the avalanche of the past two years can be placed in this category, as I believe that they were more largely the result of the efforts of designing politicians to secure stepping stones for future political advancement. Let us, therefore, endeavor to regulate ourselves in this respect, so as to be in the confidence of the people for the future as much as possible. I believe that one result of the present situation will be a close relation between the railroad and its customers for the future, so that the old saying, "'Tis an ill wind that blows nobody good," will be realized, as it has many times in the past. The railroad subject should in any event be stripped of its mysteries to the public, as there is nothing in the general characteristics of the railroad business whatever different from any other business, it being merely a problem of barter and trade, like all other businesses, and every effort should be put forth so that the public should realize that this is so.

A PLEA FOR THE BUSINESS TRAINING OF THE ENGINEER.

R. A. Ross, E.E. *

The only justification in the eyes of the community for the existence of the engineer are the results which he obtains. His business is a purely utilitarian one, the object being the production of value. Value is not measured by the cost of an engineering construction, but by the results obtained therefrom when used as a tool for the extraction of dividends. The value of the engineer to the community being determined by the results obtained from his engineering, it becomes pertinent to enquire when such results are shown. These become apparent only when the work for which he is responsible has been in operation for a time and operating profits or losses can be determined.

Without drawing the lines too closely there may be conceived to be three stages in the life of an enterprise:

1. The scientific—when the tool is forged by the engineer.

2. The business—when methods of using the tool are evolved and used.

3. The economic—when the results of the tool and its handling become apparent.

The engineer as a purely technical man will consider his work done at the end of the first stage, leaving to other hands the completion of the task and the obtaining of results therefrom. This tendency is fathered by the purely technical nature of the training which he has received, fostered by a lack of business knowledge in which he finds himself deficient and ingrained in his system by the attitude of the business world towards him, which believes the engineer to be lacking in business ability whereas it is only lack of training and confidence.

The general result so far as the engineer is concerned is that by keeping his nose so closely to the technical grindstone he has little opportunity, or even desire, to look up and see what the larger business world is doing with his product; he therefore does not take his real position in the scheme of things and attract that attention to himself and his profession which he should, nor does he do that full justice to the community which has educated him, and which has a right to demand the highest dividend possible on capital invested in his training.

No remark is more frequently heard, especially among financial and business men, than that the engineer does not understand business. And this is in general true. He is therefore hired by a company, and regarded by it merely as a species of glorified plumber. He constructs the tool with which the financial man works and without which he could have no standing in the community, and being given this tool he is able to bring business methods to bear and produce results, for which he and not the engineer is given credit and reward.

The engineer is a man with a trained mind, trained to logical reasoning and deduction, brought up on good, old Euclid, thoroughly grounded in rigid scientific principles and taught to think straight. If, therefore, he applies his logically trained mind to business and economic matters with one-half the diligence which he exercises in his purely engineering functions, it is difficult to see why he should not obtain better results than the business man who generally has had no real training in business, but has absorbed such knowledge as he possesses from the business atmosphere surrounding him—does not read, study, or examine into the real reasons of things, and knows only business usage and custom. If this be doubted, inquire from business friends as to the amount of reading and real study they have given to business matters, it will be found to be inconsiderable. As a matter of fact, the engineer side-steps a business proposition whenever he can, stating in effect, if not in words, that his business is engineering and leaves the business of what should be his work to others, when given a certain amount of study and courage he could settle these questions satisfactory for himself and to the benefit of the public. The reason for this attitude on his part toward the field which promises him an improved status as a citizen, a broader knowledge of the world at large, and increased dividends, is to be found in the fact that the business part of his training is not taken up or even hinted at during his college course.

It is, of course, impossible that an art such as business is can be taught in a college devoted to science, but neither can the art of engineering be taught there. Whether there is a science of business is very questionable. There is certainly nothing in the nature of an exact science, nor even of approximate science, but there are certain laws and general principles which if absorbed by the student during his college course would give him a different outlook and broaden his horizon He would at least learn that there is nothing weird and incomprehensible in ordinary business terms or business methods and therefore be encouraged to extend his field of operation beyond the technical so as to embrace the business and economic end of the subject.

If, however, through lack of ability or aptitude in business matters, or through the bent of his mind being purely scientific, he does not find an opportunity to expand in the direction indicated, yet he will at least be able to understand the terms used, and to talk intelligently to men in the business world.

This expansion of the engineer's sphere of usefulness is evidenced in the career of certain engineers in other countries who, beginning as purely technical men, have since launched out into contracting, and finally added financing and operating, so that they in their business have forged the tools, have used them and have obtained results, and the credit and returns are all theirs.

The rapid expansion of industrialism is making its demands for trained men felt more and more, and engineers are being chosen for administrative offices in large corporations and as the directing forces in large enterprises, and this tendency must of necessity increase, and who are better fitted to operate under directions of the laws of men and with a knowledge thereof than those who have built well under the much more rigid and exacting laws of nature.

In any system of engineering training, science must of necessity be the foundation, but upon this foundation the

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the engineer may erect a superstructure which will be visible to the public, and attract attention to the fact that he is a power in the community. This superstructure, which may readily be a part of engineering, is dedicated to the business and financial departments of his business; without the foundation the structure is useless, but the foundation itself not being visible receives precious little attention from the community when the building is complete. The basement rentals are also low.

The institutions wherein engineers are taught must in justice to the profession keep pace with this tendency, and that they are beginning to do so is evidenced by the fact that a number of colleges in other countries have added to their purely technical studies a course on the business and economic aspects of engineering. In this country, McGill is about to set the example, and it would appear that the other technical schools will have to follow suit or their graduates will be distanced in the race for preferment.

There are two arguments against adding a course of this kind to the curriculum of a science school—

1. That the students are already overburdened with work.

2. The reluctance of the authorities to teach anything but science.

As regards the first it seems to be a question as to whether certain of the more purely scientific studies could not if necessary be dropped in favor of the more practical course here advocated, but it is thought that this may not be necessary as a fairly extensive course can be given, covering only the principles of business, without overburdening the student, for the reason that his training having been along rather strenuous lines, demanding a high degree of concentration, the study of the mechanism of business will be found to be child's play by comparison.

The second objection can be met by asking whether the college is not for the inculcation of principles. If this is true as regards science, why not as regards the business of engineering.

The engineer as he develops and gets away from purely technical routine work is supposed to be able to draw up specifications, make contracts, hire and direct labor, and report on properties. These are within the legitimate field as at present understood, and yet all of these demand that he should have in reason a knowledge of money and values, of business methods and some knowledge of law, and that he should be able to present his reports in such a way as to be readily understood by business interests.

The mere expansion of these functions with the same knowledge of principles brings him to a point where he should be able to present a financial scheme for the consideration of financial people, and practically to act as their engineer, promoter and director of the scheme at its inception and thereafter. He should be able to operate it to a successful issue, to obtain commercial results and dividends. To this end, in addition to the knowledge of business which the engineer should have to enable him to draw up specifications, contracts, etc., he should have a knowledge of the general business methods of the community in which he lives. He should understand something of stocks, bonds, bills of exchange, notes, the formation of companies, of partnerships, the general laws relating thereto, the functions and powers of different corporation officials, and the method of incorporating companies. These are matters, the principles of which an engineer trained to study can acquire. To practice is of course a different matter, and results will depend upon his ability in dealing with the world as a business proposition.

His scientific training has taught him to deal with the laws of nature. His business training should teach him how to deal with men and money and the laws relating thereto. Business has not been taught or developed as a science, and it is therefore considered an art, and ability therein can only be developed by practice. But this is so even in engineering, the science of which is taught in the colleges and the art developed later in the larger world of practice.

It is not expected, nor is it desirable that the engineer should by thus expanding his functions, eliminate the lawyer or financier. But his knowledge of business should on the other hand indicate the necessity for these gentlemen's services, and above all show just when and where their services are needed and enable him to appreciate them at the proper value when given.

In short a business training should develop a new view of his relations to other professional men and place him in the position of engaging their services rather than acting as their servant.

The engineer is a utilitarian to a commanding degree and much more so than the other professional men, such as the doctor, lawyer and clergyman. The lawyer is a special pleader and does the best he can with the case given him. The doctor buries his mistakes. The clergyman deals in the future, but the engineer has to deliver the goods and the goods have to be commercial, therefore why restrict an engineer's education to purely scientific subjects, and why not expand his horizon to enable him to take the position in the community which he deserves and can command, and enable him to reap the rewards both in credit and dividends for which such training fits him.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

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

5618—November 18—Authorizing R. H. Ashton, Morrisburg, Ont., to lay a water pipe under the tracks of the G.T.R. in the village of Morrisburg, Ont.

5619 to 5628—November 18—Authorizing the Bell Telephone Company to erect, place, and maintain its wires across the tracks of the G.T.R. at one mile west of St. Basile Station, P.Q.; St. Bruno Station; 1½ miles east of Ridgeway Station, Ont.; Albert Street, Stratford, Ont.; ½ mile north-east of Port Dover, Ont.; 3 miles north of Beeton Station, Ont.; 3½ miles south-east of Alliston Station, Ont.; 2½ miles south-east of Alliston Station, Ont.; one mile east of St. Bruno Station, P.Q., and at St. Basile Station, P.Q.

5629—November 18—Authorizing the C.P.R to open for traffic these portions of its line from mileage 0 to 14.0, and from 18.6 to 31.2, on its Kenora Section; from mileage 51.1 to 63.5, from 97.9 to 104.3, from 104.3 to 115.0, and from 127.8 to 133.5, on its Ignace Section; and the second track of the double track diversion, from mileage 98.6 to 99.0, from mileage 102.64 to 104.81, and from mileage 130.0 to 132.0 on its Ignace Section.

5630—November 18—Authorizing the C.P.R. to construct a bridge at mileage 12.55 of the Owen Sound Section.

5631-2—November 18—Authorizing the Alberta Government Telephones, to erect, place, and maintain its wires across the tracks of the C.P.R. at ½ mile west of Coaldale, and 2 miles west of Woodpecker, Alta.

5633—November 13—Authorizing the C.P.R. (Walkerton & Lucknow Railway) to cross highway between Lot 1, Con. 2, N.D.R., Tp. of Bentinck, Co. of Grey, and Lot 74, Con. 2, N.D.R., Tp. of Brant, County of Bruce, Ont., at mileage 28.38.

5634—November 5—Ordering the G.T.P. Ry. to treat with Messrs. Graves & Ferris, as owners of the N.E. ¼ of Sec. 16-53-24, W. 4th M. through which the railway is intended to pass, respecting the purchase of same.

5635—September 23—Approving of the location of the C.N.R. Goose Lake branch, from a point where the line joins the Qu'Appelle, Long Lake and Saskatchewan Ry. in the City of Saskatoon, Sask., to a point in Section 6-31-12, West of 3rd M., mileage 57.96.

5636—November 3—Authorizing the People's Telephone Company and E. P. Smith, of Johnville, P.Q., to erect, place and maintain wires across the tracks of the C.P.R. near Johnville Station, P.Q.

5637—November 3—Dismissing application of Calixte Franche, Wendover, Ont., for suitable farm crossing over

C.N.R. in the middle of his Lot No. 31, Con. 1, Wendover, Ont.

5638—November 3 — Authorizing the St. Maurice & Champlain Telephone Company to make telephonic connections with the ticket offices in the stations and with the freight offices of the C.P.R. in Louiseville, Yamachiche, Batiscan, Ste. Anne de la Perade, and Lac a la Tortue, Quebec.

5639—November 3—Authorizing the C.N.Q. Ry. to take part of Lot 8, Parish of Longue Pointe, P.Q., the property of the Montreal Protestant House of Industry & Refuge for the construction of a " Y."

5640—November 19—Authorizing the G.T.P. Telegraph Company to erect, place and maintain its wires across the tracks of the C.N.R. east of Portage la Prairie, Man.

5641—November 14—Ordering the C.N.Q. Ry. that the derails provided at the crossing of the C.N.Q. Ry. by the Montreal Street Railway at the intersection of Valois Avenue and Ontrio Street, Montreal, be interlocked with home signals on the track Applicant Co.

That the applicants construct the necessary drains to ensure the proper working of the said derails.

That the signal levers be placed in an elevated signal tower.

That the work herein directed to be done by the applicants be completed by the 31 December, 1908.

5642—June 23—Authorizing the C.N.R. to construct an overhead crossing across the track of the C.P.R. at a point on Lot 11, Con. 2, Tp. of Nepean, Co. of Carleton, Ont., at mileage 12.03 from Ottawa, near Bells Corners.

5644—November 3—Authorizing the C.P.R. to take possession of, use, and occupy parts of the South Halves of Lots 34 and 35, 3rd Con., Tp. of Humphrey, Dist. of Parry Sound, belonging to the C.N.O. Ry.

5645—November 3—Rescinding Order of Board No. 5107, dated July 28th, 1908, directing the G.T.R. to install an electric bell at the crossing where its railway intersects the public highway in the Township of Cornwall, Ont.

5646—November 3—Authorizing the G.T.R. to construct, maintain and operate branch lines or spurs from Lot No. 5 to Lot No. 7, 12th Con., Tp. of Tay, Co. of Simcoe, Ont.

5647—November 20—Directing that every railway company subject to legislative authority of the Parliament of Canada be forbidden to erect, place, or maintain, on or after the 1st of January next, any mail crane along its line of railway, at a distance less than 7 feet 1¾ inches from the centre of the track to the extreme point of the crane when in position, or at a height less than 10 feet 10 inches from the bottom of the rail to the top of the arm when in position.

5648—November 20—Authorizing the Mount Carmel & Centralia Telephone Company to erect, place, and maintain its wires across the tracks of the G.T.R. at public crossing north of Centralia Station, Ont.

5649—November 20—Authorizing the town of Thorold, Ont., to erect, place and maintain two wires for the conveyance of electricity for lighting purposes across the tracks of the G.T.R. at two different points on St. David's Road, Thorold, one at grade crossing of the railway, and the other where the said highway is carried across the railway by a bridge.

5650—November 20—Authorizing the Manitoba Government Telephones to erect, place and maintain wires across the tracks of the C.P.R. 1,000 feet west of Plum Coulee, Man.

5651—November 12—Ordering the Toronto Electric Light Company to remove certain poles east of Scott Street, Toronto, near the G.T.R. and complained of by the said railway company, within four months from the 12th November, 1908.

5652—November 20—Authorizing the C.P.R. as lessees of the British Columbia Southern Ry. to construct, maintain and operate a branch line or spur into the premises of the East Kootenay Lumber Company, Lot 6673, Group 1, Kootenay Dist., B.C.

5653—November 3—Directing the C.P.R. to submit plans for approval of Board, showing a 16 foot clearance over the tracks of the C.N.R. at Little Key River, Tp. of Mowat, Dist. of Parry Sound, Ont., and to make alterations at said crossing in accordance therewith, within fifty days from the date of this Order.

5654—November 16—Ordering the C.P.R. to complete the work of connecting its railway with the G.T.R. at Galt, Ont., by the 1st of January, 1909.

5655—November 10—Authorizing the Guelph & Goderich Ry. Co. to cross road allowances on its Listowel branch, from mileage 0.00 to 16.54, through Tps. of Wellesley and Mornington, Ont.

5656—November 12—Ordering that the speed of the C.N.R., G.T.R., and C.P.R., when crossing Yonge Street, Toronto, shall not exceed four miles an hour between the hours of 7 a.m. and 12 p.m., from the 11th day of May to the 15th October of each year.

5657—November 21—Authorizing the C.N.R. to connect its line of railway (Prince Albert Branch) with the Qu'Appelle, Long Lake and Sask., Railroad and Steamboat Company, crossing 1st Street, West, Prince Albert, Sask.

5658—November 21—Approving of the C.P.R. specifications for steel bridges, comprising sections A, B, C, D, & E.

5659—November 21—Authorizing the C.N.O.R. to reconstruct the superstructure across the North Nation River, Lots 21 and 22, Tp. of North Plantagenet, Con. 1, County of Prescott, Ont., 23.6 miles west from Hawkesbury, Ont.

5660—November 21—Rescinding Order of the Board No. 5463, dated 22nd October, 1908, authorizing the C.P.R. to construct the bridges described therein at points on the New Brunswick Southern Railway.

5661—November 10—Ordering the Berlin and Waterloo Street Railway Company to pay to the G.T.R. the sum of $1.25 per day for the period of time from the 12th December, 1905, to the 1st May, 1907, that the Light Commissioners of Berlin, Ont., pay to the G.T.R. the sum of $1.25 per day for the period from the 1st May, 1907, to the 10th November, 1908, and thereafter to pay to the G.T.R. the said sum of $1.25 until further ordered by the Board, re King Street Crossing, Berlin, Ont.

5662—November 16—Dismissing application of the Board of Trade of Preston, Ont., for an Order directing the C.P.R., G.T.R., and the B. W. W. & L. H. Ry. Co., to connect their lines in the towns of Galt, Preston, Hespeler, Berlin, and Waterloo for interswitching purposes.

5663—November 16—Dismissing application of the town of Hespeler and Board of Trade of Galt, Ont., for order directing the C.P.R., G.T.R., and B. W. W. & L. H. Ry. Co., to connect their lines or tracks in the towns of Galt, Preston, Hespeler, Berlin, and Waterloo, Ont., for interswitching purposes.

5664—November 16—Dismissing application of the Board of Trade of Berlin, Ont., for order directing the C.P.R., G.T.R., and B. W. W. & L. H. Ry. Co., to connect their lines or tracks in the towns of Galt, Preston, Hespeler, Berlin, and Waterloo, Ont., for interswitching purposes.

5665—November 16—Dismissing application of the Board of Trade of Waterloo, Ont., for order directing the G.T.R., C.P.R. and the B.W.W. & L. H. Ry. Co., to connect their lines or tracks in the towns of Galt, Preston, Hespeler, Berlin and Waterloo, Ont., for interswitching purposes.

5666—November 10—Ordering the G.T.R. to erect gates and a day and night watchman at Thames Street where the railway crosses the same in the town of Ingersoll, Ont.

5667—November 24—Authorizing the Brantford & Hamilton Electric Ry. Co. to open for traffic that portion of its line of railway from Alfred Street to Market Street, in the City of Brantford, Ont.

5668—November 23—Rescinding Order of the Board No. 5510, dated the 14th July, 1908, granting leave to the Grand Valley Ry. Co. to cross with its track the track of the G.T.R. in the City of Brantford, Ont.

5669—November 24—Approving Supplement No. 4 to Canadian Classification No. 13, subject to certain conditions.

5670—November 11—Authorizing the C.N.O. Ry. Co. to construct a suitable farm crossing opposite the property of Mrs. H. A. McLeod, Staney Brae, Ont.

CORRESPONDENCE

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

WELL DISCHARGE.

Sir,—In reply to your subscriber, "Correspondent," on page 899, let me refer him to page 203 of the "Two Books on the Water Supply of Rome, of Julius Sextus Frontinus," by Clemens Herschel, where it says, quoting Hero, of Alexandria, who flourished about 125 B.C.: "Hero, of Alexandria, who, by means of his widely-circulated writings, and possibly at the school in Alexandria, where Hero formerly taught, may be considered as the teacher of Frontinus, had already said: "Dioptera," 31: "Observe always that it does not suffice to determine the section of the flow to know the quantity of water furnished by the spring. This, we said, was twelve square digits. It is necessary to find the velocity of its current, because the more rapid the flow, the more water the spring will furnish, and the slower it is, the less it will produce. For this reason, after having built a reservoir under the stream, examine by means of a sun-dial how much water flows into it in an hour, and from that deduce the quantity of water furnished in a day. Thus, one has no need to measure the section of the stream. The measure alone of the time suffices to make evident the flow of the stream."

Instead of a sun-dial, our friend may, in this year of grace, 1908, use a dollar watch or a split second chronometer; and, instead of a reservoir, dug in the ground, he may use a modern washtub, or a barrel set on a platform scales.

New York, Dec., 1908. C. H.

WELL DISCHARGE.

Sir,—In your issue of 15th inst., "Subscriber" asks for information as to the quantity of water discharged from a flowing well. This is a problem to which the ordinary formulæ for flow through an orifice are apparently not applicable, though approximate results can be obtained by using the Francis Weir formula, $Q = 3.33\ LH\ 3/2$.

Where H is the height in feet to which the water rises above the pipe, L is the length of the circumference of the pipe in feet and Q is the quantity discharged in cubic feet per second.

In 1905 some experiments were made at Cornell University on similar flows, the results of which were published in Vol. LVII. of the Transactions of the American Society of Civil Engineers. The formula deduced from these experiments was $Q = 8.88\ D\ 1.25,\ H\ 1.35$, D being the diameter of the pipe in feet, H and Q as in the Weir formula. It is obvious that the greatest accuracy is required in measuring both H and D, as a very small error would make a great difference in Q, and, as these measurements are usually roughly made in the field, it is probable that the simpler Weir formula will be found sufficiently correct for practical purposes.

From the measurements given by "Subscriber" the flow would be 0.412 cubic feet per second by the "Cornell" formula and 0.396 cubic feet per second by the Weir formula. Roughly speaking, it can be taken as about 150 gallons per minute.

Yours truly, J. M. S.

Montreal, Dec., 1908.

COLOR ON PLANS.

Sir,—I am preparing a plan indicating five different kinds of pipe—steam, condensation, water, gas, compressed air. Can you tell me the colors usually used on plans to designate these different pipe?

Yours, W.

Hamilton, Ont.

ENGINEERING SOCIETIES.

ARCHITECTURAL INSTITUTE OF CANADA.—President, A. F. Dunlop, R.C.A., Montreal, Que.; Secretary, Alcide Chaussé, P.O. Box 259, Montreal, Que.

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

CANADIAN STREET RAILWAY ASSOCIATION.—President, J. E. Hutcheson, Ottawa; Secretary, Acton Burrows, 157 Bay Street, Toronto.

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

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, J. Galbraith; Secretary, Prof. C. H. McLeod. Meetings will be held at Society Rooms each Thursday until May 1st, 1908. Annual meeting at Toronto Jan. 28, 29 and 30, 1909.

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

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

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

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

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

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, W. G. Miller, Toronto; Secretary, H. Mortimer-Lamb, Montreal.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Vice-President, C. T. Pulfer, London, Ont.; Secretary-Treasurer, Alfred E. Uren, 62 Church Street, Toronto.

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

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS (TORONTO BRANCH).—W. H. Eisenbeis, Secretary, 1207 Traders Bank Building.

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

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, C. A. Jeffers; Secretary, C. L. Worth.

GROUNDED TRANSMISSION MEDIUMS.—IV.

Stray Transmission.

By J. Stanley Richmond.

Electrolytically, the most important of the many phases of grounded return investigations is the securing of data relative to the amount of accidental transmission by means of auxiliary earthed conductors, such as water-pipes, gas-pipes and cable sheaths; to obtain which several methods have been adopted. These can be roughly summed up under four headings, as follows:—

1. Amperes calculated from drops taken on two-foot lengths.

2. Amperes calculated from ampere and drop readings taken between distant points.

3. Amperes measured between the ends of a break in the accidental conductor.

4. Amperes taken experimentally in connection with plant laid especially for such purpose.

Of these four methods, the first is the most popular one; particularly with those corporations which are arranged on the opposite side to the traction interests. The apparatus required is a meter with fifteen and 150-millivolt ranges with its calibrated leads (preferably a duplex one, Richmond pattern; because such is useful in checking the Conant bond-tester used in another branch of the investigations); a medium-sized rough file; a two-foot rule; a cold chisel and a chipping (machinist's) hammer. To use the apparatus, excavations about four feet long and wide enough to allow ingress and egress to the reader are made at various points of such a depth as to completely uncover the pipe or other earthed conductor to be tested. In each hole excavated, the conductor is cleaned at two places about two feet apart by means of the chisel and hammer followed by the file. Points two feet apart are then accurately laid off on such cleaned surfaces with the rule and the drop taken between such with the meter. When all the drops are taken and by use of a prepared table of the resistances of two-foot lengths of different sized pipes or cable-sheaths, the C is calculated by $\frac{E}{R}$, where E = the reading obtained and R = the resistance of the two feet. This popular method, whereby the two feet of metal in each case become a temporary shunt, has been more or less fully described by Maury in vol l., No. 4, p. 74 of Engineering News. For this class of testing, however, the writer prefers to use both sides of the duplex instrument by laying off two two-foot distances (three points), only accepting as true those duplex readings which simultaneously agree. This, because he has found that duplex readings so taken on cable-sheaths have not often agreed. Whether such disagreement was due to the imperfect contacts made by the lead terminals or to the use of the cables for alternating transmission can not, however, be definitely stated at present.

The second method, and, as a rule, most satisfactory one, consists in taking the voltage between two points and then immediately short-circuiting them and taking the voltage and amperage. The apparatus required is a light wagon, a reel, about 500 feet of flexible rubber-covered No. 6 B. & S. wire, the same length of electric light cord, a duplex instrument (ammeter and voltmeter), two single-pole double-throw switches and four heavy iron clamps. About 475 feet each of the wire and the cord (which should have an inner insulation of rubber) are bound together at points about twelve inches apart by means of insulating tape and wound on the reel which is mounted between two upright castings similar to those which will be described in another article. On one of the flanges of the reel and around but insulated from the axle is secured a circular brass ring which makes contact with a brush so held by a brush-holder attached to but insulated from the frame that the brush will make good contact whether the reel is revolving in one or the other direction. The inner end of the cord is threaded through a hole bored in the flange, projecting a few inches beyond its edge. The outside ends of both the wire and the cord are connected in multiple to the bodies of two of the clamps by means of roundhead machine screws and copper burrs.

Fig. 17 is a sketch showing diagrammatically the arrangement of the switches and instrument, in which A is the duplex instrument with "two" and "twenty" ranges. The left side, in connection with the two shunts B and C, is used as an ammeter; while the right side is used as a voltmeter. D is a single-pole, double-throw switch, to the middle point of which is connected thirty feet of the heavy wire. E is a small single-pole, double-throw switch, to the middle point of which is connected thirty feet of the flexible cord. To the outer ends of both the wire and the cord are connected in multiple the other two iron clamps. The remainder of the wiring can be traced out without any description.

The two shunts, the two switches, the calibrated leads and the instrument should be obtained from the instrument-makers all mounted on one base; and on no account ought the makers to be directed as to the details. The method of making shunt connections is a question for the instrument expert only.

To install the apparatus, the reel is placed in the rear end of the wagon and the instrument portion mounted on a smooth plank attached to the side of the wagon which is protected by a canvas covering stretched on a light frame-

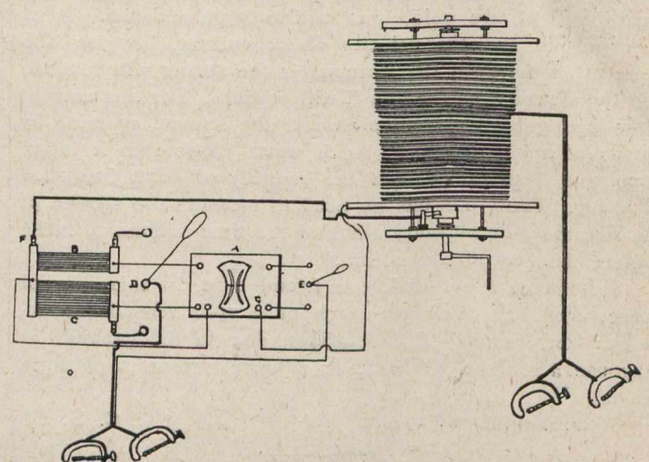


Fig. 17—Diagrammatic Sketch of Arrangement of Apparatus for Measuring Stray Transmission.

work. From F (Fig. 17) is run a piece of heavy wire to the brush-holder; and from the binding-post G of the meter is connected a small piece of flexible cord long enough to reach to the end of the cord projecting beyond the edge of the reel.

To use the apparatus, the wagon is taken to a hydrant and the clamps from the reel attached to it. The driver is then instructed to go ahead to the next hydrant, to which the clamps from the shunt are attached. Care should be used by one of the attendants that the reel does not "run away with itself" when the wagon is moving. Both switches are then thrown down. If the readings are so slight that the lower scales would be preferable, the switches are thrown up instead. When the proper scales have been selected, the ammeter switch is opened and the deflection of the voltmeter needle watched until satisfactory and steady. Then, remembering this deflection, the ammeter switch is quickly closed and both deflections at once noted. The three readings are then entered as voltage before short-circuiting and as voltage and amperage after short-circuiting. To facilitate the entering of the readings, the reader is supplied with sheets similar to those shown in Fig. 18.

The hands required for the operation of the apparatus, excepting, of course, the expert in general charge of the investigations, are a college or other student of electricity at $1.50 per day; a driver at the local rate of pay; two strong active linemen (helpers) at $1.50 a day; and one bright boy at 50 cents a day. The work and data obtained should be, in his case, for the legal department. The wagon and the hands should report at the office at 8 a.m., and immediately

start for the scene of the day's operations. Lunch should be taken at noon and the wagon start for the stables at 5 p.m. The reader should then return to the office and enter on clean sheets the readings which have been taken together with the calculated results. These sheets should then be at once turned over to the legal department which, when considered necessary, will confer with the general manager.

The reader will find it a little difficult at first to remember correctly the three readings up to the time of entering them, but with a little practice the difficulty will be overcome. He can, too, and in time acquire the habit to take not only the steady deflections but also their maximum and minimum

READINGS BETWEEN HYDRANTS.

Readings taken by _____
Date _____
Weather _____
Preceeding Weather _____ *for* _____ *Days*

READING No.	LOCALITY.	TIME.	BEFORE SHORT—CT	AFTER SHORT CIR-T		CALCU'D	REMARKS.
			VOLTS.	VOLTS.	AMPERES	AMPERES	
	TO	TO					
	TO	TO					

Fig. 18.—Printed Form for Entering of Readings.

fluctuations. Such, however, is exceedingly trying and wears the reader out in quick order.

After the readings are taken at this point, the clamps are unloosened at the second hydrant and the wagon returns to the first one. While so returning the cable is rewound on the reel, and when the first hydrant is reached the other clamps are also unloosened. The performance is then repeated between the other hydrants.

The principle of this method is based of course, on the $C = \frac{I}{R}$ —law as applied to divide circuits. To calculate the C, the formula is $C = \left(\frac{V'}{V' = V''} \right) \times C'$ where V′ = the voltage before short-circuiting and V″ and C′ = the voltage and amperage, respectively, after short-circuiting; or, in plainer words, the transmission in amperes taking place by means of the pipes is equal to the amperage after short-circuiting multiplied by the quotient of the voltage before short-circuiting divided by the difference between the voltage before short-circuiting and the voltage after short-circuiting. Thus, if the three readings are 1.5 volts before short-circuiting,

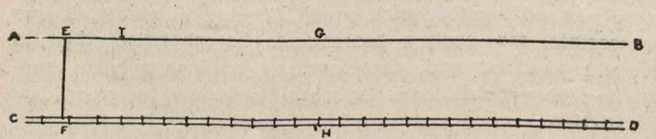


Fig. 19.—Diagrammatic Sketch of Relation of Track Rails and Line of Pipe.

and 1 volt and 2 amperes after short-circuiting, the transmission is

$$\frac{1.5}{1.5 - 1} \times 2 = 6 \text{ amperes.}$$

The third method, while very accurate, can seldom be carried out, and, as it consists of simple ammeter reading, requires no description.

As a preliminary to a description of the fourth method, consider the diagrammatic illustration marked Fig. 19, in which AB represents the track rails, CD the line of pipe and EF a connection between the rails and the pipe. Now, if the resistance of the earth between the rails from G to B and the pipe from H to D, plus the resistance of the pipe from F to D, be high as compared with the resistance of the rails from E to B, the accidental transmission by means of the pipe will be a negligible factor. If, however, a heavy connection be made between B and D with an ammeter inserted the reading obtained will depend upon the load between A and I and the relative resistances of the rails and the pipe line. Such connections as FF and BD often exist through gate-boxes, pipe valves and rails being jammed together; or from accidental contacts between rails and service-pipes or cable-sheaths or bare auxiliary copper returns. That a connection such as EF exists is no reason that a connection should be made between B and D. For two wrongs do not make one right. In such a case, therefore, EF should be removed; even if, for some special reasons, a connection is made between B and D.

Having dealt with the preliminary, the fourth method, which has often been proposed by the writer, but which up to the present time he has been unable to follow, may now be considered. Assume a portion of a straight piece of track forming the suburban or outer end of some line, as represented diagrammatically in Fig. 20, in which AB represents a trolley wire, connected while experiments are being made to a storage battery with an ammeter inserted near A; CD represents a track divided into insulated sections, as shown by the crosses; EF represents a pipe line deadened at both ends and also divided into sections by breaks, as shown by the crosses; and L, L^1, L^2, L^3, L^4, L^5 represent similar pieces of apparatus, each one supplying an equal load of, say, fifty amperes to the track. At each of the points designated by a cross a short length of insulated cable would have to be electrically connected to the metal work on each side of the cross; and on each free end of each cable a suitable lug would have to be sweated. By then bolting the lug faces together, the track and pipe sections, respectively, could be made continuous, or by inserting an ammeter between two lug faces readings could be taken. To use such apparatus

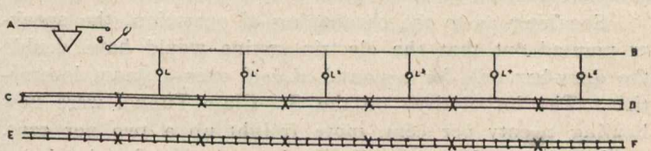


Fig. 20.—Diagrammatic Sketch of Relation of Trolley Wire, Track Rails, Pipe Line and Measuring Apparatus.

the switch G would have to be closed and the ammeter inserted in the trolley wire be watched until it showed a steady load. The ammeter readings would have to be taken at all the points marked with a cross. Voltmeter readings would also have to be taken between the tracks and the rails. Such tests, carried out first with the rails not bonded and then with the rails bonded, would give some very valuable data to assist in the consideration of the problems connected with electrolytic corrosion. The pipe line would, of course, have to be specially laid and covered up, except at the points marked with the crosses; but could, however, be laid with the intention to use it afterward as a water-main by making up the breaks after completion of the tests.

The writer, like many others, has several times installed apparatus and made tests with a view to find out the values of earthed-plates as transmission mediums in connection with roads operated with grounded returns. Using (in Philadelphia about 1894) a large number of copper sheets buried in the ground near the low-voltage bus-bars and surrounded by charcoal, the connection between the plates and the bus-bars being made with a large number of 1,000,000-circular-mil cables, he was unable to obtain any deflection of the ammeter. Using (in Richmond, Va., about 1904) a plate with the surface of about 900 square feet on the bed of a river at a point about one-quarter of a mile from each of two power-houses, and with 500,000-circular-mil cables and connections between the plate and the low-voltage bus-bars of each, he found that the transmission between the plates and one power-house was about three-quarters of an ampere, and between the plate and the other power-house about one-quarter of an ampere; these with a load of about 2,500 amperes. He has also found that ironwork set in concrete forms a much better earth connection than ironwork set in soil when a connection is made through a resistance in each case be-

tween the ironwork and the trolley wire of a grounded system. The probable reason for this is that the ironwork set in soil soon becomes coated with a thick incrustation of oxide, which forms a poor connection between the iron and the soil; while in the case of ironwork set in concrete, the iron, having a fairly clean surface when so set, makes a fairly good contact by means of the concrete with the surrounding soil. Small iron pipes running through the inside of lamp-posts to the mains and larger pipes running down to and for a few feet through the ground (even to within a few inches of the rails) form poor earth connections between the rails of a trolley system and other earthed conductors.

SOCIETY NOTES.

CENTRAL RAILWAY CLUB OF CANADA.—The annual meeting of the club was held at the Rossin House, Dec. 22nd, 1908. Mr. A. M. Wickens read a paper dealing with the electrification of steam railroads in this country. Mr. Wickens maintained that if the motive power were electricity instead of steam, the present roadbeds could increase their carrying capacity by fully thirty per cent. This one feature would do much to relieve the present congestion, as has been clearly proven by the short time in which electric locomotives have been hauling traffic through the St. Clair Tunnel. For these reasons he had no hesitation in recommending the electrification of all roads in Canada. The centre of gravity in an electric locomotive being so low most of that swinging from side to side so noticeable on fast steam-propelled trains, would be done away with, while another feature worth considering would be the almost complete absence of dust, noise and cinders.

Speaking as to the cheapening of operation, the speaker pointed out that the electric engine would have double the draw-bar pull for a pound of coal over a steam locomotive. The locomotives on the St. Clair Tunnel were now hauling twenty per cent. more freight up a two per cent. grade at a speed of ten miles an hour than under the steam regime, for under the old conditions with the lessened carrying ability the steam engine seldom reached the top of the incline at a speed greater than two miles an hour.

At the close of the discussion the following officers were elected:—President, Mr. C. A. Jeffers, master mechanic, Consumers' Gas Company, Toronto; First Vice- President, Mr. J. C. Garden, general foreman, G. T. R., Toronto; Second Vice-President, Mr. Howard G. Fletcher, Toronto.

Executive Committee, R. Patterson, and G. Black, Stratford; J. Bannon, G. Baldwin, J. Markey, H. Ellis and W. R. McRae, all of Toronto. Mr. C. L. Worth, Toronto, was re-elected Secretary.

CANADIAN CLAY PRODUCTS.—The annual convention of the Canadian Clay Products Manufacturers will be held at Brantford, Ont., January 12, 13 and 14, 1909. Papers both practical and theoretical will be discussed.

D. O. McKinnon, 408 McKinnon Bldg., Toronto, Ont., Secretary.

THRUST BEARINGS.*

By Mr. G. B. Woodruff,
At the Institute of Marine Engineers.

In looking into the opinions of various writers upon the subject of friction, one is struck with the apparent want of connection among the different published results. The figures given vary within such wide limits without much apparent cause. In dealing with the subject of thrust bearings, therefore, it will perhaps be as well to also touch upon bearings in general in order to show why an ordinary thrust bearing gives such poor results as compared with a good journal bearing, the more especially as I propose to introduce to your notice a new form of thrust bearing which gives similar results as regards load-carrying capacity and low friction loss as a perfectly lubricated journal bearing.

Journal and thrust bearings have not changed their forms to any extent since they were first made. The first is still essentially a hole with a shaft revolving in it, and the second merely a collar on the shaft rubbing against the edge of the hole. So long as the speed of machines was low these early forms answered their purpose well enough. The old millwright who could design and make a water-wheel or a windmill with his own hands according as the orders came in, did not trouble much about such a thing as efficiency, but so long as his machines did their work, he and his customers were content.

When the speed of machines began to increase with the introduction of reciprocating steam engines, greater care had to be exercised in the manufacture of these essential parts, and probably it was only then that notice was taken of the fact that a thrust bearing always gave more trouble than a journal bearing.

In 1884 Beauchamp Tower made a number of tests of the efficiency of journal and thrust bearings, and found that while a perfectly lubricated journal bearing would maintain its lubrication and carry a load of up to 500 pounds per square inch with a comparatively low friction loss, on the other hand a thrust bearing would not support continuously more than 60 to 70 pounds per square inch, and had a very high friction loss. In other words, he found that while the early form of journal bearing, if properly lubricated, happened to be from its form a really very efficient piece of apparatus, the thrust bearing happened for the same reason to be quite the reverse.

He also showed the reason for this difference. In case of the journal bearing he showed how the oil was carried by the rotation of the shaft from the point of no pressure in the bearing, and how it formed a wedge, continually forcing apart the shaft and the bearing, so as to completely prevent metallic contact between the surfaces. This refers to a theoretically perfect journal bearing, which is not often found in practice. He illustrated this by fixing pressure gauges at various points in the bearing, and showed that the oil pressure gradually increased from zero and reached its highest point a little past the mechanical centre line of the load, and gradually fell towards the ends of the journal. Also, that the friction diminished with the arc of contact between shaft and the bearing, which in practice exists to a considerable extent.

In a flat thrust or collar bearing he showed that there was no point of zero pressure, and, as the two surfaces were pressed together with equal force at all points, it was impossible for such a bearing to be otherwise than in metallic contact, and, therefore, to be incapable of supporting heavy unit loads or working without a great deal of friction.

Since Tower's experiment much has been written on the subject and many other tests made, but the discussion has been chiefly confined to methods of improving oil-lubricated journal bearings—the thrust bearing seemed to be a hopeless case.

Of those who have worked at the theory of oil lubrication no one has done more than the Professor Osborne Reynolds, to whom the commonly accepted theory is almost entirely due. Among other things he showed that perfect lubrication can be maintained between two flat surfaces (when one is a rectangular block moving in a constant direction upon the other) by keeping the moving block at a very slight angle to the fixed plane. He also showed that the friction at any speed can be calculated if the area and viscosity of the oil are known. But he did not show how this principle can be utilized in practice.

There are so many different methods of reducing friction on the market that it will be as well to try to show where these special fuel savers come in, in a general theory of friction. One advocates ball or roller bearings, another some special anti-friction metal, and another the advantages

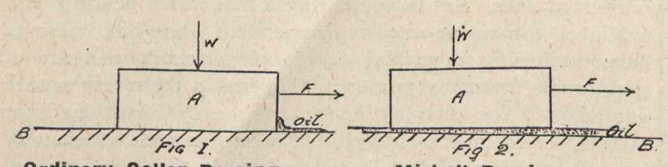
* The lecturer is indebted for data kindly furnished by H. T. Newbigin, A.M.Inst., C.E.

of his special brand of engine oil. Now, all of these have their uses in reducing friction, and it is worth while to endeavor to see clearly where and when the saving takes place in the use of any of the remedies. Let us briefly consider the theory of the matter.

Friction is of two kinds: (1) Static Friction, or the friction between two bodies at rest; and (2) Kinetic Friction, or the friction between bodies in motion.

Static friction is the force required to produce motion between two bodies; it is directly proportional to the normal pressure between them and independent of the areas of the surfaces in contact. It depends almost entirely upon the nature of the surfaces.

To have a low starting friction in a bearing the surfaces require to be highly finished and to be of such metals as have naturally a low co-efficient of friction, and it is here



Ordinary Collar Bearing. **Michell Bearing.**

Oil squeezed out and surfaces in metallic contact.

Wedge of oil maintained between surfaces and no metallic contact.

$$\text{Co-efficient of friction} \frac{F}{W} = \text{about } .003.$$

$$\text{Co-efficient of friction} \frac{F}{W} = \text{about } .03.$$

that the use of an anti-friction metal comes in. The best eliminator of friction, however, is the roller ball.

Referring to the diagram, if all the curves had been continued until they intersected the vertical line, the intersecting points would indicate the co-efficients of static friction for each of the four bearings, and you will notice that these would all be about the same, and very high compared to that of the ball bearing. One advantage, then, of the ball or roller bearing is its very low starting friction, and in machines which are constantly being started and stopped, such as travelling cranes, this is a most valuable feature, and a saving of about 50 per cent of power can be effected. We see that this advantage is lost when the speed of the latter has reached about 10 feet per minute. The blue line on the large diagram, which shows the co-efficients of friction in a theoretically perfect journal bearing (taken crom Archbutt & Deely on "Lubrication"), shows a sudden drop in the friction when the speed approaches about 10 feet per minute. On the other hand. if you look at the red line, which shows the co-efficient of friction of a flat thrust bearing, you will see that while there is a slight fall as the speed increases there is no sudden drop and the friction remains high. There is, therefore, some change which takes place in a properly lubricated journal bearing, and not in an ordinary thrust bearing. This change is the foundation of the oil wedge, as pointed out by Beauchamp Tower. It forces the surfaces apart and brings a new condition of things into operation. The bearing then no longer follows the laws of static and low-speed friction, but those of the flow of viscous fluids, with which Professor Osborne Reynolds' name is intimately associated. According to this theory, the co-efficient of friction increases as the area of the surfaces in contact, as the speed and as the viscosity of the oil. In other words, the friction then becomes merely the force necessary to shear a certain sectional area of oil. It also depends upon the proportion of length to breadth of surfaces in contact; but for any given bearing under these conditions the work done in shearing the oil film increases as the spread increases, consequently you will notice that the blue line gradually rises, as does also the yellow line of the ball bearing.

It is not necessary to deal with the laws of low-speed kinetic friction(which are similar to those of static friction), as my principle object is to point out:—

(1) The change that takes place as soon as the oil wedge is formed.

(2) That an ordinary thrust bearing never has a co-efficient of friction anywhere near as low as a properly lubricated journal bearing.

Having shown a reason for differences in the behaviour of a journal and ordinary flat thrust bearing is the absence of any point of "no pressure" at which the oil can insinuate itself, I will now deal with a new form of thrust bearing which gives similar results to a properly lubricated journal bearing. The black line on the diagram shows the result of a test of one of these bearings and the close agreement which it has to a journal bearing as shown by the blue line.

In 1902 Mr. A. G. M. Michell—an Austrailan engineer—published a paper in which he shows mathematically, on Reynolds' principle for the lubrication of plane surfaces, how the position of the centre of oil pressure in such surface could be calculated, and that if the external pressure were applied at the calculated point the block would then be free to lift at its leading edge and admit oil in the same way as a journal bearing (Figs. 1 and 2). He also demonstrated this by means of a model. Although of scientific interest, this was not of much practical value, as slides moving in one direction only are never used in practice. Three years later, however, he took a patent for the application of his theory to thrust bearings, and showed by practical tests that his calculations as applied to a block moving in a straight line were very closely approximated to a number of blocks moving in a circular path. Since then several of these bearings have been made and applied with complete success to centrifugal pumps and steam turbines. They are specially adapted to continuous running machinery, and enable similar pressures to be supported on a thrust bearing as on the journal type, and with equally low co-efficients of friction.

Ordinary marine thrust bearings are loaded up to about 60 or 70 pounds per square inch, and doubtless many of you have experienced trouble in keeping them cool without the water service even at this low pressure. You will, therefore, probably be interested in a thrust bearing which will work at 500 or 600 pounds per square inch and with about one-tenth of the friction. To give two actual cases, a Michell

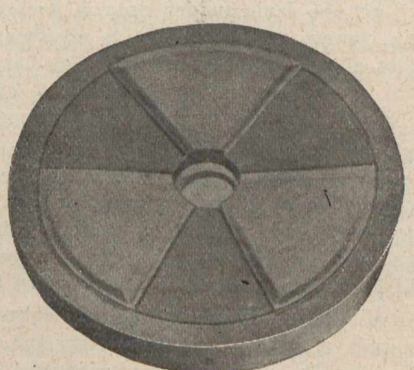


Fig. 3.—Michell Thrust Bearing.

thrust bearing on a vertical type centrifugal pump running at 300 revolutions per minute and loaded to 220 pounds per square inch was examined after running night and day without stop for four months and the marks of the scraper tool found to be still on as when started. Another fitted to a steam turbine has been running at a speed of 1,800 revolutions per minute with a load of 375 pounds per square inch for the last two months without requiring attention. Blue prints are shown giving the details of these two bearings (Figs. 4 and 5).

The essential feature of Michell thrust bearings consists in dividing the working face into a number of segmental blocks, each of which is pivoted at a point about one-third the width of the block from the trailing edge, and

the principle of the action of bearing is such that when pivoted blocks are freely lubricated the oil pressure under each block is zero at the leading edge and twice the average pressure at the trailing edge. The oil is, therefore, free to enter and force the rubbing surfaces apart in the same way

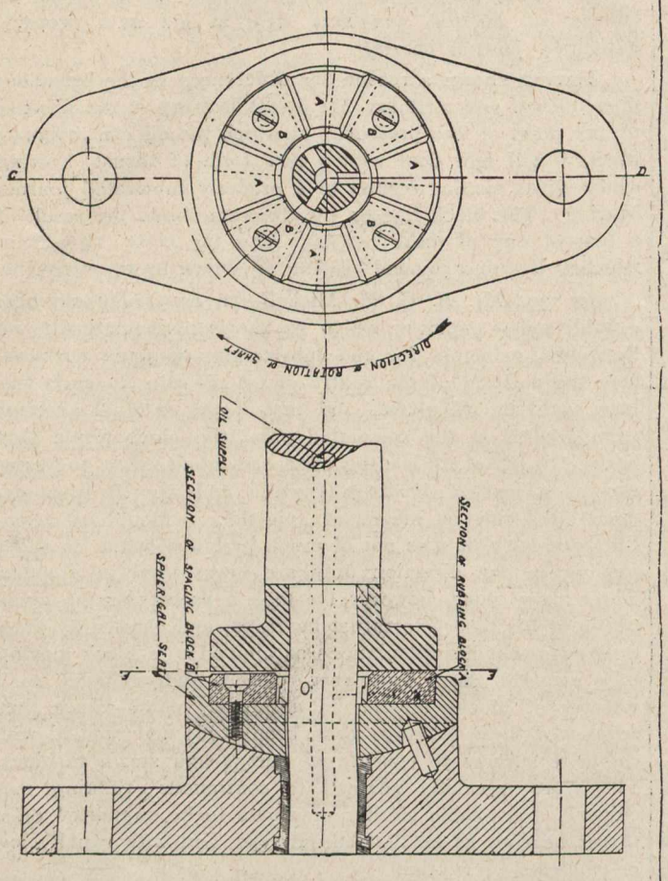


Fig. 4.—Special Design of a Michell Bearing Applied to a Steam Turbine.

as in a journal bearing, instead of being squeezed out under very moderate pressure as in a flat thrust bearing.

As shown by the diagram (which gives the results of actual tests) in place of the high friction loss of flat thrust bearings we get the same sudden drop in friction from that of metals in contact to that of simple oil shear when the speed reaches about ten feet per minute, as has been found by others to take place in journal bearings, and with this change we get the capacity to carry much heavier loads.

It should be mentioned that the importance of having a low co-efficient of friction is greater in the case of high-speed machinery than in that running at low speeds, because, supposing the co-efficient of friction is the same and the speed is doubled, then the work done in overcoming the friction will be doubled and the heat generated doubled.

As you all know, the mechanical equivalent of heat is 778 foot pounds of work; therefore, every 778 foot pounds of work done in overcoming friction generates enough heat to raise one pound of water one degree, and if the resistance offered to a shaft turning is a constant quantity the heat generated in the bearing increases directly as the speed. For example: Say, we have a shaft with 1,000-pound thrust and a collar one foot mean circumference. If this is an ordinary thrust bearing it will have a co-efficient of friction of about .075, and if it rotates at 60 revolutions per minute the work lost in friction will be—

$$1{,}000 \times .075 \times 60 = 4{,}500 \text{ foot pounds,}$$

and the heat generated will be enough to raise one pound of water nearly six degrees per minute, but, as it rotates at 600 revolutions per minute, the work is lost and heat generated will be ten times as much.

If, however, a bearing can be made with a co-efficient of friction of one-tenth of the ordinary thrust the heat generated at 600 revolutions will be the same as in the first case.

You will, therefore, see how important it is in these days of high-speed machinery to have bearings which will run with the very minimum of friction, not so much because of the coal which efficient bearings save, but because of the freedom from "hot bearings" which this efficiency gives, and in this connection it is well to note that the effect of heating in a bearing is cumulative, because as the heat rises it reduces the viscosity of the oil (in other words, makes it thinner) and more liable to be squeezed out and allow the metallic surfaces to come into contact with the usual attendant results.

I have shown you that the advantage of a ball bearing over a Michell thrust bearing is the very low starting friction which such bearings have as compared with oil-lubricated ones. But in comparing a ball thrust bearing with a Michell thrust one must remember that while ball bearings have attained a wonderful degree of perfection and are of great value for many purposes, they are in their very nature not adapted for carrying continuous heavy thrust loads at high speeds. Professor Stribeck, who has gone extensively into the subject of ball bearings, states that the capacity of the ball thrust bearing decreases as the speed increases, and that it is not possible to design a ball bearing within practical dimensions which will carry a heavy load for an indefinite time, as the continual overstressing of the material of the ball must ultimately result in failure, and the practical experience of many users has fully confirmed this opinion. This, however, is not the case with the flexible roller bearing, as has also been well proved. The usual method of failure in ball bearings is that the surface of one or more of the ball scales off, this abraided material getting between the ball and the race brings all the load on one

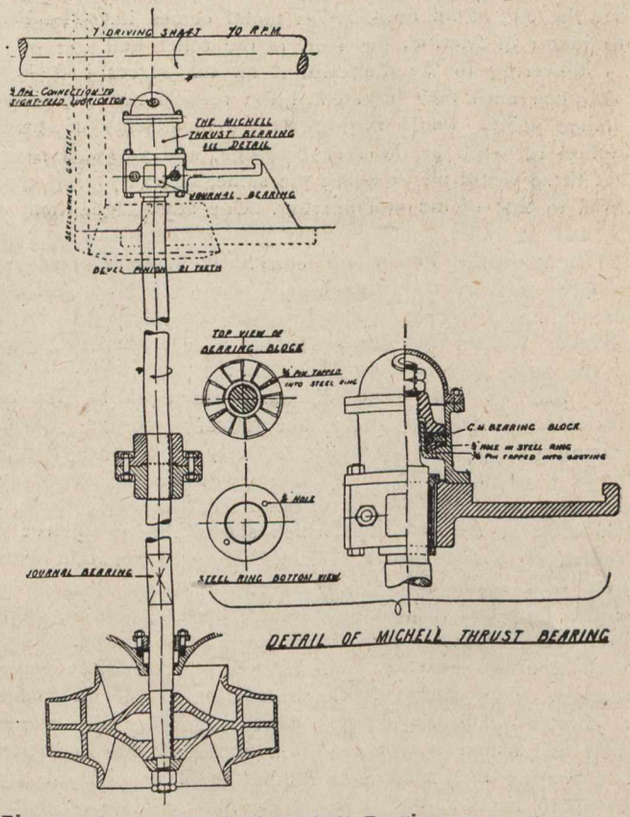


Fig. 5.—Arrangement of Michell Bearing as applied to two Large Vertical Type Centrifugal Pumps for the State Rivers and Water Supply Commission, Victoria, Australia.

ball, crushes it, and then produces a general destruction of the bearing.

I have now endeavored to show you:—

1st. That the chief advantage of a ball bearing is the very low starting friction which it has compared with an oil lubricated journal bearing, but that for heavy loads at high speeds it is not so reliable.

2nd. That while the starting friction of oil-lubricated journal and thrust bearings is high, there is a sudden drop in the friction of a journal bearing, which does not occur in an ordinary thrust bearing.

3rd. That this sudden drop in the friction is caused by a wedge of oil forcing the surfaces apart and changing the frictional resistance from that due to metallic surfaces in contact to the very much lower resistance which a film of oil offers to shear, and that it is necessary to have a point of "no pressure" in a bearing before such a wedge of oil can form and maintain itself.

4th. That in an ordinary thrust bearing there is no point of "no pressure" at which the oil can enter, and, therefore, the surfaces are always in metallic contact, and have a high co-efficient of friction and a very low capacity for carrying load.

5th. That by dividing the annular rubbing surfaces into a number of segmental blocks, each of which is pivoted at a point about one-third of the distance from its trailing edge, each block has a point of "no pressure" at which the oil can enter, and that such a bearing gives similar results in running as a journal bearing, and will carry similar loads.

6th. That the importance of having a low co-efficient of friction in a bearing increases as the speed of the shaft increases, and that while high efficiency is valuable as a

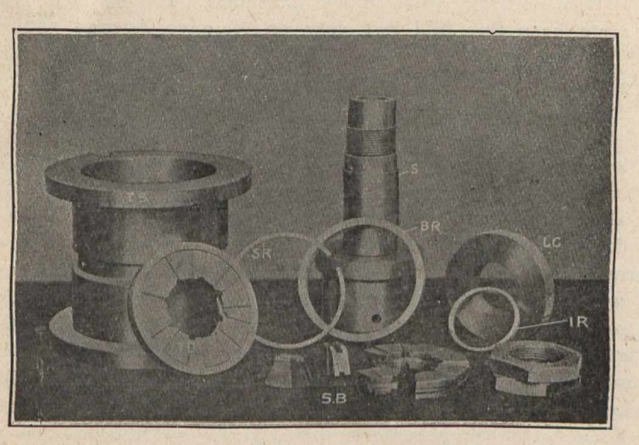


Fig. 6.—Illustration of a Michell Bearing for a Steam Turbine.

coal saver it is also of much more value from the practical point of view of avoiding "hot bearings."

I have now explained that what is aimed at in the Michell thrust bearing is to get points of "no pressure" at which the oil can enter and keep rubbing surfaces from the metallic contact, and that this is obtained by dividing one of the surfaces into a number of segmental blocks pivoted on their back side at points about one-third of the distance from their trailing edges. In order to better illustrate this, suppose this match box is a block moving on a lubricated surface from left to right. If I place the weight on the box at the centre thus, the oil pressure will be about the same all over its under surface, but if I place the weight at the left-hand end thus, you can easily see that there will be no pressure at the right end, and all of the pressure will be at the left end. Similarly it can be shown, on Reynolds' theory of the flow of viscous substances, that if I place the load at about one-third of the distance from the left hand. and that there will be still no pressure at the right hand, that the pressure at the left hand will be double the average pressure, and that whole reaction of the oil pressure will act through this point. Now, the same reasoning holds good if instead of a rectangular block we use segments of a circle revolving around a common centre. The load that such a block will support without allowing of metallic contact depends upon the speed at which it is moving and the viscosity of the oil, so that if the speed is doubled it will carry double the load, or if the viscosity of the oil is doubled and the speed remains the same. And a valuable feature in the Michell bearing is that, given the speed load per square inch and viscosity of the oil, the co-efficient of friction can be calculated very nearly without actual test.

Coming now to the mechanical details of the Michell bearing, in order to get the best results the bearing surfaces should be of suitable metal to secure as low a starting friction as possible. They should be highly finished, and provision made by means of a spherical seat to allow them to adjust themselves in the plane of rotation. They should also run in oil or be amply supplied with it by some suitable means.

TD shows a complete thrust disc which is composed of a ring of segmental blocks, SB having overlapping rubbing surfaces and having internal and external grooves turned in their circumference.

These blocks are assembled around the internal ring IR. The split ring SR is pressed into the external groove, the binding ring BR is then placed in position. This ring has a groove turned in its inside face of one-half the thickness of the split ring into which the split ring springs and holds the whole together. Small holes are tapped in the binding ring BR, into which screws may be placed to compress the split ring if the disc is required to be taken to pieces. The segmental blocks SB have sufficient play to allow them to take the required inclination to the rubbing surfaces.

S shows the shaft, against the collar of which the face of one disc rubs.

TS shows the thrust sleeve, which has an internal flange, against which the discs rub for either direction of thrust.

LC shows the loose collar, which is held on to the shaft S by the checknuts and against which the second thrust disc rubs.

EFFECT OF THE ROAD SURFACE ON VEHICLES.*

By the Hon. C. S. Rolls, F.R.G.S.

One of the early difficulties in the problem of mechanical road locomotion, and perhaps the principal one at its inception, was the fact that it was necessary to design somewhat complicated propulsive machinery, which not only had to be extremely light and capable of adjusting itself to very varying loads, but had also to withstand the continual shocks and vibration transmitted by contact of the road wheels with an indifferent road surface.

The internal combustion engine such as was in use prior to the introduction of motor-cars generally took the form of a single-cylinder gas engine of great weight, developing comparatively small horse-power, and fastened to the floor of a workshop or engine-house by means of a massive concrete foundation, the whole engine, with its foundation, often weighing several tons for an output of perhaps ten horse-power.

Compare this with the automobile engine. The working conditions are very different. The engine itself has to be constructed as lightly as possible, then it has no such solid foundation to work on, but is slung on to a framework, the whole of which is liable to upward and downward motion, and is in a state of more or less constant vibration.

The experiences of the early Continental road races were undoubtedly of great value to automobile designers, and taught them that the chief problem for them to study in this direction was the insulation of the motor and transmission gear from the vibration and shocks of the road.

The advent of pneumatic tyres in the place of solid rubber or iron tyres greatly facilitated the problem, but inasmuch as the speed attained by motor vehicles increased proportionately with this as with nearly every other improvement, the attention of motor engineers was being constantly

* Paper read before International Road Congress, Paris.

directed to the question, which thus resolved itself into matter of spring suspension.

In the earliest days when the speed attainable by motor-cars was barely greater than that of the horse-drawn vehicle, the principal vibration emanated from the engine itself, owing to the small number of cylinders used, the weight of the moving parts and the lack of proper "balancing"; in fact, many of the earlier engines fitted to road vehicles literally "shook themselves to pieces."

As, however, the art of correct "balancing" in internal combustion engines began to be mastered, and also the use of lock nuts and split pins became universal, the trouble from mere vibration was greatly diminished, but the breakages from road shocks became more serious as the speeds increased.

The method of suspension used on modern motor-cars—the long springs on a long wheel-base, the use of the transverse or "three-quarter elliptical" in addition to the ordinary rear springs, and the various "dampers" or shock-absorbers—is as perfect as we are likely to have with the present road surfaces; more cannot be done by the motor builder. It therefore rests with the road builder to effect further improvements which will increase the life of the vehicle and the comfort of the passengers.

Good as now is the springing of a motor-car, it is as nothing compared to what would be possible with universally improved road surfaces. At the present time the frames, axles and other essential parts have to be constructed far heavier to withstand the strains than ought really to be necessary. The shocks to which the various parts of an automobile are subjected when the latter is driven fast over an indifferent road surface are very severe, and in course of time they affect the machinery in numerous ways, by increasing the wear in the main bearings of the engine and of the transmission—especially the bearings connected with the back axle in the case of chainless cars—by causing excessive wear in the universal couplings of propelling shafts, in the pins and pivots of the radius rods and torque rods, spring shackles, steering pins, etc. The constant "pounding" also causes the axles to become gradually brittle, so that they have to be built with a bigger factor of safety than would be necessary on a really smooth surface.

With ideal roads, not only could the whole car be constructed far lighter in weight, but especially those parts which are situated between the springs and the road surface—e.g., wheels, axles, steering gear, etc. These parts, if reduced in weight, would respond more readily to any slight unevenness, whereas at present their inertia is such that when travelling fast they have not time to respond to each "bump" in the road, with the result that they simply bound up and down in a manner suitable to the "period" of the springs, and not in true accordance with the inequalities of the surface; shock dampers also have often to be fitted to check the excessive rebounding of the springs.

With a general reduction of weight such as would follow the advent of smooth roads, far more sensitive springs could be used, with corresponding increase in comfort and luxury of travelling, and in the life of the vehicle and its mechanism.

While dealing with the subject of road shocks, attention might here be drawn to the severe and wholly unnecessary jolting that is often caused to motor-cars and their occupants by the bad joining up of different repaired strips of road surface, when encountered at high speed; these shocks could be very greatly reduced by the simple method of making the joins diagonally to the road instead of at right angles to it. By this means the bump would be encountered by each road wheel successively and separately, instead of by the two front wheels simultaneously, and then by the two back wheels together.

Among other considerations of importance in regard to the nature of the road surface is the degree of adherence afforded to pneumatic tyres by the surface. There are certain materials used such as oolite and various chalky substances, which make an excellent surface when dry, but which become very slippery in wet weather, and which should therefore, from the motor-car's point of view, be avoided if possible, or mixed with other more gritty substances. Apart from the question of danger, the continuous driving of a powerful vehicle over a very slippery surface is liable to cause excessive wear and tear in the differential gear.

Another matter, and one which helps to emphasize the importance of aiming at dustless roads, is that not a little of the wear and tear in the various bearings of motor-car mechanism is traceable to grit, sand, and in fact fine particles of stone, which are drawn up from the road surface by fast-moving vehicles.

Finally, in regard to tyres, so much is now known as to the effect of different kinds of road surface upon the life of a tyre that comment thereon is not here necessary; but one point of importance may be mentioned, and that is that with the ever-increasing use of fast-moving mechanical road vehicles it is hoped it will now be but a matter of time before the practice of "banking" all highways at bends and corners will be introduced. This practice, besides reducing considerably the dangers of the highway at certain points would reduce to an enormous extent the amount of wear and tear, both in the tyres and in the side-thrust bearings of the road wheels and axles.

CARBOLINEUM WOOD BLOCK.

Carbolineum wood block pavement on a six-inch concrete base was laid last year on Namayo Avenue and on First Street in Edmonton, Alta. This was the same class of wood block as laid in 1907 on MacDougall Avenue, except that this time some changes were made in the method of laying. In 1907 the sub-foundation was not rolled before depositing the concrete foundation, and in laying the blocks no provision was made for expansion. In the spring of 1907 at several places on MacDougall Avenue the blocks heaved, due to expansion. Last year the sub-foundation was thoroughly rolled and consolidated before depositing the concrete foundation, and expansion of the blocks was provided for by leaving an expansion joint one inch wide between the gutter and the pavement. This joint was filled half way up with sand and the balance of the way with bitumen. Similar joints were left crosswise of the street every hundred feet. Thus far these pavements have given no trouble due to heaving, and I do not think will do so in future, as these joints will undoubtedly provide for any expansion that may take place in the blocks. The blocks used in this pavement are British Columbia fir, supplied by the W. H. Harvey Co., of Vancouver. The dimensions of the blocks are 4-inch by 3-inch and of varying width. This pavement carries a ten-year guarantee, and cost on a six-inch concrete base $3.65 per square yard.

NEW INCORPORATIONS.

British Columbia.—Ingenika-Finlay River Development Company, $2,000,000.

Richmond, Ont.—Malahide & Bayham Telephone Co-operative Association, $10,125.

Westmount, Que.—Westmount Plumbing & Heating Company, $90,000; W. A. Rousseau, J. Gignere, M. A. Cardinal.

Listowel, Ont.—Oliphant Oil and Gas Company, $22,500; T. J. Walsh, Amabel Township; J. H. McCorkindale, Owen Sound; J. C. Hamilton, Listowel.

Hamilton, Ont.—Midfield Natural Gas Company, $40,000; A. S. Devine, C. C. Foote, M. H. Little. Canadian Road Machine Co., $60,000; R. Mancill, C. Walters, W. Bell.

New Brunswick.—Sovereign Coal Company, $300,000; A. Mehler, New York; H. Shaw, Beersville; E. Mead, Adamsville. Kent Coal Company, $5,000; H. Von Hagen, New York; E. Mead, Adamsville; E. O. Seeley, Maccan.

Montreal, Que.—J & T. Bell, $300,000; J. T. Hagar, E. J. Hagar, C. B. Keenan. Canadian Crown Castings Company, $199,000; F. M. Gibson, M. M. Tinsley, G. L. Gillon. Western Engineering Company, $100,000; A. J. Brown, R. O. McMutry, F. G. Bush.

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.

Nova Scotia.

TENNYCAPE.—Tenders for Tennycape breakwater extension will be received at this office until 4 p.m. on Monday, January 4, 1909, for the construction of an extension to the breakwater at Tennycape, Hants County, N.S., according to a plan and specification to be seen at the offices of C. E. W. Dodwell, Esq., resident engineer, Halifax, N.S.; E. G. Millidge, Esq., resident engineer, Antigonish, N.S. Napoleon Tessier, Secretary, Department of Public Works.

Quebec.

MONTREAL.—Tenders for rubber coats and boots will be received up to noon, Saturday, the 2nd January, 1909, for rubber coats and boots, which shall be delivered as they are required and ordered during the year 1909. Samples must accompany each tender. L. O. David, City Clerk.

Ontario.

OAKVILLE.—The time for receiving tenders for intake pipe for Oakville waterworks has been extended to 8 p.m. on Wednesday, January 6th. Contractors are to furnish all materials and labor. Plans may be seen at Oakville or at Chief Engineer's office, 103 Bay Street, Toronto. A. S. Chisholm, Esq., Chairman Board of Water Commissioners, Oakville, Ont. W. Chipman, C.E., Chief Engineer, 103 Bay Street, Toronto, Ont.

ST. CATHARINES.—Tenders for supplies addressed to the Superintending Engineer, Welland Canal, St. Catharines, Ont., will be received until 16 o'clock on Saturday, the 16th of January, 1909, for the supply and delivery of various articles of timber, hardware, castings, oils, etc., for use on the Welland Canal and its branches for the year 1909. L. K. Jones, Secretary, Department of Railways and Canals.

British Columbia.

VERNON.—The municipal council of the city of Vernon, B.C., invite tenders for delivery, f.o.b. cars, Vernon, of the following quantities, more or less, of cast-iron work: 80 manhole covers, about 20 inches diameter opening; 20 catch basin covers, about 15-in. x 18-in. opening; 6 flap valves, 8-in. diameter, on 2-ft. length of pipe; 6 flap valves, 6-in. diameter, on 2-ft. length of pipe. Dipped, while hot, in coal tar. Manufacturers' own designs will be considered if full particulars are given. Sealed tenders, marked "Manhole Covers," should be in the hands of the city clerk not later than 8 p.m. on Monday, 11th January, 1909. Frank McGowan, City Clerk. Galt & Smith, Consulting Engineers, Toronto and Vernon.

CONTRACTS AWARDED.

Saskatchewan.

MOOSE JAW.—Contracts for supplying coal to the power-house was awarded to Hitchcock and McCulloch at $5.80 f.o.b., power-house, and $5.50 when spur track is put in. The tenders were:—Milestone—Bellevue, $5.50 per ton f.o.b., Moose Jaw. Pioneer—Leitch collieries, $5.70 per ton f.o.b., Moose Jaw. Robert Allison Company, steam coal, 5.75; pea coal, $5.50 f.o.b., Moose Jaw. Simington—Steam coal, $5.70 f.o.b., Moose Jaw. Wellington—Leitch collieries, $5.60; Maple Leaf, $5.70; and a cheaper grade, $5.50 f.o.b., Moose Jaw. McMicken & Traux—Roche Perce coal, $1.50 at mines; $3.10 f.o.b., Moose Jaw; nut, 95c. at mine; $2.25 f.o.b., Moose Jaw; screenings, 55c. at mine; $2.15 f.o.b., Moose Jaw. Hitchcock & McCulloch—Hillcrest, $5.80 f.o.b., Moose Jaw, and $6.10 delivered; mixed, $5.50 f.o.b., Moose Jaw, and $5.80 delivered.

Ontario.

TORONTO.—Tenders were opened by the City Council for the year's supply of cements with the following result:—

Tender No.	Portland Cement. Brand.	In sacks. Per 350 lbs. net.	In sacks. Per 87½ lbs. net.
1	Star	$ 1 85½	.....
2	Belleville	1 42½	.....
3	.....	*1 81	.....
4	Superior	*1 95	.....
5	National	1 49	.....
6	Lehigh	*1 68	.....
7	.....	1 57	.....
8	Star	†1 50	.....
9	Monarch	.....	35

* Ten cents allowed for each sack returned.

† Including sacks which are not returnable.

Tender No. 6, that of the Thorn Cement Co. (Lehigh Brand), Belleville, Ont., was accepted.

British Columbia.

VICTORIA.—The executive council awarded to W. W. Forrester, of New Westminster, the contract for carrying out public works at Prince Rupert. The work will be paid for jointly by the G.T.P. and the Provincial Government. The cost was not to exceed $200,000. Mr. Forrester's figures were at 14½ cents per square foot for plank roadways, 7 cents per square foot for plank walks, 29 cents per cubic yard for excavating earth, $1.50 per cubic yard for excavating rock and $34 per acre for close cutting. The plank roadways planned will embrace about 560,000 square feet, and the plank walks 112,000 square feet. The excavation work is in connection with the sewer system which is going to be put in.

Foreign.

GREENFIELD, MASS.—The Goodell-Pratt Company, manufacturers of hand-working tools, have awarded the Aberthaw Construction Company, of Boston, Mass., the contract for a new foundry. The building, which is to be 75½ feet wide by 120 feet long, will be constructed of reinforced concrete throughout and provided with metal sash. The working floor will have a clear span of 44 feet.

NIAGARA FALLS, N.Y.—The State Reservation Commissioners, at a meeting held here yesterday, awarded the contract for the elevator shaft and its appurtenances to Charles E. Fraser & Company, of New York, at $88,487, the job to be completed in 155 working days. The elevator proper will be supplied by the Otis Elevator Company for $15,000, which will make the total cost of the work $103,887. The appropriation of the Legislature was $104,500. The bid of W. J. S. Cowdrick & Co., of this city, was $107,895, and of Morris Kantrovitz of Albany, $110,700.

BROOKLYN.—The Raymond Concrete Pile Company of New York and Chicago has been awarded the contract for placing Raymond concrete piles in the foundations of a compressor house that is being erected at the Erie Basin, Brooklyn, for the John N. Robbins Company, Wm. T. Donnelly, engineer; C. F. Bond Company, general contractors. Another contract awarded to the Raymond Company calls for the placing of Raymond concrete piles in the foundations of public school No. 17 which will occupy a site extending through from West 46th to West 47th Street, between Ninth and Tenth Avenues, New York; C. B. J. Snyder, architect, Board of Education; Clark & Stowe, general contractors.

RAILWAYS—STEAM AND ELECTRIC.

Quebec.

MONTREAL.—It was learned on good authority that, although no actual decision had been arrived at, there is every probability of the Canadian Pacific Railway Co. building a railway to Cowganda, the new silver field. The Canadian Pacific is prepared, it is said, to construct the road without a subsidy from its system at Sudbury. The road would run in a north-easterly direction into the heart of the new silver country.

Ontario.

BRANTFORD.—The city council passed a by-law allowing the Street Railway Co. an extension of time in which to fulfil its former agreement with the city, its franchise, granted a year ago, to be sustained on condition that the agreements stated in the previous by-law and somewhat amended, be carried out. The company is to give the city, within two months, a bond for $25,000 as a guarantee that the agreement will be adhered to.

COCHRANE.—The National Transcontinental Railway is about to put in a large storage yard at Cochrane, the junction with the Temiskaming and Northern Ontario Railway. It will be in readiness, it is expected, some time next month. There will be capacity for thirty or forty thousand tons of rails and fastenings. At the new town site there are already some settlers.

PORT ARTHUR.—Taylor & Mercier have received a contract to transport one hundred tons of supplies into the Grand Trunk Pacific right-of-way from Jackfish. Contractor Davis, of Ottawa, has a contract for that portion of the line north of Jackfish. It is the intention of the contractors to build a tramway from the right-of-way to Jackfish, and this work has already commenced, and it is likely that by next summer the line will be under operation.

PORT ARTHUR.—General Manager McLeod, of the Canadian Northern, states that the company will make large additions to the terminal facilities here. Some are definitely arranged and others are in contemplation. To increase the freight storage capacity at the docks a shed is now being built over the steel dock. A new dock is to be built just south of the present dock, and on it work will be started as soon as feasible. It will be used as a steel dock during the early summer and for freight when the fall rush comences. New tracks will be laid through the yards, including lines to the new elevator to be built by Piper & McWilliams.

SAULT STE. MARIE.—The Canadian Pacific Railway has ordered 20,000 tons of rails from the Algoma Steel Co. at Sault Ste. Marie.

WELLAND.—A copy of the electric railway by-law announced by George H. Burgar has been handed to each member of the council. The by-law sets forth that the rights and privileges granted are to be held by Harry D. Symmes, of Niagara Falls, as trustee. The franchise is to date from October, 1909, for twenty years, the work of construction to begin before the date named, and the road is to be in operation before October 1st, 1910. The franchise is to apply to East Main Street, Muir and South Main Streets, and "such other streets as may be deemed advisable." The company is to lay a 56-pound rail, and agrees to maintain the roadway between the tracks and for eighteen inches on either side. There are the usual clauses relative to the preservation of the interests of the corporation in the streets.

British Columbia.

PRINCE RUPERT.—The railway ferry barge Georgian arrived here with two steam shovels and four Davenport locomotives. The whole outfit has been unloaded and distributed at convenient points along the first mile of construction, where big bluffs, aggregating 300,000 cubic yards of rock, will have to be removed. The largest of these bluffs, containing over 200,000 cubic yards, is now being bored with "coyotte" holes. There are eight of these tunnels, and they are not big enough for a workman to stand erect. When bored to a length of 75 to 100 feet, they will be crosscut at the end and huge pockets blasted out of the rock. These chambers will then be filled with tons of dynamite and the tunnel filled with broken rock and cement to keep it from blowing out. They will all be connected by wires with a galvanic battery and exploded at the same time. When this blast has been fired it is expected the rock will be so shattered that the steam shovels will have no difficulty in handling it.

LIGHT, HEAT, AND POWER.

Ontario.

BOBCAYGEON.—The wheels for the municipal power-house have arrived. The wheels, which were manufactured by the Madison Williams Foundry Co., Lindsay, are of the Triumph turbine type, and each is capable of developing 80 horse-power with a five-foot head and about 100 horse-power with a six-foot head, the two weighing over fourteen tons. The dynamo and other apparatus has already been transferred to the new power-house and the poles have been changed, so that the wheels and line shaft are now the only things to be fixed.

NEWMARKET.—The Electric Light Committee brought in a report based on actual figures, in which it was shown that the cost of electric light this year was 7.95 cents per 1,000 watts, and domestic water 2.39 per 1,000 gallons.

OTTAWA.—The emptying of the final bucket of concrete into the forty-ninth pier of the Chaudiere dam of the Ottawa River on Saturday afternoon completed one of the quickest pieces of concrete work ever done in the Dominion. The contracts call for the dam to be finished in every detail and handed over by December 1st, 1909. It is likely that it will be done now by about midsummer.

PORT STANLEY.—The electors will, on January 4th, vote on the question of bringing Niagara power to this town.

Manitoba.

WINNIPEG.—City Electrician McCulloch is now prosecuting an inspection of the water mains of the East End to ascertain the extent of the probable injury to the pipes through currents of elecricity leaking from the tram rails. Following the route taken by the Grandview cars from the tram office it is found that the leakage o fthe current varies with every block, and as Venables Street is reached the variance increases. Along the head of False Creek there seems to be a tendency of the current to go toward the creek, with the result that the nearer to the coves of the basin the tracks run the less leakage is shown by the tests on the mains. Another curious fact is found by reason of the varying nature of the soil in different parts of the city. In certain sections where the ground is impregnated with carbonates the effect of the leakage of the current has been to set up a chemical action, which coats the mains and renders them passive to the effects of the current. In the central portion of the city, however, where the soil is filled with chlorine from the salt water, a distinctly increased harmful effect is noticed on the pipes.

SEWERAGE AND WATERWORKS.

Ontario.

BRANTFORD.—The Brantford waterworks continue to be successfully operated under municipal ownership commission. The annual report shows this year to be the best in its history. The net earnings are $51,793.68, being $5,600 in excess of last year. The Commissioners, Messrs. Alfred Watts and William Whitaker, were reelected by acclamation.

SIMCOE.—The electors will vote on January 4th to place the Simcoe waterworks under a commission.

ST. THOMAS.—On January 4th the electors will vote on a by-law to raise funds with which to install a septic tank.

TORONTO.—New Toronto township have for some time back debated the question of sewering their district. The population is only small, and the amount of domestic sewage small compared to the trade effluents from certain works, consisting principally of leather and paper works, with a large effluent from G.T.R. roundhouse. The problem of sewering the district is not a serious proposition. On the

other hand, the problem of sufficiently purifying the sewage before it enters the lake is a complicated and difficult one, owing to the large proportion of offensive trade effluents in comparison to the amount of domestic sewage. Mr. Andrew F. Macallum and Mr. T. Aird Murray, engineers, Toronto, are now jointly engaged on plans, in order to present to the township a proposed scheme to deal with the question.

WATERLOO.—Messrs. Harvey Bros., well drillers, of Petrolea, who have been engaged in drilling another well for the Waterloo waterworks during the past week, were successful in striking a splendid flow of water at a depth of 110 feet, resulting in a flow of about 150,000 gallons per day. There are now five artesian wells with a capacity of nearly 800,000 gallons per day. The Commission will now be in a position to furnish outside parties with water during the coming summer.

British Columbia.

VICTORIA.—The Committee on Waterworks have submitted the following new rates: Flat Rate—Four rooms, $1.10; with discount, $1; five rooms, $1.10; with discount, $1; six, seven and eight rooms, $1.10; with discount, $1; nine and ten rooms, $1.40; with discount, $1.25. Meter Rates—First 1,000 gallons, $1.10; residences, all over 1,000 gallons, 12 cents per thousand gallons. All other amounts as follows: Under 75,000 gallons per month, per thousand gallons, 22½ cents; 75,000 to 100,000 gallons per month, per thousand gallons, 20 cents; 100,000 to 200,000 gallons per month, per thousand, 17½ cents; 200,000 to 300,000 gallons per month, per thousand, 15 cents; over 300,000 gallons per month, per thousand, 12½ cents. All meter accounts subject to ten per cent. discount if paid within fifteen days after becoming due. Meter rentals to remain as at present. Frontage tax for all pipes of four-inch and upwards to be levied at the rate of three cents per foot.

FINANCING OF PUBLIC WORKS.

Nova Scotia.

HALIFAX.—Halifax county council have decided to guarantee the bonds of the Halifax and Suburban Electric Co., Limited, to the amount of half a million dollars. Parties interested in the Waverley Gold mine are ready to furnish the capital for utilizing the Fall River water power and transmitting to Halifax, via Dartmouth and Bedford, for manufacturing and other purposes.

Ontario.

BRANTFORD.—The ratepayers of Brantford, Ont., will vote on January 4th on a by-law to issue $5,000 4½ per cent. 20-year debentures for the purpose of additions to the John H. Stratford Hospital; and on January 5th on a by-law to issue $20,000 4 per cent. 20-year electric plant debentures.

FORT WILLIAM.—The ratepayers of Fort William will vote on January 4th on a by-law to issue $10,000 4½ per cent. 15-year debentures for electric light purposes. The existing debenture debt of the city, exclusive of the local improvement debentures is $1,501,444.48.

FORT WILLIAM.—Fort William will apply at the next session of the Provincial Legislature for the validation of a by-law to raise $170,000 for the purpose of extending and improving the electric railway system, and the validation of by-laws for $6,000 for the purchase of lands from the Dominion Government, and $9,000 to complete a contract with the Mount Mackay and Kakabeka Falls Railway Co.

SIMCOE.—A by-law to raise $6,000 for waterworks extension will be voted on January 4th.

WATERLOO.—A vote will be taken on a by-law to authorize the issue of debentures for $15,000 to build and equip a ward public school.

WINDSOR.—Tenders for debentures will be received by the undersigned up till 5 o'clock p.m. on the 30th day of December, 1908, for $15,000 twenty-year five per cent. Windsor waterworks debentures, consisting of twenty debentures for $1,203.64 each. Stephen Lusted, City Clerk.

Foreign.

NEW YORK.—A special meeting of American Telegraph and Telephone Co. stockholders has been called for January 7th to authorize an increase in capital stock from $250,000,000 to $300,000,000. This action is taken to allow a sufficient margin for conversion into stock on and after March 1st next of the $150,000,000 four per cent. convertible bonds, which will then be outstanding.

TELEPHONY.

Ontario.

LONDON.—Superintendent Nixon, of the G.T.R. at London, Ont., has announced that the telephone system is to be put in for the despatching of trains on that division. The staff of telegraph operators will be retained for the present at least.

Manitoba.

WINNIPEG.—At the New Year it is expected the Manitoba Government will reduce the telephone rates, the approximate profits for the year being $225,000.

Alberta.

CALGARY.—The Alberta Government telephone system now covers 1,400 miles of trunk line and 600 miles of farmers' rural line. Since May 1st 1908, 200 miles of trunk line and 400 miles of farmers' rural line have been constructed. There are 165 telephone exchanges.

MISCELLANEOUS.

Ontario.

KINGSTON.—The report of City Engineer Craig for the year just closing shows that $61,632 was spent on the streets. The largest amount spent in any one year before was $40,000. Over six miles of concrete walk was laid, and a mile and a half of macadam roadway made.

PETERBORO.—City Engineer Hay has submitted to the city council plans for 3-arched span of 100 feet each for the Smith Street Bridge. Estimated cost for 18 feet roadway and two walks, $37,500; 24-foot roadway and two walks, $46,500.

Manitoba.

WINNIPEG.—Nearly all the quarrying firms in Manitoba have merged in the Garson Quarries, Limited, with a capital of a quarter of a million. This amalgamation is likely to have an important bearing on building material prices in Western Canada.

Alberta.

CALGARY.—The city council are advertising for a city engineer.

Foreign.

PHILADELPHIA. — The United States Government dredge "Clatsop" passed down the Delaware River recently on a 15,000 mile journey to Portland, Oregon. The dredge is only 183 feet long. The voyage will be made by way of the Straits of Magellan.

LONDON.—The general offices of "Concrete and Constructional Engineering" have been removed to Dewar House, Haymarket, S.W. (Telephone 6577 Gerrard), and the January issue will be published from that address.

PERSONAL.

MR. C. W. NOBLE, formerly of Winnipeg, has removed to Toronto, where he has assumed the general management of the Preston Metal Roofing and Siding Co.

MR. J. B. TYRRELL, M.E., Toronto, Ont., remembered many of his friends on Christmas Day and sent them an attractive Christmas card, the cover design of which comprised a view of Fort Churchill in winter.

MR. REGINALD W. BROCK, M.A., of Ottawa, has been appointed Director of the Geological Survey. For a number of years Prof. Brock occupied a chair at Queen's University and did field work for the Geological Survey in the summer. For the past year he has been separated from Queen's and has been acting Director of the Geological Survey. He is now confirmed in the directorship, and will act under Mr. A. P. Low, Deputy Minister of Mines.

TENDERS CALLED FOR

NOTICE TO CONTRACTORS

Construction of Hydraulic Dredge

Tenders will be received by registered post only, addressed to the Chairman of the Board of Control, City Hall, Toronto, up to noon on Tuesday, January 19th, 1909, for the construction of a hydraulic dredge complete.

Envelopes containing tenders must be plainly marked on the outside as to contents.

Plans and specifications may be seen and forms of tender obtained at the office of the City Engineer, City Hall, Toronto.

The usual conditions relating to tendering, as prescribed by city by-law, must be strictly complied with, or the tender will not be entertained.

The lowest or any tender not necessarily accepted.

Jospeh Oliver, (Mayor),
Chairman Board of Control.

City Hall, Toronto, Dec. 21, 1908.

MARKET CONDITIONS.

Toronto, December 29th, 1908.

The holidays are still interfering with the markets. Few large orders are being placed, but the continued mild weather is favorable for building and builders' supplies are still active. Pig-iron is steady, but not much demand. Copper is firm.

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

Antimony.—Price unchanged at 8¾c., with less enquiry.

Axes.—Standard makes, double bitted, $8 to $10; single bitted, per dozen, $7 to $9.

Boiler Plates.—1-4 inch and heavier, $2.40. Boiler heads 25c. per 100 pounds advance on plate.

Boiler Tubes.—Orders are active. Lap-welded, steel, 1 1-4-inch, 10c.; 1 1-2-inch, 9c. per foot; 2-inch, $8.75; 2 1-4-inch, $10; 2 1-2-inch, $10.60; 3-inch, $12.10; 3 1-2 inch, $15.30; 4-inch, $19.45 per 100 feet.

Building Paper.—Plain, 30c per roll; tarred, 40c. per roll. Business decidedly quiet.

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

Cement.—Market still weak; cement can be had in 1,000 barrel lots at $1.70 per bbl, including the bags, which is equal to $1.30 without bags. At this time of year building operations are closing down, demand is therefore naturally limited. This week even the small dealers in Toronto find demand shut entirely off.

Coal Tar.—Season about over, price still $3.50 per barrel.

Copper Ingot.—There is more activity in the States, rather quiet demand here. Prices are higher, at 15 to 15½c. with a prospect of their maintenance for a while.

Great Western Railway of England

INDUSTRIAL SITES

Sites suitable for the establishment of FACTORIES and WORKS are available adjoining the GREAT WESTERN RAILWAY, within easy access of the principal ports, Coal and Iron fields and Industrial centres.

Particulars of such sites and of the Company's arrangements for Siding Facilities, Conveyance Rates, Etc., may be obtained from the Chief Goods Manager, Mr. T. H. RENDELL, Paddington St., London, W.

JAMES C. INGLIS,
General Manager

TOWN OF OAKVILLE

Province of Ontario

NOTICE TO CONTRACTORS

Extension of Time

The time for receiving tenders for Intake Pipe for Oakville Water Works has been extended to 8 p.m., on Wednesday, January 6th.

Contractors are to furnish all materials and labor. Plans may be seen at Oakville, or at Chief Engineer's office, 103 Bay Street, Toronto.

W. Chipman, Esq.,
Chief Engineer, 103 Bay St.,
Toronto, Ont.

A. S. Chisholm, Esq.,
Chairman Board of Works Commissioners,
Oakville, Ont.

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

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

Roofing Felt.—Very limited request. Price $1.80 per 100 pounds.

Fire Bricks.—English and Scotch, $32.50 to $35; American, $28.50 to $35 per 1,000. A growing demand this month, with fair stock.

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

Galvanized Sheets—Apollo Brand.—Sheets 6 or 8 feet long, 30 or 36 inches wide; 10-gauge, $3.05; 12-14-gauge, $3.15; 16, 18, 20, $3.35; 22-24, $3.50; 26, $3.75; 28, $4.20; 29, $4.50; 10¾, $4.50 per 100 pounds. Fleur de Lis—28-gauge, $4.30; 26-gauge, $4.05; 22-24-gauge, $3.50. Queen's Head—28-gauge, $4.50; 26-gauge, $4.25. Sheets are in very active request.

Iron Chain.—¼-inch, $5.75; 5-16-inch, $5.15; ⅜-inch, $4.15; 7-16-inch, $3.95; ½-inch, $3.75; 9-16-inch, $3.70; ⅝-inch, $3.55; ¾-inch, $3.45; ⅞-inch, $3.40; 1-inch, $3.40.

Bar Iron.—$1.95 to $2, base, from stock to wholesale dealer.

Iron Pipe.—Black, ¼-inch, $2.03; ⅜-inch, $2.25; ½-inch, $2.63; ¾-inch $3.56; 1-inch, $5.11; 1¼-inch, $6.97; 1½-inch, $8.37; 2-inch, $11.16; 2½-inch, $17.82; 3-inch, $23.40; 3½-inch, $29.45; 4-inch, $33.48; 4½-inch, $38, 5-inch, $43.50; 6-inch, $56. Galvanized, ¼-inch, $2.86; ⅜-inch, $3.08; ½-inch, $3.48; ¾-inch, $4.71; 1-inch, $6.76; 1¼-inch, $0.22; 1½-inch, $11.07; 2-inch, $14.76. Makers are holding prices stiff and anticipate a rise.

Lead.—Quiet and unchanged at $3.90 to $4.00. Old Country market quiet but steady.

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

Lime.—In adequate supply and brisk movement. Price for large lots at kilns outside city 22c. per 100 lbs. f.o.b., cars; Toronto retail price 35c. per 100 lbs. f.o.b. car

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Associate to manage Branch Office of leading Hydro-Electric Engineer. Only young Civil Engineers with Hydraulic experience and business tact, who can invest small capital need apply. Address
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CONTRACTOR'S SUPPLIES

To know where to look for what you want, to know where to dispose of what you don't want is a great convenience. You require special equipment. This department will enable you to get in touch quickly with reliable men who wish to dispose of that which you require. Whether a buyer or a seller, you will find this department an aid to business.

RATES FOR THIS DEPARTMENT ARE VERY SPECIAL. BETTER SEND FOR THEM.

FOR SALE

CONTRACTORS' MACHINERY.

1, 900 gallon Northey, vertical centrifugal pump.
1, 735 gallon Morris, vertical centrifugal pump.
1, 470 gallon Morris, vertical centrifugal pump.
1, 400 gallon standard, horizontal centrifugal pump.
1, 260 gallon Morris, vertical centrifugal pump.
1, 8" horizontal centrifugal sand pump with hose and pipe.
1, 9" x 10" Abell, semiportable engine and boiler.
1, 8" x 12" semiportable engine and boiler.
1, 7" x 10" Champion portable engine and boiler.
1, 7" x 10" Victor portable engine and boiler.
1, 7 1-2" x 12" Russell traction engine.
1, 7" x 10" Cornell traction engine.
1, 48" x 20' semiportable fire box boiler.
1, 44" x 18' semiportable fire box boiler.
1, 39" x 14' 8" semiportable fire box boiler.
1, 36" x 13' semiportable fire box boiler.
1, 48" x 10' 9" semiportable return tube boiler.
1, 30" x 12' semiportable return tube boiler.
1, 30" x 10' semiportable return tube boiler.
1, No. 2 McCully rotary stone crusher.
1, set crushing rolls, 17" diam. x 10" face.
1, 3 1-8" x 6" Dominion rock drill with tripod.
1, No. 4 Waterloo concrete mixer.
1, portable concrete mixer with gasoline engine.
2, cement block machines with side and corner plates.
1, 10" x 10" x 10" steam driven air compressor.
1, 6" x 6" vertical double cylinder air compressor.
1, 6" x 6" vertical single cylinder air compressor.
1, 16" x 12" double cylinder, single drum hoisting engine without boiler.
1, 8" x 10" single cylinder, single drum hoisting engine without boiler.
1, 7" x 12" double cylinder, double drum steam hoist with boiler.
4, 7" x 10" double cylinder, double drum steam hoists with boilers.
1, 6 1-2" x 8" double cylinder, single drum hoisting engine without boiler.
1, 5 1-4" x 7" double cylinder, double drum steam hoist with oiler.
1, 5" x 7" double cylinder, single drum hoisting engine without boiler.
1, 5" x 7" single cylinder, single drum steam hoist with boiler.

A copy of our supply catalogue or machinery stock list for the asking.

H. W. PETRIE, Ltd.

Toronto Montreal Vancouver

FOR SALE

Two 10, one 20 Stamp Mills complete with crushers, feeders, power, etc.

One pair 35 inch Trump Horizontal Turbines with shafting, pulleys and floor stands. In perfect shape, run only three months.

A. F. FIFIELD

St. Catharines, Ont.

JARDINE UNIVERSAL CLAMP RATCHET DRILL

Indispensable for Machine Repairs, Factories, Machine Shops, Bridge Builders, Track Layers, Structural Metal Workers, have use for it. Send for description.

A. B. JARDINE CO.,

HESPELER, ONT.

Steam Shovels, Locomotives, Cars, etc.

Contractors' and Railway Equipment

Telegraph, Telephone or Write Us.

A. C. TORBERT & CO.

547-548 Monadnock Block, CHICAGO.

FOR SALE

Rails—New and second-hand

Locomotives—Standard and narrow gauge.

Contractor's Equipment.

JOHN J. GARTSHORE

58 Front Street, West, TORONTO

POLSON IRON WORKS, Limited

TORONTO, ONTARIO

have the following:

1 Horizontal Boiler 36 x 12.
1 Horizontal Boiler 38 x 14.
1 Horizontal Boiler 48 x 11' 6".
2 Horizontal Boilers 48 x 12.
2 Horizontal Boilers 54 x 12.
1 Horizontal Boiler 60 x 14.
2 Horizontal Boilers 60 x 16.
6 Fitzgibbon Type Portable Boilers 60 h. p. each, good for 60 lbs. steam pressure.
1 Heine Water Tube Boiler, 70 h. p.
3 Heine Water Tube Boilers 125 h. p.
2 Yarrow Water Tube Boilers, suitable for Tugs or Steamers.

FOR SALE. Great Bargains if you act promptly in D.C

MOTORS

1—500 volt, 15 Kilowatt. 900 R. 1—250 volt, 11 Kilowatt, 1150 R. 2—250 volt, 8 H.P. 1—250 volt, 10 H.P. 600 R. Built Specially for Hoisting Purposes.

All in First Class Order and no Reasonable Cash Offer refused.

WRITE, WIRE, OR CALL.

ELEVATOR SPECIALTY CO.

Cor. Lombard and Church Sts., TORONTO

That the enlarged scope of the Portage la Prairie Industrial Exhibition showed good results is plain from the $1,264 surplus the managers showed at the annual meeting last week.

Lumber.—We quote dressing pine $32 to $35 per thousand; common stock boards as to grade $24 to $28; cull stocks $20; sidings, $17.50. Norway pine is neglected in favor of Southern, which is much stronger in fibre and the price well maintained. Hemlock continues to sell pretty freely. Some blocks have changed hands lately. Spruce flooring is quoted at $25.00 and plenty moving. The season being practically over for shingles, there is but little movement in them, and prices are weak though unchanged at $3.20 for British Columbia. White pine lath are scarcer. No. 1 especially, we quote $4 for No. 1 and $3.50 for No. 2 firm. A good deal of varied stuff is moving, not so much good pine as cheaper goods, such as hemlock and spruce. But all kinds of Canadian lumber are likely to continue firm.

Nails.—Wire, $2.55 base; cut, $2.70; spikes, $3. There is a fair supply and no especial activity.

Pitch.— Very quiet; price, 70c. per 100 lbs.

Pig Iron.—Business continues quiet; prices are decidedly maintained. Clarence quotes at $20.50 for No. 3; Cleveland, $20.50 to $21.00; in Canadian pig. Hamilton quotes $20.00 to $20.50.

Plaster of Paris.—Calcined, wholesale, $2; retail, $2.15. Trade quiet.

Putty.—In bladders, strictly pure, per 100 lbs., $2.25; in barrel lots, $2.05.

Rope.—Sisal, 9½c. per lb.; pure Manila, 12½c., Base

Sewer Pipe.—

	4-in.	6-in.	9-in.	10-in.	12-in.	24-in.
Straight pipe per foot	$0.20	$0.30	$0.60	$0.75	$1.00	$3.25
Single junction, 1 or 2 feet long.	.90	1.35	2.70	3.40	4.50	14.63
Double junctions	1.50	2.50	5.00	....	8.50	.....
Increasers and reducers	....	1.50	2.50	....	4.00	.....
P. traps	2.00	3.50	7.50	....	15.00	.....
H. H. traps	2.50	4.00	8.00	....	15.00	.....

In steady demand; price 70 per cent. off list at factory for car-load lots; 60 per cent. off list retail.

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

Steel Rails.—80-lb., $35 to $38 per ton. The following are prices per gross ton, for 500 tons or over: Montreal, 12-lb. $45, 16-lb. $44, 25 and 30-lb. $43.

Sheet Steel.—Market steady, with fairly good demand; 10-gauge, $2.50; 12-gauge, $2.55; American Bessemer, 14-gauge, $2.35; 17, 18, and 20-gauge, $2.45; 22 and 24-gauge, $2.50; 26-gauge, $2 65; 28-gauge, $2.85.

Tool Steel.—Jowett's special pink label, 10½c. Cyclops, 18c.

Tank Plate.—3-16-inch, $2.50.

Tin.—Fluctuations continue abroad; unchanged locally as to price but quiet meanwhile.

Wheelbarrows.—Navvy, steel wheel, Jewel pattern, knocked down, $21.35 per dozen; set up, $22.35. Pan Canadian, navvy, steel tray, steel wheel, per dozen, $3.30 each; Pan American, steel tray, steel wheel, $4.25 each.

Zinc Spelter.—Business less active at same prices, $5.25 to $5.50. The London market stronger.

* * * *

Montreal, December 29th, 1908.

The markets for pig-iron, steel and cognate lines is very dull, this week. In England,, there was absolutely nothing going on for several days, the markets being closed over the Christmas holidays, which, in England, are more prolonged than in Canada. Owing to this, no cable advices of importance were received on this side at all. The tone of the market, in England, however has been rather improved, of late, owing

partly to the better outlook, not only there but abroad. In Germany, for instance, where the pool was dissolved some time since, there appears to be a fair outlook for its renewal, besides which, notwithstanding all that is said to the contrary, a trade revival is expected in that country by many of the iron and steel men.

In the United States, there is practically nothing new. At the moment, it would not seem that much business is passing or that much can be looked for for a few weeks to come. However, there are reports to the effect that some business is going on in the east, and from all that can be learned, makers are looking for a revival shortly after the beginning of the New Year. Whether these expectations will be realized or not is the most important question which concerns the trade at present.

In the local market, there is nothing going on nor does the trade look for much to happen for some time to come. Prices throughout the market are holding practically steady, no alterations having taken place within the past week.

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

Bar Iron and Steel.—Prices are steady all round, and trade is quiet. 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, $2.10; 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, 14¼c.; 4-inch, 19c.

Building Paper.—Tar paper, 7, 10, or 16 ounce, $1.60 per 100 pounds; felt paper, $2.40 per 100 pounds; tar sheathing, No. 1, 55c. 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 steady at 15 to 15¼c. 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 strength, per 100 fuses:—4-ft. wires, $3.50; 6-ft. wires, $4; 8-ft. wires, $4.50; 10-ft. wires, $5. Double strength fuses, 1$ extra, per 100 fuses. Fuses, time, double-tape, $6 per 1,000 feet.

Galvanized Iron.—The market is steady. Prices, basis, 28-gauge, are:—Queen's Head, $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 steady and unchanged, and the outlook is firm. The following prices are ex-store: Canadian pig, $18 to $19 per ton; No. 1 Summerlee, $21 to $21.50; No. 2 selected Summerlee, $20.50 to $20.75; Carron soft $20.25 to $20.75; No. 3 Clarence, $18.75 to $19 per ton.

Laths.—See Lumber, etc.

Lead.—Trail lead is unchanged and steady, at $3.70 to $3.80 per 100 pounds, ex-store.

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

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 66-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: 1-4-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 59 per cent. off for galvanized; ½-inch, $8.50; ¾-inch, $11.50; 1-inch, $16.50; 1¼-inch, $22.50; 1½-inch, $27; 2-inch, $36; 2½-inch, $57.50; 3-inch, $75.50; 3½-inch, $95; 4-inch, $108

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 9 1-2c. 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.

Shingles.—See lumber, etc.

Spikes.—Railway spikes are in dull demand and prices are steady at $2.40 per 100 pounds, base of 5½ x 9-16. Ship spikes are also dull and steady at $3 per 100 pounds, base of ⅝ x 10-inch and ⅝ x 12-inch.

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

Steel Plates.—The market is steady. Quotations are: $2.15 for 3-16, $2.25 for ⅜, and $2.15 for ¼ and thicker; 12-gauge being $2.30; 14-gauge, $2.05; and 16-gauge, $2.10.

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.)

Telegraph Poles.—See lumber, etc.

* * * *

Winnipeg, December 29th, 1908.

Building operations and things in general among contractors are at their dullest at this season of the year, and will likely not be much improved for a few months. The feeling, however, is that the spring will see a more marked revival of the building trade than has been the case for several years. Supply dealers are laying in large stocks. The prices of material are steady, and not much change is expected to take place. The West has had an excellent holiday season and business has been brisk. Local prices follow:—

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 1,000, three grades.

Cement.—$2.65 to $2.75 per barrel.

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

Dynamite.—$11 to $13 per case.

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

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.

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

Roofing Paper.—60 to 67½c. per roll.

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

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

Tool Steel.—8½ to 15c. per pound.

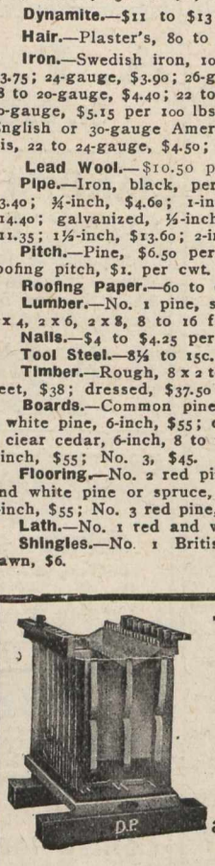
Timber.—Rough, 8 x 2 to 14 x 16 up to 32 feet, $34; 6 x 20, 8 x 20 up to 32 feet, $38; dressed, $37.50 to $48.25.

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

Flooring.—No. 2 red pine, 4-inch, $43; No. 3 red, 4-inch, $38; No. 4 red and white pine or spruce, 4-inch, $28; ceiling, No. 2 white pine, 4, 5, and 6-inch, $55; No. 3 red pine, $38.

Lath.—No. 1 red and white pine mixed, $5.50; No. 2, $4.75.

Shingles.—No. 1 British Columbia cedar, $4.25; No. 2, $3.75; band sawn, $6.



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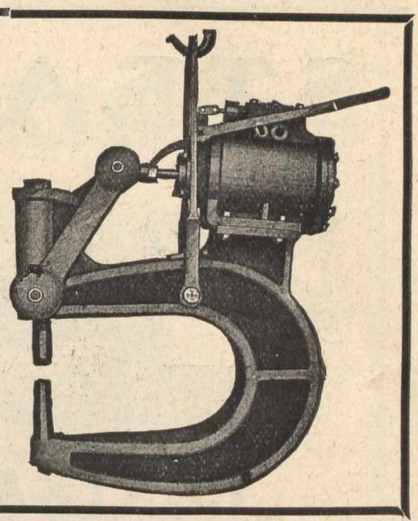

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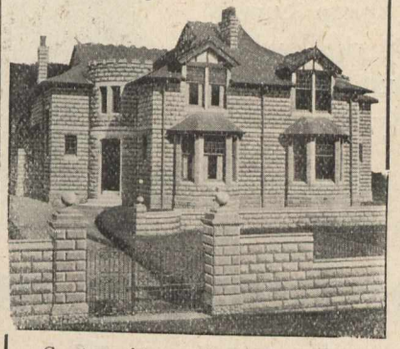

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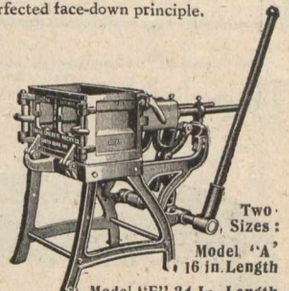

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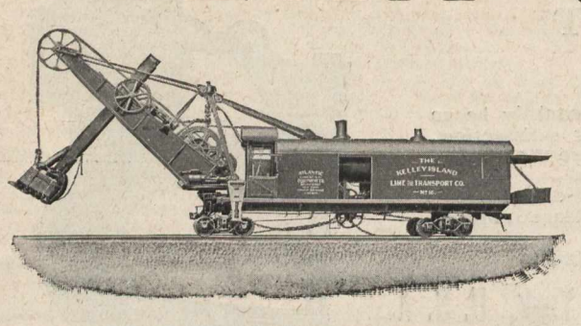

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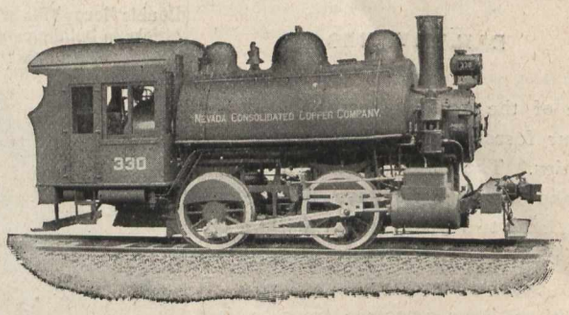

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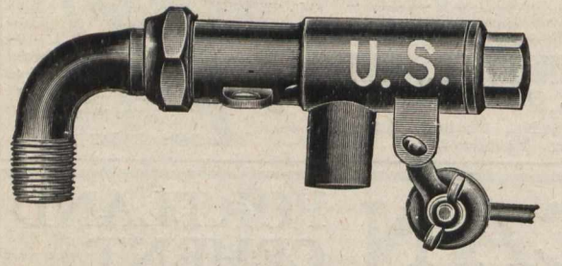

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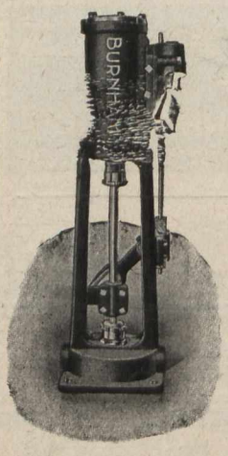

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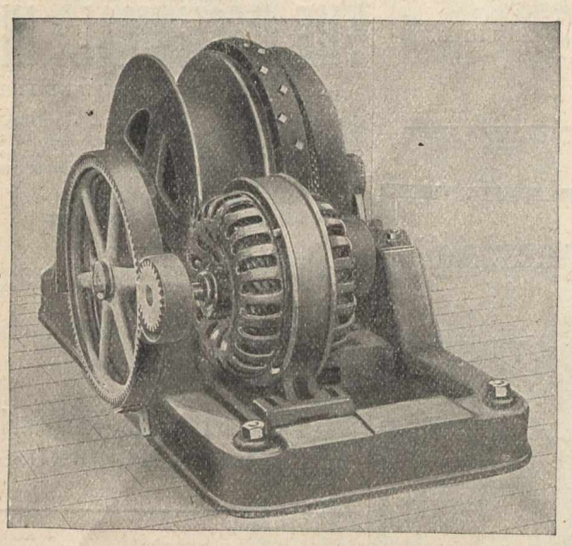

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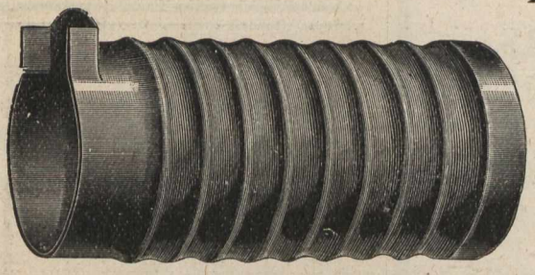

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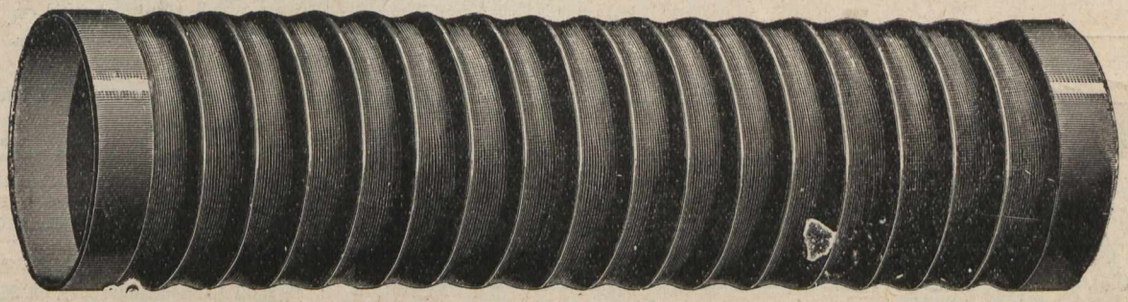

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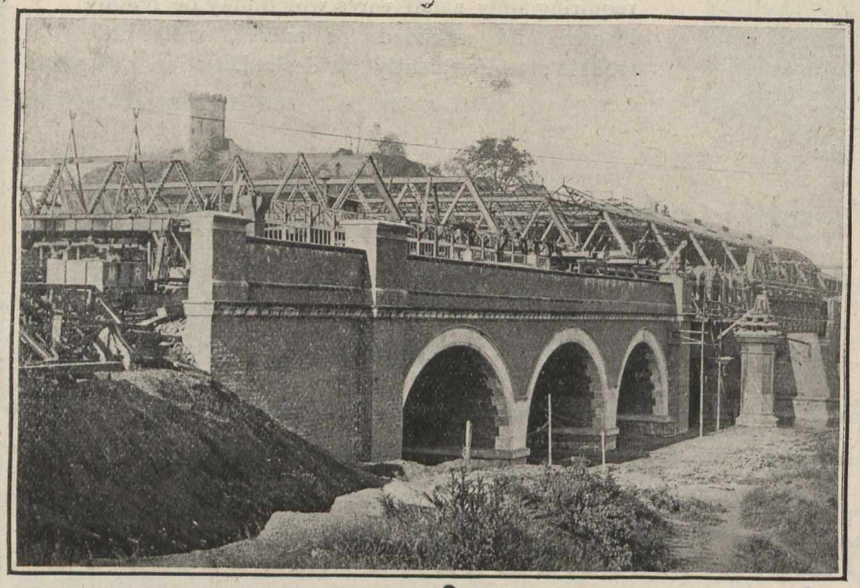

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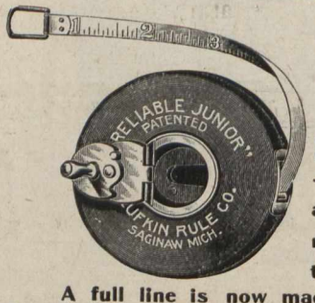

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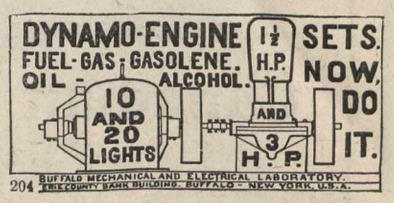

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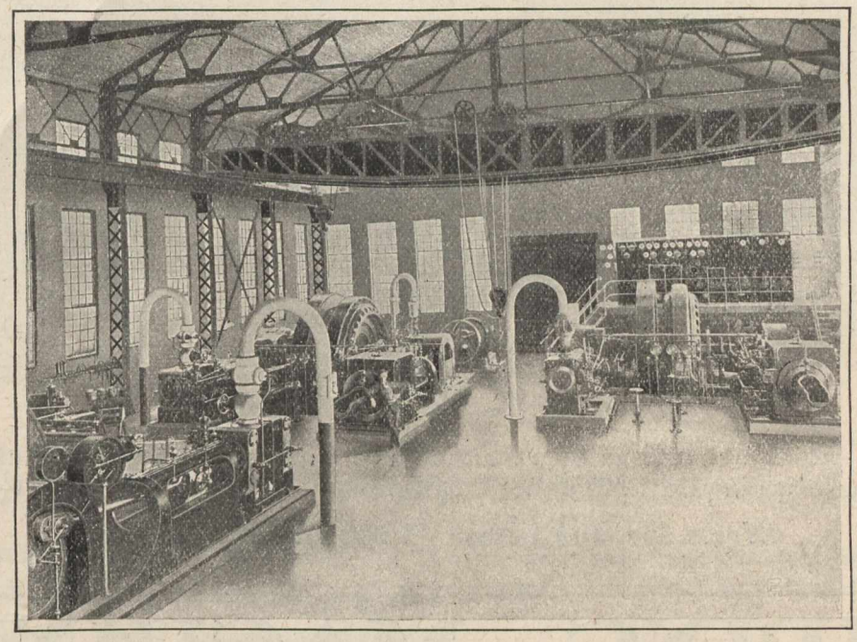

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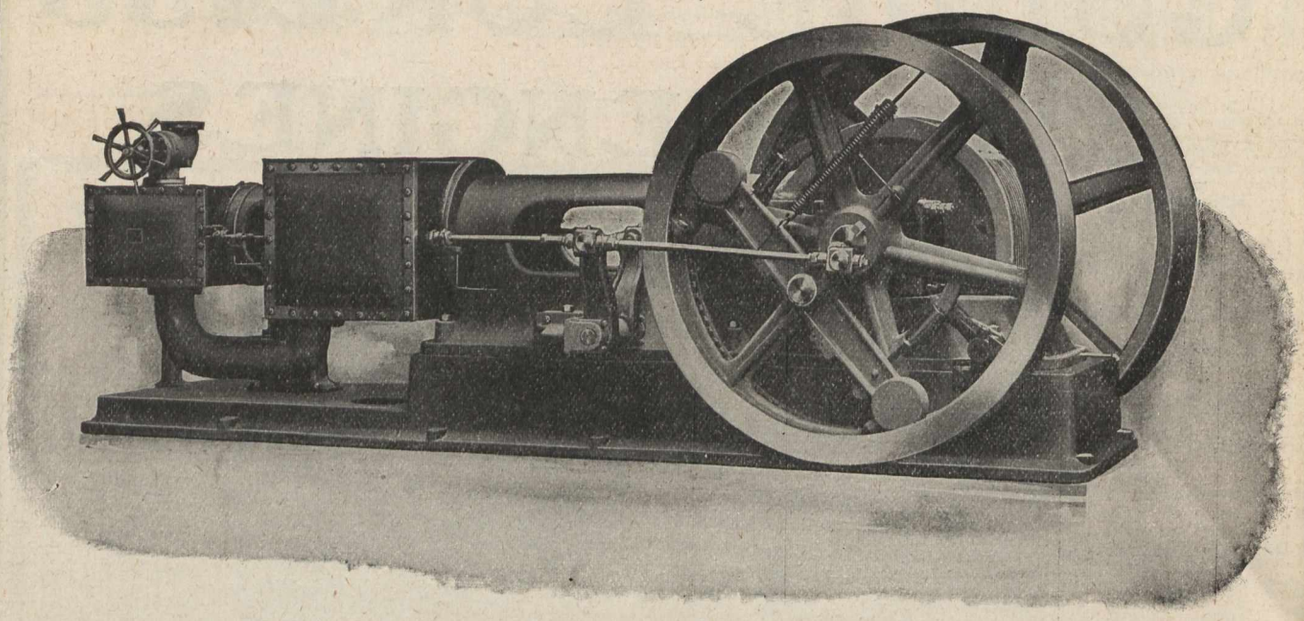

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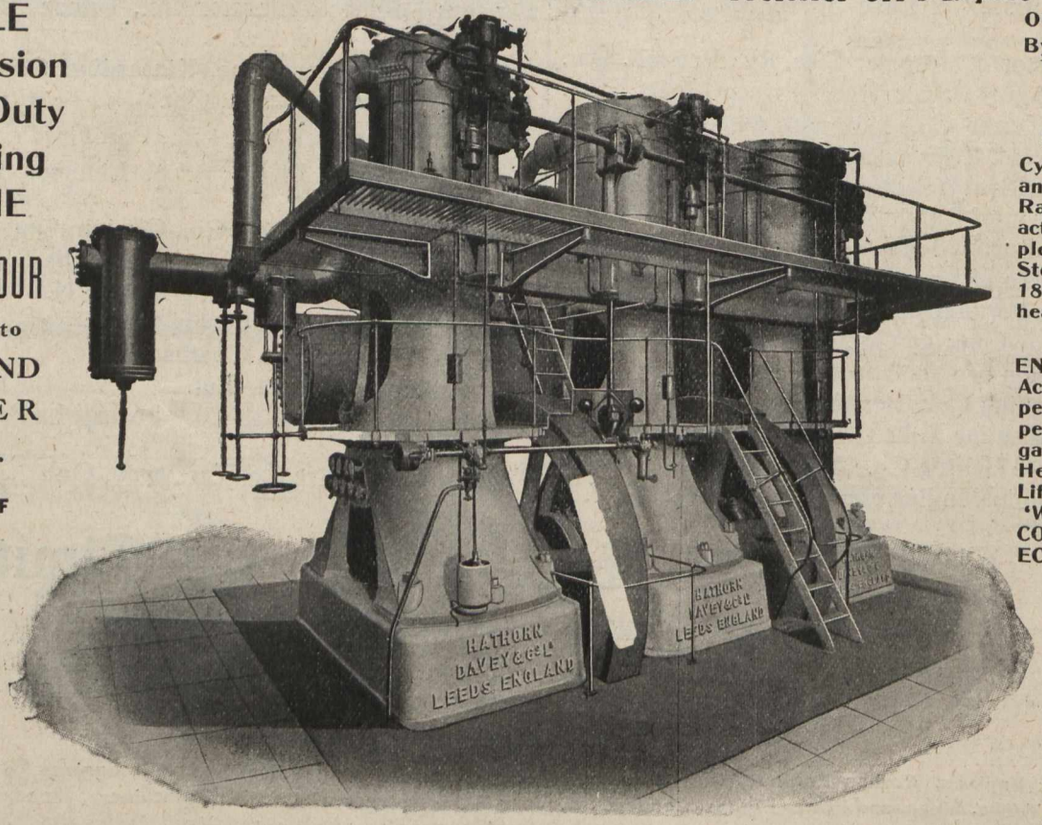

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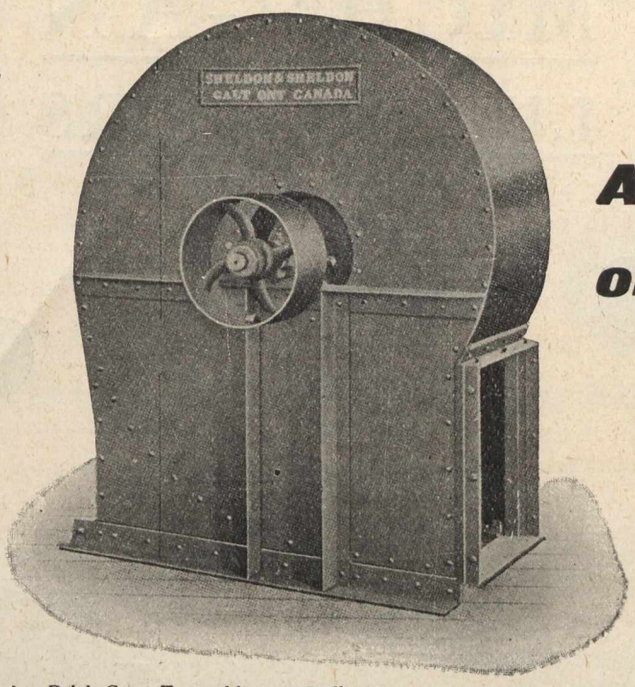

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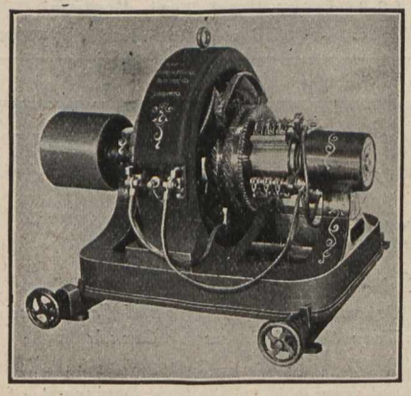

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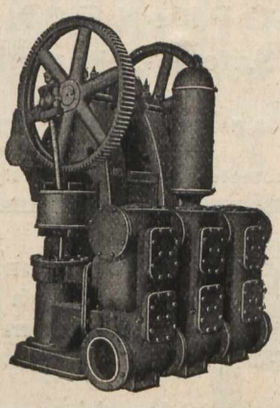

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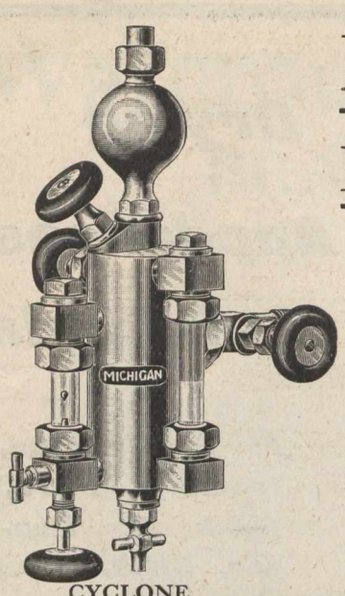

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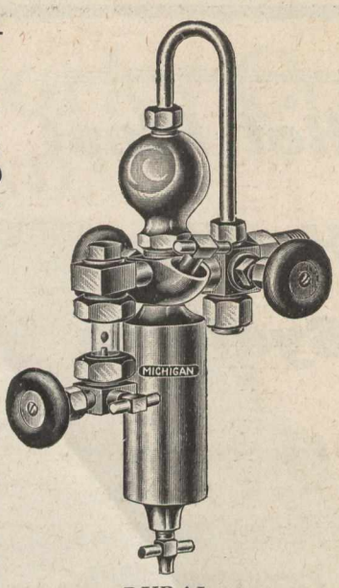

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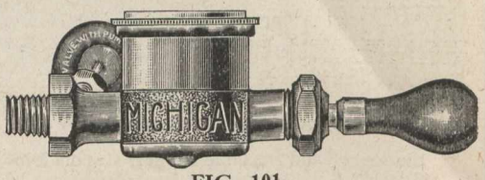
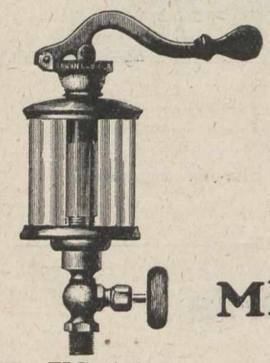


FIG. 101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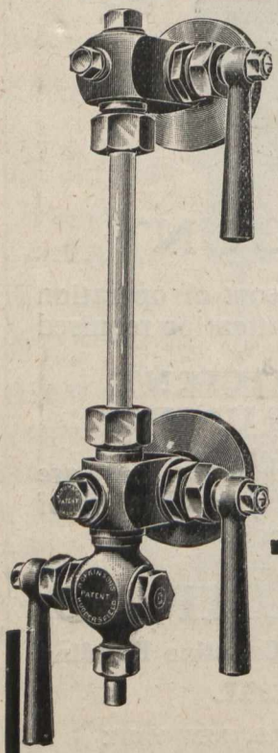

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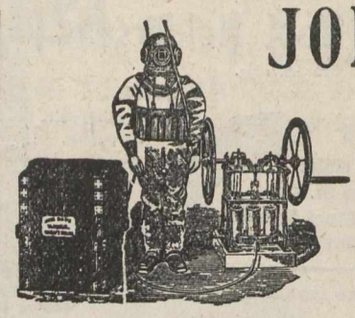

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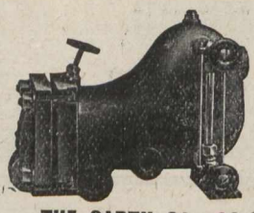

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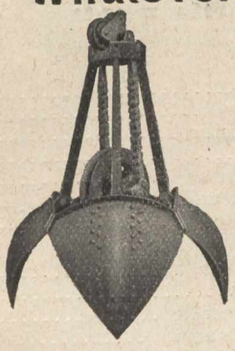

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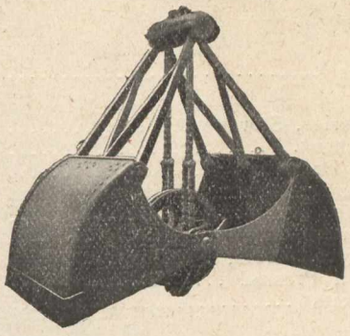

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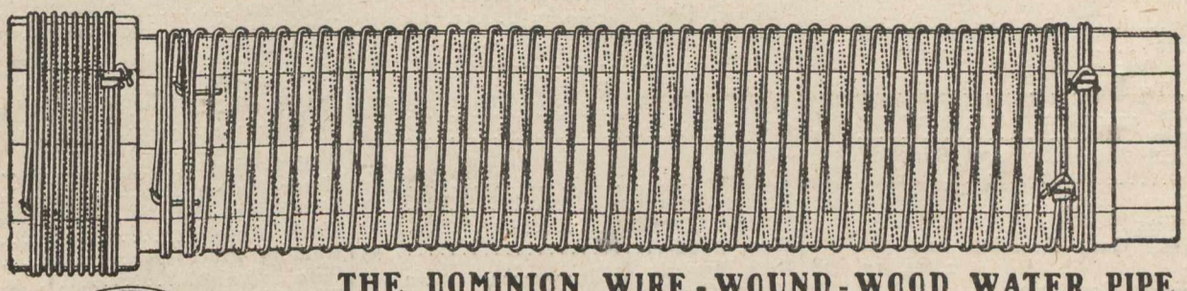

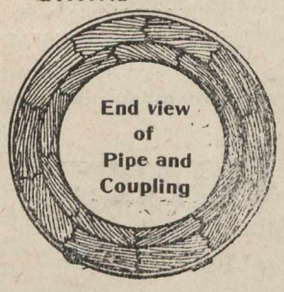

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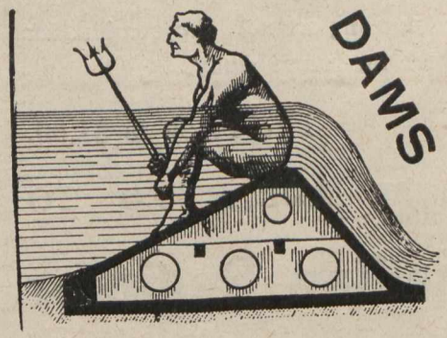

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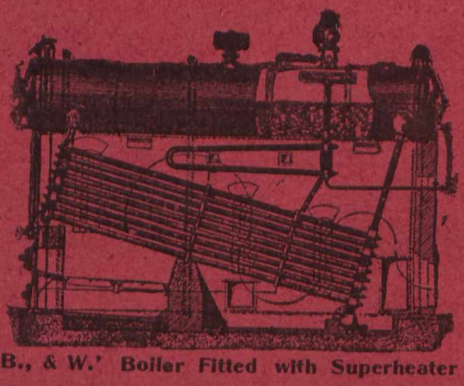

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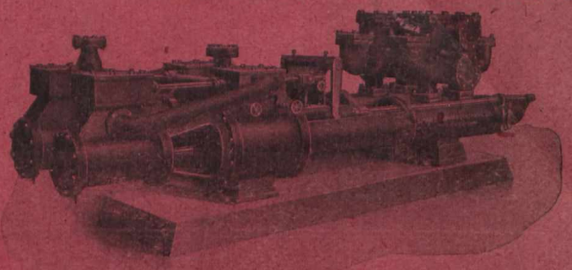

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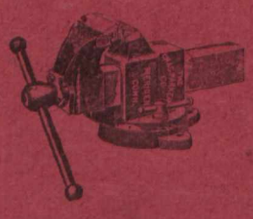

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