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The Canadian Engineer

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The Canadian Engineer.

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CONTENTS OF THIS NUMBER:

THE NEW POSTAL LAW.

The Hon. William Mulock comes within an ace of being a great postal reformer. Although not the originator of the Imperial penny postage, the ready co operation he has given to the plans of the Imperial Government is appreciated throughout all the British Empire, he has brought about many economies in the administration of his department, and last of all, the domestic two cent rate, which has just come into force in Canada, is the consummation that thousands have long devoutly wished. In order to cover up in part the deficiency which this reduction creates, he has framed a law imposing postage upon newspapers. With such a law in itself we have no fault to find. In fact, the publishers of this journal advocated such a law several years ago, before the present Postmaster General came into office, but it is just in this law that the Hon. Mr. Mulock fails to be a great man, and discloses either the weakness or shadiness of his public career. The new law is in fact a deception, in that it allows one class of papers to get the benefit of postal service free as before, while it imposes the whole burden of the tax on another class of papers. Whether, as some suppose, the Postmaster General was moved by a craven fear of the country Press, which forms, in numbers at least, the largest section of the newspapers of the Dominion, or whether he was moved by another motive, we cannot say, but the fact remains that this new law, by creating a zone of forty miles from the office of publication, within which all newspaper matter is free, relieves ninety-nine out of every hundred local papers from the payment of postage, while the newspapers that have a general circulation benefit practically nothing by this exemption.

The Monetary Times shows up the injustice of this arrangement by the following concrete instance. "We know of one case where a journal having a circulation of 4,500 will, by the operation of this Act, benefit to the extent of only 110 copies. On the other hand, a paper having a local circulation of an equal number would pay no postage at all. Mr. Mulock, we are assured, will see the injustice of such an arrangement." We sincerely share in this hope, for a discrimination so unjust was never framed in the history of newspaper laws. As before stated, the whole burden of this tax falls upon one class of newspapers, while another class is permitted to escape altogether. A law founded upon injustice cannot, and should not, stand, and we believe the Postmaster-General has a sufficient sense of right to see that this discrimination is removed.

OILING UP.

BY J. W. WILLIAMS.

In the broad range of the art of mechanics there is no more engaging feature than that of the problem of the reduction of waste power caused by friction, and the extent of these efforts may be measured by comparing the shrieking ox-cart of India and Africa and the ball-bearing axle of the present, with this great extent of improvement in mechanical construction there still remains one feature which seems to have been understood by the wagon driver of a thousand years ago just as simply and as clearly as the engineer of to day, that is, lubrication. This is an item of knowledge as valuable as many of those which are incidental to machines of all kinds, and one which cannot be overlooked, both from a theoretical and practical value, as proper and improper lubrication raises and lowers the coal bill, and is an item of expense necessary to take into account. The main features of the operation of lubricating may be considered, the conditions and the material.

Attention may be given to the elements which constitute a plant. There is a source of power, a machine possessed of limited force usually in excess of the call or requirement, this may be an engine (steam, gas, or oil), water-wheel, motor, etc., and this machine has to exert its strength in moving the working parts of the plant, the machinery, and execute a varying amount of work. In the effort to overcome the resistance of this work is produced the friction referred to, this friction exists from two causes, the actual weight of the material of the machinery and the pull or stress due to the effort of the motive power to do the work, this latter is the main part of all the friction, the amount due to weight of machinery material becoming less in the ratio of motion at ordinary speeds. The possible loss of power may be imagined from the results of experiments which were tried with a cast iron shaft on a dry bell-metal bearing with the result of a loss of one fifth of the power, with a wrought iron shaft a loss of one fourth, these proportions were reduced by lubrication to six per cent. in the first instance and nine per cent.

in the second. These two examples should be sufficient to indicate that "oiling up" is an important part of the care of machinery.

The conditions may next be considered, and the first which presents itself is that of varying pressure and varying speeds and, as important to consider, varying temperature; these are the conditions under which a lubricant is required to work, and to meet these it should possess sufficient body to withstand pressure, and to be fluid and free running for speed. The qualities which we may look for in a lubricant are a freedom from injurious elements, abrading or corrosive, and having stability in that it will not solidify in the cold nor evaporate in the heat, this latter tendency producing two results, either the total loss of the lubricant, or what is called gumming, which is part of the lubricant evaporating and leaving the solid portion in the bearings; this latter is a characteristic of vegetable substances, the total evaporation occurring with mineral oils of light grade. The corrosive nature referred to occurs with animal products, these having a greater tendency to rancidity and also requiring more chemical treatment to bring into condition and thereby being in greater danger of being tainted with corrosive impurities.

We need not consider the long list of substances which have been used as lubricants, solid, liquid, dry, wet, thick, thin, clean and dirty, for all these have been features of the various lubricants which have had their place in the markets, but we may be satisfied that in the animal oils and greases, with their great range of body, their freedom from impairment by atmospheric action and other physical changes, that we may obtain a lubricant fitted especially for our requirements, but it lies with the users to examine them in practice for the features enumerated, and, what will be found the main cause of dissatisfaction, misuse of them must be corrected. It is within bounds to say that the use and not the stuff is what is wrong, and in this direction should improvement be sought, with a better attention to bearings to keep them *steadily* supplied; three cents a gallon cut obtained on an oil is nothing to boast of if thirty cents worth of coal be used instead of the oil.

THE ELECTRIC LIGHTING OF TRAINS.

ROBERT A. ROSS, E.E.

Electric train-lighting is occupying the attention of the larger railway companies on this continent at present to a large extent, and in a number of cases has been adopted for the better class of train service. In Europe the development has been much more rapid and on many lines it has or is in process of displacing the oil and gas formerly in universal use. The reason for the change is not far to seek. The public demands the utmost luxury when traveling, and having been educated to the advantages of electric lighting at home is quick to appreciate the same advantages on the railways where at the present time it is counted a luxury, but will soon become a necessity. The public recognizes the fact that as the electric lamp is free from flame there is no risk of fire and no vitiated atmosphere to breathe and it has an illuminant and not a mere gloom disperser as with oil and gas. Its ready adaptability to being placed where wanted makes possible the use of reading lights in the seats and in other positions where any other form of illuminant would be impossible.

The railway companies are not slow to appreciate these advantages, but naturally wish to be assured that electrical illumination will not be more costly and less reliable than other methods. As regards the cost, from recent experiences of different companies it appears that it is at least as cheap as gas and more expensive than oil. That this inferiority in point of cost as compared with oil will not hinder its introduction is evident, for oil has superseded candles although more costly, and even if electric lighting were more expensive than gas its acknowledged superiority would render its use advisable. As regards reliability, which is certainly equally important with cost, the apparatus used in all systems of electric lighting is practically identical with that used for the illumination of buildings and should be as reliable in operation.

Storage batteries at the present time are thoroughly commercial, as are the dynamos and generating apparatus. In the case of axle driving some complication in the regulating apparatus may exist and it is particularly at this point that a careful selection of apparatus is essential. The several systems in practical operation may be divided into two general classes, the first where each car on the system is independent and capable of taking care of itself, and the second where each car is dependent upon some method of charging located either upon the train or at certain points along the line. The first class necessitates the use of an axle-driven dynamo under each car with sufficient storage battery capacity to carry the lights over the periods when the train is not in motion or running too slowly to

JOHN GALT, C. E., CITY ENGINEER, OTTAWA.
A Biographical Sketch appeared in the December Issue.

enable the dynamo to light the car. Generally speaking the operations of this equipment is as follows: When the train is at rest or running under fifteen to twenty miles per hour the battery operates the lights, when the speed mentioned is reached the dynamo having attained the proper voltage is automatically connected to the lights and battery through the operation of a governor or electro magnetic mechanism, and the battery is charged and the lights operated from the dynamo. To regulate the voltage which would increase in proportion to the increase of speed of the train if not controlled, two general methods are adopted, either by keeping the speed of the dynamo constant or by regulating its field strength. The first is attained where the machine is belt-driven by allowing the belt to slip, the amount of slip being governed by some form of belt-tightening arrangement. This, while apparently unmechanical at first sight, works well in practice, and has the merit of extreme simplicity. Where the dynamo is rigidly geared to the axle the system of the regulation of the field strength to vary in inverse proportion to the speed is adopted, which may be done either by an automatically controlled resistance in the shunt field, by changing the resistance of the magnetic circuit of the field magnet, or by a system of differential field winding. By the above system each car is a separate and self-contained unit and may be attached to any train on any line. Under the second class, where each car is not a separate unit but is dependent upon outside assistance, there are two general systems, the first where the car equipment consists of storage batteries alone, which are charged at suitable stations along the line, and second, where either an engine and dynamo unit driven by steam from the locomotive boiler or a separate boiler in the baggage car, or an axle-driven unit for the entire train is located in the baggage car. Where the simple storage system is used each car is dependent upon obtaining charged batteries at regular intervals and its travel is limited by this consideration. Where the baggage car equipment is used the train is the unit, and except for short intervals determined by the capacity of the battery installed on each car the unit must be maintained intact and the entire train must be wired, at least for the main conductors for through connection to the last coach. In the case of through trains, where the amount of disconnection is small during long runs, the batteries might be dispensed with and dependence placed upon the generating unit in the baggage car, or a single set of cells used in the baggage car or last car of the train to carry the lighting over the periods of disconnecting of the engine or baggage car.

As regards the initial cost of these several systems the writer, after a careful investigation of what has actually been done and what can be done at prevailing prices, has come to the conclusion that the order of cost is about as follows, beginning with the cheapest :

1. Engine and dynamo unit in baggage car without batteries.

2. Engine and dynamo unit in baggage car with batteries under each car.

3. Single axle unit in baggage car with cells under each car.

4. Battery equipments under each car with charging stations at intervals.

5. Separate axle units and batteries under each car.

The last two are not far apart in initial cost per car It may be pointed out, however, that allowance has been made for charging stations on the understanding that they are not used for other work, but in many cases the companies have lighting plants already established which are available for charging, which would diminish the cost of the charging station plan considerably. As regards reliability any of these systems to be commercially successful must be capable of being placed in the hands of the train crew, the supervision of experts being only available at large terminal points, and the expert supervision necessary should not be great even when available, and this will be secured by the use of the system which requires the least apparatus on the cars. This condition is best met by the charging station system where the batteries are inspected after each run and the charging apparatus is under competent supervision. The chances of failure are greatest on the systems employing the axle units for charging, but even in this case from the reports of several companies the failures are few. Regarding the comparative cost of operation of the various systems it is impossible to speak generally, as each is dependent upon the local conditions on the particular railway system under consideration. It may, however, be pointed out that the interest and depreciation accounts, if properly allowed for, will be the largest item in the cost, and the investment in the original instalation will to a large extent govern the annual cost per car for its operation. This acts against the charging station scheme because of the large number of batteries used, and on them the depreciation is larger than on the rest of the apparatus.

The voltage employed where batteries are used should be kept as low as possible with due regard to the wiring losses, to take advantage of high efficiency lamps and to reduce the weight and cost of the batteries as much as possible. In practice the voltages range from 24 to 60 and in many cases 2.5 watt lamps are adopted; the decreased life of these being compensated for by the smaller size of battery and charging apparatus. Where axle units are used the problem to be met approximates in a small way to that of street railway motors which are operating under the floor of a moving car and subject to the shock and disturbance of the motion, but the amount of attention which they will receive while operating is less than in the case of the motor.

To sum up the relative advantages of the several systems in a general way we may say that the system employing a steam unit in the baggage car without batteries is the cheapest and is very simple in operation, but when the locomotive is uncoupled the lights are extinguished, for which reason batteries under each car are a necessity unless the train is never broken. The batteries need, however, be but small. A single axle unit in the baggage car is in a good position for operation without chance of failure, but requires somewhat larger batteries on each car than the steam unit system to carry the lights while the train is stopped or running slowly. Each of the above systems requires that the train be wired throughout from car to car. The advantage of the separate axle unit under each car is that each is independent and no through wiring is necessary, but the initial cost is higher, and the necessary supervision greater than those previously mentioned. The charging station plan is simpler in operation, but its initial cost is high, and its operating costs probably higher than any of the others for the same conditions. It may be pointed out that where any road is contemplating the use of electric light the natural course is to proceed cautiously and invest as little as possible until success has been demonstrated, and for this reason the separate axle unit has an advantage, as only those cars upon which the system is to be tried need be fitted up, while with the other systems expense has to be incurred for wiring all cars or establishing charging stations.

These are merely general views and should not be applied indiscriminately to all cases, as the local conditions of each road will modify the above conclusions profoundly, each case requiring a careful study of existing conditions to ensure that the best system is adopted to meet the requirements Under the varied conditions of traffic each of the above systems has its place and with the possible conditions met by such varied systems it is not too much to hope that the train of the immediate future will be the electrically lighted.

THE EVILS OF INTERCEPTION TRAPS, ETC.

BY W. M. WATSON.

In the July issue of THE CANADIAN ENGINEER I gave an epitome of the sanitary experiments carried out by the authorities of the city of Cologne, Germany, that proved that it was both dangerous to the public health and in direct opposition to sound sanitary science, to place interception traps on private drains and useless vent pipes on the interior house plumbing arrangements.

Another paper on "Sanitary Excesses" in your September issue showed that the engineers and surveyors of Old London who had pressed the American drainage obstruction system on their employers, the public authorities, plainly saw that a serious mistake had been made, and, that after the aerating advantages of the old draining system were discontinued, that all the public sewers and private drains were simply turned into putrefaction chambers or receptacles for breeding diseases, and that the foul gases generated in the sewers invaded the houses and streets, and that they, the engineers and surveyors, were meeting together to find out a plan to crawl out of the difficulty without tarnishing their former reputation.

The model by-laws, as they call them in Great Britain, or town laws compelling property owners to place the interception trap on their drains and to have useless vent or back air pipes attached to all the house traps, has only been enforced for a very short time, and in a few towns of Great Britain, but the injurious effect of such dangerous innovations was soon felt, because the people are more crowded together there than out here, and the highest sanitarians and engineers have begun to speak out boldly against such cruel and expensive model by-laws, and considerable valuable information has been published in the engineering and sanitary journals of Great Britain proving the injurious effects on the public health.

The lectures and debates of the 17th annual Congress of the members of the Society of Sanitary Science, held lately at Birmingham, England, dwelt largely on the evils of the interception trap and the excesses that have crept into plumbing and draining work. W. Henman, Esq., F.R I., B.A. Sc., etc., chairman of the Sanitary Section of the Congress, in his opening speech stated that the day would come when all interceptors and traps would be abolished, and with them the sewer gases which the interceptors had retained about our dwellings. He proved, during the delivery of his address, that public engineers and surveyors had deeply sinned against the public in the construction of public sewers, because, instead of aiding a rapid removal of sewage and refuse by water carriage, nearly all the sewers they constructed acted as filters or separators, invariably leaving the solids in the sewer pipes to fester and become offensive and dangerous to the public health.

Dr. Bostock Hill at the same meeting showed the falsity of using drain pipes too large for the flow and placing interception traps on the private drains He stated that the smallest waste or drain pipes which will convey the necessary quantity of liquid intended to pass through are certainly the best for reasons of cleanliness and flushing. From a single house a 4 inch drain is ample, yet Mr. Bostock says he has known public surveyors insist on having a 6-inch pipe and interception trap installed instead of a 4 inch, stating that they compelled the larger pipe because there was less likelihood of the drain becoming choked, which cannot be true, and there are many other disadvantages that tell against using too large a drain pipe, viz., from small houses solids and sewage are chiefly sent down in gushes, the pipe itself, if it is 6 inches, can never be nearly full, and the crown and upper half of the sides only get splashed, so that dirt and filth accumulate and set up putrefaction and generate dangerous gases. Continuing his address on the interception trap he states that when the trap is put in the main line of the private drain a ventilation pipe has to be installed somewhere near the surface of the ground, near the house, to ventilate the private drain and house waste pipes, and in that case the following evils must of necessity occur, viz., each syphon or dip on the trap holds a quantity of foul water, and where water closets are used fœcal matter lodges in them, which generates poisonous gases that take the easiest way out to the open air, which is through this breather or private ventilation pipe. This same breather delivers the accumulated contents of putrid gases each time the house sewage is rushed down the waste pipes and private drain. By these two methods alone a large amount of putrid and poisonous gases are discharged into atmosphere near the windows and doors of private dwellings, causing constant smells, and if some of the dwellings have fever in the place, and the stool of the patient is sent down the sewer, then the foul gases discharged from the breather pipe or air inlet at this time is dangerous and will spread the epidemic. It is certainly undesirable to store sewage even in such small quantities as the amount that lodges in the dip of a trap near inhabitable premises, and I am strongly of opinion that the system of placing interception traps and other impediments in waste and sewer pipes induces a state of things that, from a sanitary point of view, is very much worse than the system which the modern model by-laws have superseded. These are the opinions of a public health officer in England, and many of his associates are fully in accord with him, but I will not weary the readers with repeating their speeches, but proceed to give the results of the tests made by Dr. Porter, M.D., showing the resistance of traps to the freedom of the flow of water and solids when flushing water closets, because it is further extending the experiments begun at Cologne and proving another reason why their adoption is injurious to the public health. Dr. Porter shows by his experiments, what amount of water it takes to flush a water closet properly and prevent the private drain from becoming little better than an elongated cesspool, and states that to gain a thorough knowledge of the requirements of house drains he made 120 test experiments by flushing on the lines laid down for such purposes by the Sanitary Institute in 1893. The class of water closet he used was Duckett's washdown closet having an S trap and a Unitas washout closet, flushed by a water waste preventing cistern graduated for a flush of 6, 4, 3½, 3, 2½ and 1½ gallons of water at one flushing, and connected to the basin by 5 feet of 1¼-inch lead pipe. The water closet in each case discharging through 47 feet of glazed earthenware 6-inch pipe and again through the same length of 4-inch tile piping to an interception trap, the usual quantity of fœcal matter and paper used being supplied from a factory privy. The weight of the quantities at one flushing being 4 ounces, 6 ounces, and in a few trials 8 and 12 ounces used at each flushing. The first series of trials (fifty in number) were made with a 4-inch drain (fall 1 in 40) and 4-inch disconnecting trap. This trap was filled by 4 pints of water and at the lowest part measured 3½ inches transversely and 4 inches vertically. Flushes of 3, 2½, 2 and 1½ gallons were employed, the result being that 3 gallons invariably sufficed to thoroughly flush closet, drain and 4-inch trap; a 2½ gallon flush generally failed to clear the 4-inch trap; with 2 gallons the interceptor was not once cleared, and most of the solids were left in the trap. By repeated 2-gallon flushes in rapid succession, causing a head of water in the drain, the trap was eventually cleared with a rush, but this did not happen if one flush were allowed to trickle away before the next followed it. A 1½ gallon flush was found to be of little use. The drain was never cleared and became rapidly blocked.

The second series included twenty-one experiments, and was made with a 6-inch drain (fall 1 in 60) and 6-inch disconnecting trap, which, it is noteworthy, required 12 pints of water to fill it, and at its lowest part measured 5⅜ inches transversely and 5⅜ inches vertically. Flushes of 6, 4, 3½, 3 and 2½ gallons were used, and it is a remarkable fact that, though 3 gallons and upwards sufficed to clear the closet and drain each time, the 6-inch trap was cleared by a 6-gallon flush in only two out of four cases ; 4 gallons cleared it in only one out of six cases, and anything less than 4 gallons altogether repeatedly failed to clear the trap.

The *third* series numbered twenty-two experiments with a 6-inch drain and a 4-inch intercepting trap. With a 3-gallon flush the closet, drain and trap were efficiently cleansed every time, but a flush of less than 3 gallons failed each time to clear the drain and to reach the trap.

The fourth series (eighteen trials) with a "Unitas" washout closet, 4-inch drain and 4-inch interceptor, flushes of 3, 2½ and 2 gallons being used ; 3 gallons sufficed to clear the trap in two out of six cases. With smaller flushes the trap retained a portion of the charge in every case ; in five cases the drain was not cleared, whilst in eight the closet trap was not cleared, due evidently to the inherent faults of the washout closet. I shall be pleased to supply fuller details of these results to anyone interested in the matter, and I venture to submit the following

CONCLUSIONS.

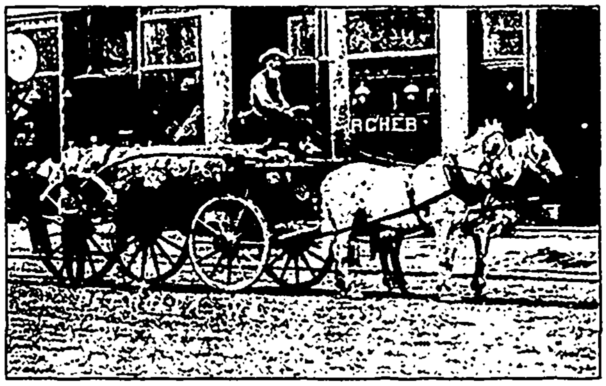
(1) That 3 gallons is the minimum amount that can be relied upon for efficient flushing—*i.e.*, prompt carriage of dejecta through closet, drain and interceptor to sewer even with a good form of washdown closet well laid, 4 inch or 6 inch drain, and good 4-inch interceptor. (2) That if an inferior type closet be used, or if the intercepting trap exceed 4 inches in diameter, 3 gallons is clearly not sufficient for effecting flushing. The proper remedy then, however, is to correct such structural deficiencies rather than to increase the flush. (3) That if no intercepting trap be employed a flush of 2½ gallons is the minimum amount that can be relied upon to efficiently cleanse the closet trap and drain. (4) That the invariable employment of a disconnecting trap, as recommended by the model by-laws, is far from being an unmixed benefit, and, owing to the obstacle the disconnecting trap presents to the cleansing of house drains, its use should be strictly limited to those dwellings inside which a drain opening exists—*e.g.*, in the cellar—and that if such drain openings inside houses were prohibited in new dwellings, disconnecting traps might, with great advantage, be entirely dispensed with. There i much reason to believe that we have hitherto exaggerated the potency of sewer air ; assuming, however, that it is noxious in its effects, the object of a disconnecting trap is wholly gone if we keep all drain openings outside our dwellings ; and having done this, it is absurd to continue to insist on disconnecting traps, which only diminish the efficiency of the flush of water.

This is the opinion of Dr. Porter, an eminent authority on sanitary matters. If our readers turn up the back number of April, 1897, they will find an article on sanitary appliances, showing how cellars and basements can be properly drained without the drain entering the premises. this is the way Dr. Porter suggests they should be.

PETROLEA WATERWORKS.

The Board of Water Commissioners, Petrolea, Ont., has presented a statement of receipts and expenditures for the year ending November 30th, 1898, that is most encouraging, and considering the prospects for the future the chances are that next year the works will be self-sustaining. These works were constructed in 1896 and 1897, and have been in continuous operation since January, 1897, although not fully completed until a few months later ; they were fully described in THE CANADIAN ENGINEER for November, 1897. Few people, even in Petrolea, believed that a town of less than 6,000 population could afford to spend $172,000 on a waterworks system, and many prophesied that the works would not only be a failure financially, but that they would not be a success mechanically. The town engaged as engineer Willis Chipman, of Toronto, to design the system and to superintend construction. The cost was kept well within the estimates and within the amount raised by the sale of the debentures. Not only has the cost of all the service pipes, but the cost of all the extensions of mains laid in 1897 and 1898 has been paid out of the amount raised by the sale of original debentures.

The town of Petrolea in 1893 entered into an agreement with a private company to put in works on the franchise plan, but the company not succeeding in finding an available source of supply near the town failed to complete the works after laying two miles of pipes. By this



PETROLIA WATER WORKS, 1890.

agreement the town was to pay $4,900 per year for 70 fire hydrants. Upon the recommendation of their engineer in 1895 the town decided to construct its own works and go to Lake Huron for its water supply, a distance of twelve miles in a straight line from the town hall, pumping the water over a rise of 150 feet above the lake to a water tower in the town, its base being 87 feet above the lake level. The size of the main to be laid from the lake to the town, the protection of the intake on the fully exposed lake shore, the class of machinery required and the probable necessity of filtration, were all important problems with the town council, and other engineers were called in to report upon the plans, but their recommendations were not followed and the works were constructed as originally designed. The intake has now stood two winters without injury, the water supplied has given the best of satisfaction to the citizens, the cost of pumping, owing to the high class of machinery adopted, has been no greater than in many other places where the pumping station is not distant more than a mile from the town, and there have been no breakdowns since the works were started.

The commissioners report the receipts from consumers as $8,800 and they allow for fire hydrants only $4,000; making a total revenue of $12,800 for the year ending November 1st, 1898. The operating expenses for the year have been $3,560, leaving a balance of $9,240. The interest and sinking fund charges amount to $9,947 per year, and the net revenue is now $9,240. If the amount the town agreed to pay the private company for fire protection were substituted for the $4,000 the works would now be self-sustaining, and it is evident that in a year or more they will be so even with the present allowance for fire protection.

With the present low rate of interest for municipal debentures every town can afford to construct a system of waterworks, but it will be found to pay to put in a general sewerage system at the same time.

ONTARIO WATER WORKS SYSTEMS.

We are indebted to Willis Chipman, C.E., Toronto, for data upon which the following valuable tabular history of water works systems of urban municipalities in Ontario for the past fifteen years has been compiled. Cities of 20,000 and over, in which large sums had been spent in a long series of years previously, have been omitted. A separate list is given of water works constructed by private corporations and afterwards acquired by the municipalities; and of water works built by private companies and still operated by such companies. The list will be a valuable one for reference purposes.

WATER WORKS BUILT BY MUNICIPALITIES.

	Pop.	Date	Cost	Engineer.
Alexandria........	1,700	1895	$23,000	Potter, Alex.
Amherstburg......	2,300	1891	25,000	Galt, John
Aylmer	2,200	1891	17,000	Milne, Alex.
Alliston	1,400	1892	.. ..	....
Beamsville	900	1895	14,000	....
Beeton	800	1892	20,000	Galt John
Bracebridge	1,400	1894	20,000	Brough, W. C.
Brampton	2,500	1882	65 000	....
Brantford	17,000	1885	230 000	Cole, J A., & Jones, T. H.
(Small works, built by a private company for fire protection, were purchased by the city in 1885).				
Cambellford	2,500	1890	19,000	Galt, John
Collingwood	5,000	1890	79,000	Galt, John
Deseronto	3,500	1896	35 000	Butler, M. J.
Dunnville	1 800	1891	5,000	Galt, John
Essex	1,700	1891	31,000	Galt, John
Fort William	3,000	1898	36,000	Galt, John
Galt..............	7,000	1891	157,000	Chipman, Willis
Gananoque	3,000	1892	20,000	Chipman, Willis
Goderich	4 000	1888	68 000	Chipman, Willis
Georgetown	1,500	1891	40,000	Warren, Jas
Huntsville	1,200	1897	20 000	Roberts, V. M.
Kingsville	1,400	1894	......	Newman, Wm.
Leamington	1,900	1891	16,000	Bell, J A.
Markham	1,100	1891	10,000	....
Meaford	2,000	1892	22,000	Sing, J. G.
Merritton	2,000	1888	78,000	Monro, Thos.
Milton	1,500	1888	20 000	Bell, J A.
Morrisburg	2,000	1887	26,000	Kennedy, Wm.
Mt. Forest........	....	1898	25,000	Galt, John
Newmarket	2,200	1886	20,000	....
Niagara Falls	4,000	1890	77,000	Kennedy, Wm.
(The original works built and owned by a company, were purchased by the town in the year given, and the works rebuilt and extended)				
Niagara-on-the-Lake	12,500	...	35 000	Galt, John
North Bay........	2,000	1892	38,000	Galt & Rourke
North Toronto	3 000	1892	40,000	Venables, J.
Orangeville	4 000	1895	50 000	Chipman, Willis
(Small works built originally for fire protection on the main streets. Rebuilt and enlarged in year given).				
Orillia	5 000	1892	.. ..	....
Owen Sound	7,000	1890	125,000	Kennedy, Wm.
(The original works, built and owned by a company, were purchased by the town in the year given, and the works rebuilt and extended)				
Paris	3 500	1884	40 000	Bell, J. A
Parry Sound	2,000	1892	35,000	Galt, John
Penetanguishene ..	2 200	1891	30,000	Galt, John
Pembroke	4,500	1893	56,000	Chipman, Willis
Petrolea	6,000	1896-7	170,000	Chipman, Willis
Picton	3,300	1889	33,000	Bolger, T
Port Colborne	1,500	1898	16,000	Witmer, J. F.
Port Hope........	6,000	1895	50,000	Stuart, J
(Small works built originally for fire protection on main streets. Rebuilt and enlarged in year given).				
Renfrew	3,000	1897	52,000	Chipman, Willis
Sandwich	1,500	1891	19 000	....
Shelburne	1,200	1890	13,000	....
Stouffville	1,400	1897	22,000	Galt, John
St. Thomas	11,000	1891	150,000	Bell, J. A.
(The original works, built and owned by a company, were purchased by the town in the year given and the works rebuilt and extended)				
Sudbury	1,400	1896	......	Gordon & Rourke
Tilbury Centre ...	800	1888	16,000	....
Toronto Junction..	5,000	1889	180,000	Venables, J.
Welland	2,500	1888	32,000	Kennedy, Wm.
Wiarton	2,000	1889	30,000	Ronald, J. D.
Woodstock........	9,000	1892	150,000	Keefer, T. C., & Davis, W. M
(The original works, constructed for fire protection, were rebuilt by the town in 1892).				

WATER WORKS BUILT BY PRIVATE COMPANIES AND ACQUIRED BY THE MUNICIPALITIES.

	Pop.	Date.	
Barrie	6,000	1891	*Town purchased in 1898 for $78,000.* Willis Chipman, engineer for town.
Berlin	8,000	1888	Town purchased in 1898 for $102 000 Willis Chipman and H. J. Bowman, engineers for town
Brantford	17 000	1870	Purchased by the city for $63,000
Brockville	9,000	1884	Town purchased in 1882 for $129,000. Willis Chipman, engineer for town.
Chatham	9,000	1891	Town purchased in 1895.
Cornwall	7,000	1886	Town purchased in 1887 for $86,000. Willis Chipman, engineer for town.
Kincardine	2,600	1890	Purchased by town in 1894 for $45,000.
Niagara Falls..	4,000	1884	Purchased by the town for $17,000.
Owen Sound ..	7,000	1880	Purchased by town for $35,000.

WATER WORKS BUILT BY COMPANIES BUT NOT YET ACQUIRED.

	Pop.	Date.	
Belleville	10,000	1888	City now negotiating to purchase.
Cobourg	5,000	1888	....
Iroquois	1,500	1886	....
Ingersoll	4,000	1891	....
Lindsay	6,500	1892	....
Napanee	4,000	1888	....
Perth	3,500	1897	....
Waterloo	3,000	1889	....

CARBOLITE.

Of "Carbolite," the recent invention of Hartenstein, of which accounts have been published in the technical papers, The Engineering and Mining Journal says: "The material which he produces and calls carbolite is a biproduct in iron smelting, and is claimed to be a cheap substitute for calcium carbide, being of the same nature as the latter; it is claimed that the profit in producing it from blast-furnace slag promises to be so great that the pig iron may then be regarded as a biproduct. It is a calcium-aluminum-silicon-carbide. The slag is taken directly from the furnace blast in converters like those used in steel-making, impregnated with pulverized coke by means of a gas-blast, and the mixture brought into contact with carbon bars through which a current of electricity is passed, which generates the intense heat required to produce the carbide. It is shown that these claims are misleading. Such slags contain at most only 50 per cent. of lime, and the carbide thus produced would be very poor substitute for the calcium carbide: the silicon in the slag would form carborundum, which gives off no gas on the addition of water; the aluminum would form aluminum carbide, which, with water, evolves the methane, which is only faintly luminous, it being like natural gas; the iron oxide would form iron carbide, and would add another impurity. The mixture would therefore contain so many non-gas-making impurities that it would only produce a small amount of illuminating gas as compared with the calcium carbide. Moreover, the production of these useless impurities costs electrical energy, and it is doubtful whether the saving in heat due to using the already heated product would offset the waste of electric power. It is moreover, doubtful if this material could be made without infringing on one or more existing patents.

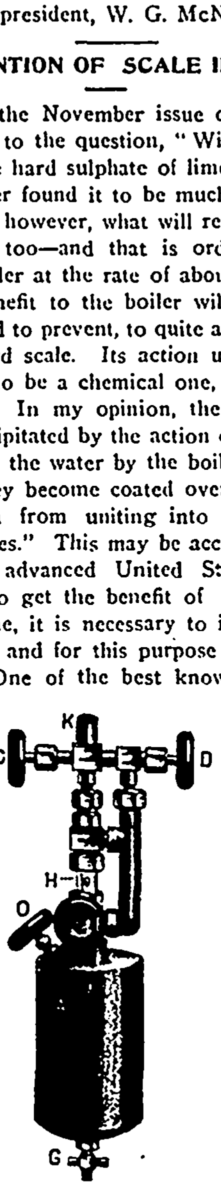
CANADIAN SOCIETY OF CIVIL ENGINEERS.

The thirteenth annual meeting for the election of the council for 1899, and the transaction of other business, was being held in the Society's rooms, 112 Mansfield street, Montreal, as we went to press, a full report of the meeting will appear in the February issue of The Canadian Engineer. The following is the programme: Tuesday, January 10th.—11 a.m., meeting for the election of scrutineers in the Society's rooms; 2 p.m., excursion from the Bonaventure depot to the New Victoria bridge, by courtesy of the Grand Trunk Railway; 8 p.m., meeting in the

Society's rooms, paper upon the construction of the new Victoria bridge prepared under the direction of Joseph Hobson, chief engineer, Grand Trunk Railway, illustrated by lantern projections. Wednesday, January 11th.—Excursion of the Society to visit the works of the Laurentide Pulp Company, Grand Mere, for which a courteous invitation has been extended by the company. Thursday, January 12th.—10 a.m. and 2 p.m.. technical meetings in the Society's rooms, at which the following illustrated papers will be read: The Soulanges Canal, by Thos. Monro, past president, Can. Soc. C.E.; the Trent Canal by R. B. Rogers, M. Can. Soc. C.E.; the Georgian Bay and Ottawa Ship Canal by H. K. Wicksteed, M. Can. Soc. C.E.; 8 p.m., members' annual dinner, at the Windsor hotel. Friday, January 13th.—10 a.m. and 2 p.m., business meeting and an address by the retiring president, W. G. McN. Thompson.

THE PREVENTION OF SCALE IN BOILERS.

In an article in the November issue of The Home Study Magazine, in answer to the question, "Will carbonate of soda or plain soda remove hard sulphate of lime scale?" the expert replies, "I have never found it to be much good for that purpose. I can tell you, however, what will remove it pretty effectually—very cheaply too—and that is ordinary kerosene. If this is fed to the boiler at the rate of about one-quart per day per 100 h.p., the benefit to the boiler will soon be apparent. It has also been found to prevent, to quite an appreciable extent, the formation of hard scale. Its action upon the sulphate of lime does not seem to be a chemical one, however, but rather a mechanical action. In my opinion, the minute particles of sulphate of lime precipitated by the action of heat, are first carried to the surface of the water by the boiling and bubbling of the water. There they become coated over with the kerosene, which prevents them from uniting into a solid mass when deposited on the plates." This may be accepted as the opinion of one of the most advanced United States engineers it is claimed. In order to get the benefit of the scale removing properties of kerosene, it is necessary to introduce it into the boiler drop by drop, and for this purpose a special device has been constructed. One of the best known and most widely



used of these is that shown in the accompanying cut, made by the Detroit Lubricator Co., of Detroit, Mich., and known as the Detroit Kerosene Oil Injector. Besides being extensively used in the United States, several thousand of them have been sold in Europe. For more than two years past the Vienna Dampfkessel untersuchungs und Versicherungs-Gesellschaft have been conducting a series of experiments with these Detroit kerosene oil injectors, and their report has recently been published. It agrees with the American opinion cited above, but it is more detailed and specific. It states, for instance, that "kerosene injected by way of drops with the feed water comes into the boiler as an emulsion, and remains waving in the water. The evaporating process separates the pulverized scale, which gets covered with a thin hide of oil, whereby the sticking to the wall is diminished." In regard to its action on the scale already formed, a very interesting explanation is given. On account of its peculiar nature, the kerosene penetrates into the scale, which being a very bad conductor of heat, is much hotter at the shell than on the water side. As the *minute penetrating* particles of kerosene get deeper into the scale they become hotter and hotter, till finally they become changed into a gas, and the resulting expansion bursts off pieces of the scale, just as dynamite does in a mine, and this process continues until all the scale is removed. As scale is one of the most annoying troubles of steam plants everywhere, this method of disposing of it, being both cheap and effective, will doubtless be very generally taken advantage of.

ELECTRICAL POWER TRANSMISSIONS.*

BY R. A. ROSS, E.E., M. CAN. SOC. C.E.

(Concluded).

Having sketched in a general way the points to be considered and determined upon the general features of the transmission, we may take up the figuring of lines, efficiencies and horse-powers to be generated. To do this, certain assumptions must be made as to the allowable efficiencies of the line and apparatus at various loads, which has been done in the tables below. As regards the apparatus, commercial efficiencies have been assumed, which are usual for this class of work, and will be guaranteed by the manufacturers. The line efficiencies are what would be usually allowed, considering the copper as designed for those efficiencies at maximum demand.

	Loads.			
Transmission (generator to sub-station)	100%	75%	50%	25%
Generators	96	95	94	90
Line	90	92.5	95	97.5
Raising and lowering transformers.	96	95	94	90
Total efficiency of transmission	83	83	84	79
Incandescent (distribution to lamps).				
Primary distribution at 2,000 volts..	96	97	98	99
Large reducing transformers	97	97.5	97	95
Secondary distribution to lamps	97	98	98.5	99
Total efficiency of distribution.	91	92.5	93.5	93
Arc Lighting (distribution to lamps).				
Efficiency of motor	92			
Efficiency of arc machine	86			
Efficiency of line distribution to lamps	93			
Total efficiency of distribution	72.6			
Power Circuit (distribution to motors).				
Efficiency of lines	90	92.5	95	97.5
Efficiency of transformers	96	95	94	92
Total efficiency of distribution	86.4	88	87	89.7
Railway Power (distribution to motors).				
Efficiency of rotary transformers	96	96	95	90
Efficiency of distributing lines to motors	80	85	90	95
Total efficiency of distribution.	76.8	81.6	85.5	85.5

From these efficiencies of line and apparatus the whole power necessary for all the maximum demands may be transmitted at an efficiency of 80% from the generator shaft to the distributing lines in the city. The total efficiency at full load from the generator shaft to the lamps, railway and stationary motors, is 68%, and under the average running conditions would not be less than 70%.

These figures illustrate the remarkable efficiency of electrical transmission even on such a mixed and varying load. It will be noticed that at varying loads the efficiencies are not very different, owing to the fact that, while the apparatus falls off, the line increases in efficiency, thus maintaining a balance. In fact, under light loads the efficiency is higher than under heavy, and is actually higher than given in the totals, because the tables consider the whole plant as operating at fractional load, while in actual running the apparatus would be kept at full load by shutting down units as the load dropped, thus raising the efficiency. The figure of 68% therefore may be safely taken as the lowest to be met with during the course of the year, and as it holds only for the peak of the load will not affect the average efficiency materially. The date assumed or calculated for the transmission is given below. The power is that necessary at the distributing lines to take care of the maximum demands as shown on the curve of total power. The power factor is assumed to be 100% for the class of load considered, loss in transformers 4%, in line 10%, which is not too high for the peak of the load, as this is what the line is designed for.

Electrical H.P. required at end of transmission line	11,946
Voltage of transmission at end of transmission line	15,000
Periodicity or complete cycles per second	60
Distance transmitted in miles	10
Power factor assumed p. c.	100
Loss in transformers p. c.	4
Loss in line p. c.	10
System of transmission—Three phase	

Figuring the transmission on the above assumptions the actual electrical horse-power at the generator terminals is 13,623, while the apparent horse-power as read by volts and amperes is 13,862. In other words, while the real loss in the transmission is 14% of the power required at the end of the line, the apparent loss is 16% This shows a high power factor for the whole system, and is obtained by a non-inductive load on a line well sub-divided, and with the wires properly placed.

To illustrate the effect of an inductive load upon the amount of apparatus necessary, another line with a load power factor of 90% has been figured, the other conditions remaining the same as before. This, while having the same losses as in the first case, requires [illegible] apparent horse-power at the generator, necessitating an increase of generating apparatus of 25%, or, in case the plant were installed, it would cut down its capacity 20%, and would decrease that of the distributing apparatus 10%. Were it not for these induction effects the problem would be as simple as in the case of direct current work, but as it is, they affect the matter to a very great degree, and require the most careful consideration to arrive at even a fair approximation to actual results.

Considering the fact that this power is laid down from the wheels with such simple machinery with but at most one revolving part, and therefore requiring no attention when once started, it is not surprising that electricity should have monopolized the field. The efforts at the present time to transmit to longer distances will be successful in proportion as the knowledge of insulating methods increases, and from the rapidity with which present voltages have been attained from lower formerly prevailing, it is not difficult to foresee the time when this country which is so rich in water-power, will be literally covered with power lines for all purposes The possibilities in the way of covering an increased territory by raising the voltage may be illustrated by the plant considered above, where, with 15,000 volt and 14% loss, the power covers a radius of ten miles in all directions. If the voltage were doubled, and the same loss allowed, the radius would be 40 miles, and the territory covered would be sixteen times as great. In other words the area served will vary as the fourth power of the ratio of increase of voltage. The question of the advisability of transmitting from a distance the natural power available in preference to generation at the centre of distribution by steam-power requires the most careful attention. The cost of the power laid down on the consumer's premises is made up of two items, namely, fixed charges and operating expenses. The first includes interest and depreciation on the plant, the second coal and supplies, attendance, etc. The saving by adoption of water-power is in coal and supplies, and perhaps a small part of the labor, provided the plant cost the same. Should, however, the cost of the transmission scheme be enough larger than that of the steam to eat up the saving in interest and depreciation on the increased cost of plant there is nothing to be said in favor of the transmission. If there is no cheapening of cost, the steam plant has the advantage of the greater reliability in lines and apparatus, as no high voltages need be used, and there is no risk of troubles with the water-power during the winter such as always exists to a greater or less extent in this climate.

In many cases, however, where the water-power improvement can be made with small outlay per horse-power rendered available, the gain may be large. It is not so large, however, as seems to be the idea of the public, which considers a water-power as capable of producing power for nothing, entirely ignoring the capitalization necessary for development. The transmission and utilization of electric power has got beyond the experimental stage, and is now surrounded with that mystery which used to obscure the financial facts, and the more it is considered as a commercial article depending upon the laws of supply and demand for its existence the more will its usefulness become apparent to the consumer and its financial security appeal to the capitalist.

MECHANICAL DRAFT FOR STEAM BOILERS.*

BY WALTER B. SNOW.

(Concluded from last issue).

We may now consider the influence, from a commercial standpoint, which the application of mechanical draft exerts upon the aggregate first cost of a steam-boiler plant. For this purpose there has been selected a plant of reasonable size of which the detailed cost is known. This plant consists of eight modern water-tube boilers, each of 200 horse-power nominal rating. A chimney is provided, 8 feet in internal diameter, by 180 feet high, of sufficient capacity to overcome the resistance of the two feed-water economizers and produce the draft necessary for any probable forcing of the boilers. The detailed cost of that portion of the plant which concerns the present discussion is in round numbers, as shown:

Eight water-tube boilers, of 200 horse power each	$25,000
Two feed-water economizers	7,000
Boiler and economizer setting and by pass	6,000
Automatic damper regulator and dampers	300
Chimney, complete	9,000
Building, complete	11,000
	$58,300

We may then consider the simplified arrangement which is possible when an induced mechanical draft apparatus is substituted for the chimney. There are two fans supported by the economizers, each driven by a separate engine. Each fan is capable of independently producing the draft for the entire plant, and thus serves as a relay is desired. Such an apparatus, with the short stack, can be installed, complete, under ordinary conditions, for about $3,500, making a saving of $5,800.

The omission of one boiler would bring the rated capacity down to 1,400 horse-power, and would call upon the fans to only increase the steaming capacity of the other boilers by about 14 per cent. above the normal, which could be readily done. This would show an additional saving in first cost which may be thus presented:

1,600 NOMINAL HORSE-POWER PLANT.

Cost of 8 boilers	$25,000
Cost of settings, etc.	6,000
Cost of building	11,000
	$42,000

1,400 NOMINAL HORSE-POWER PLANT.

Cost of 7 boilers	$21,875
Cost of settings, etc., about	5,500
Cost of building, about	10,500
Saving by use of mechanical draft	4,125
	$42,000

This shows a possible supplementary saving on the entire plant of $4,125, which makes a total reduction of $9,925 to be credited to the account of the mechanical method.

In any properly arranged plant the exhaust steam from the fan engine would be utilized so that the actual cost of the steam used in producing draft would be reduced to practically nothing. The value of the land may be an important factor in first cost. If figured at $2 per square foot, for instance, the omission of the chimney would in this case save $990, and the reduction in the number of boilers, $960 on the cost of the land required for the plant. The total net saving in first cost of a single plant, under the given conditions, may be thus summarized:

By omission of chimney and damper regulator	$ 5,800
By reduction in number of boilers	4,125
By saving in space occupied by chimney	990
By saving in space occupied by boiler omitted	960
	$11,875

*Abstract of a lecture delivered before Sibley College, Cornell University

This total saving is made possible by the expenditure of $3,500 for the mechanical draft apparatus, that is, the saving is nearly three and one-half times the expenditure necessary to secure it. The reduction of $11,875 in the cost would indicate an annual saving in fixed charges of about $831 to $890, according as the aggregate of interest, taxes and insurance is taken at 7 or 7½ per cent. This amount would, under conditions of the best economy, be practically sufficient to cover the cost of operating the mechanical draft apparatus, provided no attempt was made to utilize the exhaust steam, and would far more than cover it were this steam usefully employed. When to the economical advantages already pointed out is added the increased convenience of mechanical draft, its positive character, its ready adaptability, its independence of climate conditions, and its instant response to any demand for increased steam supply, the account stands decidedly to its credit. *Therefore* any further saving, as for instance in the cost of the fuel burned, is clear gain over and above any expenditure that may have been made on account of the introduction of this method. As a further factor in the matter of cost it should be noted that the fan possesses a definite advantage over the chimney in that it is portable and is always a valuable asset. The chimney, on the other hand, is a fixture, it is suited only to certain conditions and is practically valueless unless those conditions exist. The ability to utilize cheap fuels is an inherent advantage of mechanical draft, due to the fact that such fuels, being as a rule finely divided, with a large percentage of dirt and ash, require an intense draft for their combustion.

The influence of mechanical draft upon the quality and cost of the coal required is well exemplified in the case of a plant, consisting of three Babcock & Wilcox boilers of 335 h.p. each. The draft is furnished by a blower, which forces the air to the ashpits, and whose speed is automatically regulated by a special device, so that the volume of air and intensity of draft are continually changing to suit the varied conditions and requirements of the fire. Before this mechanical draft plant was put into operation, the fuel employed was George's Creek Cumberland coal, costing $4 per ton delivered. Since the fan has been in use, the quality and price of the fuel has been reduced to a mixture of No. 2 buckwheat with yard screenings and Cumberland, costing $2.62 per ton. The present average saving per week is over $126, when all fuel, including that for banking fires, is taken into account. Finally, in addition to the economic advantages of mechanical draft which have been presented, there are others which relate primarily to the convenience of installation and operation. Prominent among these is the feature of adaptability. The fan, which is usually of steel plate, may be constructed in any shape to meet specific requirements, may be located as desired with regard to the position of the boilers and without expensive foundations, may be used for either forced or induced draft, and because of its portability may be relocated or exchanged for another of different capacity. In its operation the fan is perfectly flexible, may be run at high or low speed, independently of the chimney temperature, and is always susceptible of instantaneous change in response to sudden demands. A mere change in engine cut-off produces an effect only secured with a chimney by adding to its height at great expense. External temperature changes have no appreciable effect upon the operation of mechanical draft, which, above all else, is independent of climatic conditions. The fan is a most important factor in smoke prevention, and in connection with the closed fire-room system the resulting ventilation is of vital importance. Briefly summarized, mechanical draft has here been shown to be capable of reducing the avoidable losses, of decreasing the first cost of a steam generating plant, and of reducing the fuel expense. In addition, it presents certain marked conveniences in the matter of installation and operation. In these days when every step in the process of steam generation and utilization is being scrutinized in the attempt to reduce the cost by even a single per cent. the opportunity presented by the employment of mechanical draft cannot be and is not overlooked. The economical necessity was not so imperative when Rankine and Clark pointed to its marked advantages. And the future was but dimly discerned when, only fifteen years ago, Seaton referred to the chimney as a rough and ready, but exceedingly wasteful way of inducing the air to flow into furnaces with sufficient velocity to cause the fuel to burn, and prophesied that it would some day undoubtedly be superseded by a more scientific and economical apparatus. Mechanical draft now stands so well established in the engineering world as to lead a noted engineer to remark that, "the building of tall chimneys to secure draft simply advertises the owner's lack of familiarity with modern improvements, or his want of confidence in results easily demonstrated."

A NOVEL METHOD OF SEWAGE DISPOSAL, ESPECIALLY DESIGNED FOR THE CITY OF TORONTO.

BY C. G. HORETZKY, C.E.

Upon the assumption of a present population of 200,000 inhabitants,, the city of Toronto pours daily into the bay, and deposits upon the water front directly under the noses of her citizens, and beneath the keels of steamers, and other craft frequenting the wharves, twenty tons of solid faecal matter, aggregating, during a year, the enormous quantity of 7,300 tons. To this must be added the solid excrementitious matter derived from stables, byres, slaughter-houses, and other extraneous sources, together with 10,000,000 gallons of excremental and other foul liquids. With the view of ameliorating the present conditions, C. H. Rust, city engineer, in his report of October 12th last, has recommended either of two methods of sewage treatment, i.e., intermittent filtration, the cost of which is estimated to be $730,000; or chemical precipitation, followed by filtration, presumably, through natural soil, at a cost of $550,000. The first mentioned process is estimated to involve an annual charge for maintenance of $70,000; the latter $105,000. Owing to the fact that, under the auspices of the Provincial Government of Ontario, the writer has been the pioneer of sewage treatment in Canada, that he has examined many of the best known plants in the United States, that he is in constant communication with United States State Boards, and is consequently in a position to be informed of the latest methods pursued there, it seems pardonable, in the interests of the community, to throw some additional light upon the very important question of the sewage disposal of this city.

Some time ago I outlined briefly in the columns of The Toronto Globe a method for the partial purification and disposal of the Toronto sewage. I now purpose entering more minutely into details which, since my letter was written, have been developed and elaborated, while the cost of construction and annual maintenance has been more correctly ascertained. The system of intercepting sewers recommended by Hering & Gray, with, perhaps, the slight modifications referred to in Mr. Rust's report, will, of course, be a preliminary necessity, and somewhere upon the line of the high level one in the vicinity of the Eastern city limits, the purification works, which I now advise as most suitable, regarding economy in construction, simplicity, and low cost of annual maintenance, as compared with other methods, should be located. The flow of sewage upon leaving the high level sewer would first pass through a screening chamber, 10 by 20 feet, which would intercept foreign substances, thence the sewage would enter one or more of a series of eight receiving reservoirs, placed in a row, each reservoir being 34 by 40 feet, with graded floors some 18 or 20 feet lower than the sewer invert. These reservoirs would be fitted with metallic screens extending across the whole horizontal cross-section of each reservoir, to support coke strainers, the upper screen of all being intended to intercept all the solid faecal matter, and to prevent the latter from coming into contact with the coke strainers below. In this manner it is estimated that, with the present flow of sewage (16,000,000 gallons), about twenty tons of solid matter will be held back every 24 hours.

After passing through the coke strainers the fluid sewage, now purified to a very large extent, would be allowed to fall into the pump well, the bottom of which is designed to be 8 feet lower than the floors of the receiving reservoirs. This pump well would be about 285 feet in length, and 10 feet in width, with a capacity up to reservoir floor levels of about 140,000 gallons. Immediately adjoining the receiving reservoirs, and partially over the arched roof of the pump well, would be situated the pump and boiler house. The pumping plant would consist of a duplicate set of 24 inch centrifugal pumps. Each pump is calculated to discharge 25,000,000 gallons per 20 hours.

against a total head of 40 feet (which includes the suction lift) The pumps would be run by a pair of 400 h.p. compound engines.

There would be a battery of 10 horizontal tubular boilers, each boiler of 100 h.p. Eight of these boilers are intended to supply steam for the pumps, the other two for drying out the receiving reservoirs and the contents thereof, coke and sewage matter, preparatory to the latter being run into the boiler house as fuel to be used under the boilers. The sewage effluent, after passing through the receiving reservoirs, and having been rid of all suspended and solid matter, would be as well purified as any chemical process of precipitation can accomplish, and could be allowed to pass by gravitation from the pump into Lake Ontario without further treatment, at any depth desirable below the surface, where diffusion would at once take place. But, if still further purification were at any future period insisted upon, either by local boards of health, or Governmental authority, two alternatives are open for such a purpose, viz., either by intermittent land filtration for which very much less than half the area suggested by the city engineer at page 12 of his report, would suffice; or, by the construction of two sets of artificial filters of the following materials and dimensions: Half an acre of coke filters, 3 feet 6 inches in depth, six acres of sand filters, 2 feet 3 inches in depth, the cost of which would not, in all probability, exceed $28,000. The last mentioned artificial filtration areas are larger, proportionately, than the supplemental filters in use at Glasgow, Scotland, for a similar purpose. The first alternative would necessitate the purchase of about 200 acres of land, besides its preparation, also an extra pump, while the cost of the last would be limited to material and construction only, as the sewage effluent would gravitate from the pump discharge to the filter beds.

In immediate proximity to the boilers and receiving reservoirs, there would be a brick chimney 250 or 300 feet in height. The object of such a high chimney is, by a powerful draft and steam heat, to carry off the objectionable fumes arising during the process of drying out the contents of the reservoirs, for which purpose a system of steam coils connected with one or two of the spare boilers is designed. Also, besides ventilating the reservoirs, it performs another very important function during the flow of sewage by creating a tremendous draft from the fresh air inlets upwards, and thus oxygenating the sewage most thoroughly, as the latter falls from one strainer to the other. Each receiving reservoir is capable of passing, and partially purifying from 2,000,000 to 4,000,000 gallons of sewage daily, after which it would be shut off from the sewer, thoroughly drained, and then subjected to a drying temperature of 300° F., which, assisted by the draft of the tall chimney would desiccate in a few hours the coke strainers and several tons of faecal matter intercepted by the upper screen, sufficiently to be used as ordinary fuel under the boilers, to which means have been designed to run them with a minimum of labor.

Such is the brief description of a very simple and economical plant, by which Toronto's sewage problem can be solved; and I wish here to point out particularly that this scheme involves an innovation hitherto unknown, or at least unpractised, so far as I am aware, in any sewage plant anywhere, i.e., the total and profitable combustion of the solids. By this process there is no resulting sludge to press and get rid of at considerable expense, the fuel bill is lessened, while the solid matters disappear in vapor.

It may be interesting to state here that, in any extensive chemical precipitation process the disposal of the sewage sludge has always been found an enormous drawback, as each million gallons of sewage treated produces from six to eight tons of pressed sludge cake, which it has been found impossible to get rid of without extra expense. Were such a system brought into use here, it is no exaggeration to say that the city would find itself compelled to hire daily, either a train of cars, or a small fleet of barges to haul it away. Farmers might take a very small percentage of it, but the great bulk would have to be carried away at the expense of the city, and 16,000,000 gallons of sewage daily treated chemically, mean 128 tons daily of pressed sludge cake. With regard to the coke strainers experience has shown, beyond a doubt, that after drying out, that material is as useful for fuel as before; and I shall show presently how it decreases the fuel bill, after having served its purpose as a strainer in the receiving reservoirs. It should be mentioned that this plant is amply capable of handling 16,000,000 gallons of the dilute sewage of Toronto per day, and that the receiving reservoirs can be added to if necessary; also that each of the pumps will discharge 25,000,000 gallons per day of 20 hours, with ease. The daily consumption of coke for straining purposes would be about 25 tons, or 175 tons per week, and the daily cost of pumping 25,000,000 gallons against a head of 40 feet would be 12 short tons of anthracite coal. Reduced to dollars and cents the daily cost for coke, coal and wages, may be represented as follows:

Pumping, 12 tons coal, steam drying, 3 tons coal; 15 tons coal, say at $3.75		$56 25
Deduct 25 tons coke recovered from reservoirs valued at one-fourth its weight of coal=6.25 tons at $3.75	$23 43	
20 tons desiccated faecal matter, equivalent to 4 tons combustible matter, but not taken into account		23 43
		$32.82

The daily cost for labor would be:

Wages of two engineers at $2.50	$5 00	
Wages of four firemen at $1.75	7 00	
Wages of twelve laborers at $1.75	21 00	33 00
		$65 82
Add 25 tons coke required daily for strainers (high figure) at $4		$100 00
Total daily cost of maintenance		$165 82

Or $60,524.30 per annum

ESTIMATED TOTAL COST OF DISPOSAL WORKS.

Excavation	$30,000
Brickwork	30,000
Concrete	4,200
Iron work	6,000
Drying apparatus coils, piping, etc	10,000
Ducts, or flues from receiving reservoirs to chimney	3,000
Flues from boilers to chimney	3,000
Roofing and carpenter's work	4,000
Bricking in boilers (10)	3,000
One centrifugal (24-inch) pump, one pair of 400 h.p. compound engines, 4 horizontal tubular boilers, aggregating 400 h.p.; feed pump, piping to connect boilers and engines, engines and pump set up on foundation, boilers placed ready to be bricked in $15 000	
In duplicate	30,000
Two additional boilers (steam drying)	2,000
Additional: suction and discharge piping, etc	1,000
Brick chimney (300 feet in height)	45,000
Coal and coke sheds	10,000
Eight branches connecting sewer with the different screening chambers, fitted with gates, and sundry other items	10,000
	$191,200

Note.—I am indebted to the Northey Mnfg. Co., Ltd., for the estimates as to the pumping apparatus and boilers.

It is important to explain here that the use of coke strainers has not been advocated without good reason. At Lawrence, Mass., U.S.A., experiments by the State Board upon the best known methods of sewage disposal have been tried during the last decade, and the results of the last two or three years, with regard to coke strainers, have shown that a 6-inch layer of that material has purified city sewage at the rate of 1,000,000 gallons per acre daily, and removed 62 per cent. of the organic matters (albuminoid ammonia), and 50 per cent. of that determined as "oxygen consumed," also that, at the rate of 4,000,000 gallons per acre daily, 38 per cent. of the total organic matter has been eliminated. The report of 1896 states emphatically besides, that coke straining removes organic matter as thoroughly from sewage as it is possible to do with any chemical or sedimentation process whatsoever, besides having the advantage of getting rid of the concentrated sludge liquor. It must also be remembered that, in the method which I have now advised, I have gone a step forward, by the retention of the solid faecal matter above, and entirely out of contact with, the coke strainers, thus relieving the latter of a very large percentage of organic matter to be dealt with. Obviously this is equivalent to increasing proportionately the area of the straining surface. The total combustion of the solids under the boilers, and the riddance of the expensive and intolerable sludge nuisance, are also advantages which must weigh with, and appeal to, even the least thoughtful of municipal economists.

It has been said that intolerable smells would arise from this combustion process. Not so. The high chimney will cause any bad odors to be carried away and dissipated in the atmosphere, far above the highest part of the city or neighborhood.

I may instance the Townsend and St. Rollox chemical works chimneys at Glasgow, Scotland, besides others in England, Germany, and in the United States, situated in the midst of dense populations, which carry off immense volumes of most deleterious gases, without inconveniencing the people below; but a little consideration will satisfy the most sceptical that nothing need be feared upon that score.

Mr. Rust estimates the cost of 600 acres of land, and the preparation of 300 acres for intermittent filtration, at $240,000. This, of course, presupposes the land to effect the purification of the crude sewage as it comes from the sewers.

My estimate for a filtering area of suitable natural soil, such as is said to be available to the northeast of the city, would be a tract of only 200 acres, which is amply sufficient to effect the final purification of the partially purified effluent from the coke strainers, being at the rate of 160,000 gallons per acre daily, for 16,000,000 gallons of a daily output. Such an area, upon the basis of Mr. Rust's estimate, would certainly cost less than $80,000. In the event, therefore, of a pressing public demand for complete purification, by final filtration through natural soil, entire and thorough treatment would cost, by the method I have outlined, as follows:

Coke straining and combustion works, pumping station etc	$191,200
Land for above (Mr. Rust's estimate)	10,000
Extra pumps, boilers, etc., required for pumping to land northeast of the city	20,000
Force main (Mr. Rust's estimate)	115,000
Two hundred acres of land for filtration purposes, and preparation, being taken at exactly the third of Mr. Rust's estimate. This is manifestly too high	80,000
.. ..	$416,200

Which is only 57-100ths of the city engineer's estimate for the cost of intermittent filtration and 75-100ths of that of his chemical precipitation scheme, *which has still the sludge to deal with.* The three proposed processes now stand thus, as regards cost of construction:

Coke straining and combustion process, followed by intermittent filtration	$416,200
City engineer's estimate for intermittent filtration	730,000
City engineer's estimate for chemical precipitation	555,000

And, as regards cost of maintenance per annum:

Coke straining and final purification by intermittent filtration	$65,000
City engineer's estimate for intermittent filtration	70,000
City engineer's estimate for chemical precipitation	105,000

In conclusion, I may remark that the coke straining may be carried to any extent by more frequent changes of coke than I have allowed for, it is simply a question of more coke and less coal, but the quantity estimated (175 tons weekly), will purify quite sufficiently for all practical purposes, especially if followed by intermittent filtration.

RETAINING WALLS.

Editor CANADIAN ENGINEER:

In a communication, published in your journal a year or two ago, I commented on the failure of the Bouzy dam in France, when some 230 persons perished in the flood; I then advocated a thickness of dam equal to the height or depth of the impounded fluid. That and other failures of retaining walls of masonry seem to have brought about a general concensus of opinion among engineers that this is safe practice; and in fact, retaining walls of all kinds, now-a-days, are built in a way more or less in accordance with this view.

Dams of masonry up to the present era used to be made of *a thickness hardly greater than one-half the height or depth* of water to be held back. This was done under the assumption that the weight of masonry being at least, or even more than, double the weight of water. Such a thickness of wall would suffice to retain it in situ. So it would, if the masonry could continue for all time to remain an homogeneous mass, thoroughly bound together by its cementing mortar. But it is well known now that this cannot or at least does not continue to be the case indefinitely. Whether through time and infiltration or other causes, the cementing medium deteriorates and rots away to sand in the course of years, when the superincumbent layers of masonry become, so to say, dislocated and detached and capable under sufficient pressure of sliding or moving the one upon the other. *The friction of masonry on masonry or of one* course of stone-work on another may be taken at a resistance, so to say, of 50 per cent. of the weight or vertical pressure; and, as in the case of a stone disintegrated dam of which the thickness is only half that due to the pressure weight on depth of water at any point, the resistance is therefore only equal to or less than that pressure, and the dam must in the course of time give way.

Hence, I advocated, as said before, a thickness equal to the depth of water, as in that case the loose material itself without the binding of it together by mortar, would still be of a weight more than double that of water, and such that its 50 per cent. of frictional resistance would be in excess of the pressure brought to bear against it. I am led to these remarks by an illustrated article in the last issue of The Scientific American, descriptive of a dam now in the course of erection at a point some five miles west of Mateo, a suburb of San Francisco in California.

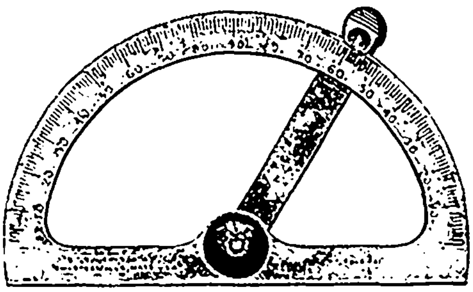
This dam is built of concrete, and is the largest of its kind in the world. Concrete dams were heretofore on the monolithic plan, or as if a solid homogeneous mass of material. Concrete, however, as may be seen, even in floors and sidewalks, is contractile and separates into parts, leaving fissures between them, and thus destructive of the impermeability of a water retaining structure. Hence they are now-a-days built in blocks, and given time to dry and contract before they are cemented together. This is the mode Herman Schussler, C.E., has adopted of doing his work. The component concrete blocks of some 30x40 feet in horizontal area being built in boxes or bottomless caissons, as it were, with movable sides, and made *to interlock or dove-tail, the one into the other, thus breaking* joint, as the saying is. These blocks are made of the uniform height of eight feet, and every layer thereof left to dry thoroughly and shrink before another layer of similar blocks is laid over it.

The dam alluded to bears out my views, and those of the profession at large, in that its thickness is equal to the height or depth of water to be held up. Its length is, or will be, when finished, not less than 832 feet on top, or at the crest. Its present height is 145 feet and breadth of base 176 feet, or equal to its finished height which, as it has to rise still by 30 feet, will be 175 feet. The thickness at the present height is 40 feet, or some five feet in excess of the depth of water above this point. The dam is curved or convex up stream to a radius of 637 feet, or versed sine, of over 100 feet, and its strength and resistance thus added to materially. The quantity of water impounded will be 19,000,000,000 (nineteen thousand million gallons). The down face slope or batter of the dam is one horizontal to four vertical. The up face slope is one to one, to within 60 feet of its full height, whence it is, like the outer slope, one to four, and the two slopes joined by a curve of a radius of 300 feet. The foundations were excavated down below the original surface to a depth of from 8 to 35 feet, until solid rock was reached, and to guard against fissures in even this, a trench was further sunk to a depth of 17 feet with a width of 5 feet at bottom and 10 feet at top, and this filled with concrete solidly rammed down with heavy iron rammers. This trench runs the whole length of the dam, following of course its curvature and reaching to its extremities at opposite sides of the valley. May we hope, sir, that these prudential measures will always obtain in the future, and that we have heard the last of the appalling catastrophies due to failures of such structures.

CHAS. BAILLAIRGE, C.E.

Quebec, December 19, 1898.

ANGLE INDICATOR.



(FAY'S PATENT).

This tool is what its name implies. It is to be used in connection with a universal bevel for transferring any given angles. It will produce a given degree as accurately as any micrometer protractor, but not the minutes. It is nicely graduated from 0 to 90 deg., reading from both ends, and it is finished in the Stevens Arms & Tool Co.'s usual superior manner. We cannot emphasize too strongly its great usefulness. It is stated that it should be in the hands of every machinist, tool-maker, draughtsman and metal sheet worker, in fact, any person who desires a handy angle indicator.

CONCRETE RAILWAY STRUCTURES.*

BY F. G. JONAH, M. CAN. SOC., C.E.

That concrete possesses many great advantages in the construction of railway structures is being more generally appreciated from year to year, and with the increasing interest in this class of work the writer feels warranted in presenting to the members of this society some designs of concrete culverts and bridge piers. These structures are particularly well adapted for use in the construction of new lines of railway, owing to the comparative ease with which the material for making concrete can be transported, as against heavy stone-work. The use of derricks for loading and unloading material and specially constructed wagons for heavy hauling are not necessary in concrete work, and, as it can be made with cheap, unskilled labor, a great saving in the wages of the force employed is thus effected. These culverts have a decided advantage over cast iron pipes on new works, owing to the great cost of transporting the pipe, but for renewals on old roads, cast iron pipe, up to five feet in diameter, is excellent. They will be much safer from washouts, however, if the ends are protected by wings, for which nothing is better than the concrete ends shown on the culvert plans. The plans submitted ranged in size from an 8 inch sewer pipe, with concrete ends, up to a five foot arch culvert. In 1894 the writer built upwards of thirty culverts after these plans, and up to the present time there has not been a failure of any kind about them.

The arches were turned with hard brick; in a larger culvert they could be made entirely of concrete, but for a small semicircular arch there would be difficulty in holding the fresh concrete in place. In the construction of these culverts, wooden forms are necessary for the work above the bottom or pavement line. The forms are practically moulds into which the concrete is dumped. They should be made of lumber not less than 1½ inch thick, dressed on the side next to the concrete. They should be well made and held together with clamps, to facilitate putting up and taking apart rapidly. If carefully used, one set of forms will serve for a great many culverts. For that portion of the culvert which is in the ground, including the back of side walls, the earth should be carefully excavated to the exact form of the culvert, any irregularities or holes beyond the figured dimensions will represent a waste of concrete. In putting the concrete in place, great care must be exercised in tamping it thoroughly, to insure a close contact with the forms. If this is not done, the work will present a honeycomb appearance when the forms are removed. Forms should be left standing in place until the concrete has partially set. It was found in this work that to make one cubic yard of concrete required 1.17 barrels Portland cement, 24.5 cubic feet of broken stone and 9.3 cubic feet of sand. To make a cubic yard of brickwork required 400 ordinary size brick and .93 barrels natural cement. The material was hauled an average distance of three miles, and cost on cars as follows:

Portland cement, per bbl.	$2 90
Louisville cement, per bbl.	90
Machine crushed macadam, per cubic yard	2 10
Sand per cubic yard	80
Brick, per M	8 00

The following rate of wages was paid:	Per day.
Teamster, man and team	$2 50
Bricklayers	2 50
Concrete gang:	
Foreman	2 00
One laborer	1 50
Six laborers at	1 25

The average cost on all culverts was:

Earth excavation in foundations	$ 35
Concrete per cubic yard	6 80
Brick-work per cubic yard	7 70

*From a paper read before the Canadian Society of Civil Engineers.

TORONTO WATER WORKS CONDUIT.

The first or north section is that across the harbor from the pumping station to Hanlan's crib. It consists of two pipes nearly parallel, the westerly pipe 3 feet in diameter, of cast iron, with each joint flexible, laid in 1874; the easterly pipe of steel, 4 feet in diameter, laid in 1889 and 1890; the length of this section is 4,660 feet. The second or central section is that through Blockhouse Bay and across the Island from Hanlan's crib to the shore crib. It consists of two parallel pipes, the southwesterly one of wood, 4 feet in diameter, laid in 1873, 1874, 1875 and 1876, but abandoned on the completion of the second pipe, which was laid in 1889 and 1890. The northwesterly and new conduit is of steel, 5 feet in diameter. The length of this section is 6,027 feet. The third or south section is that in Lake Ontario, from the shore crib to the intake. A wooden pipe 6 feet in diameter for a distance of 2,357 feet, laid in 1881 and 1882. This section was extended a distance of 365 feet in 1890 and 1891. This extension is of steel 6 feet in diameter, making the total length of this section 2,722 feet. The manholes are of iron, with a trap-door at the top of each, not air tight.

(For profile of conduit see City Engineer's Report, 1893, pp. 3 and 4. This shows the depths to top of conduit, the filling over it, the points where pipe broke, etc.).

In the latter part of 1893 after the conduit had been fully repaired, the friction head was measured and found as follows: "While by D'Arcy's formula the head consumed on the 6-foot pipe was sufficient to deliver 32,000,000, on the 5-foot pipe 28,000,000, and on the 4 and 3 foot pipes, 20,000,000 per 24 hours, or expressing it in friction head, the total measured head was 6.5 feet to deliver 22,500,000, against a calculated head of 3.91 feet, showing a loss of 2.59 feet, the water in the lake being 1 foot 0 inches above zero." (See pp. 31 and 32 City Engineer's Report, 1893). The actual head in each section is given in this Report, but it is evident that the 6-foot section was not carrying the water it should. In examining it since the last accident, sand was found in it to a depth of 2 feet in places. Making an approximate calculation for the obstruction in the 6-foot pipe, and taking a higher coefficient for roughness the theoretical head in each section necessary to deliver 22,500,000 of gallons per 24 hours would be as follows:

	Head.
North Section—4 foot and 3 foot pipes combined, 4,660 feet long	3.00 feet.
Central Section—5 feet diameter, 6,027 feet long	2.65 feet.
South Section—6 feet diameter, 2,722½ feet long	0.85 feet.
Actual head	6.50 feet

With the lake 18 inches below zero it will be found that the hydraulic grade line when delivering 22,500,000 gallons at pump well, will touch the top of the 4-foot conduit at one point only, that is, 125 feet north of Hanlan's crib, at which point the conduit rose in 1892, and again in 1895. On the profile of 1893 it is shown as uncovered with sand. In the second section the top of conduit is above the hydraulic grade line for nearly half its length, at one point being half the diameter of the pipe above it. At this point the conduit rose in 1892, also at the second highest point in this section.

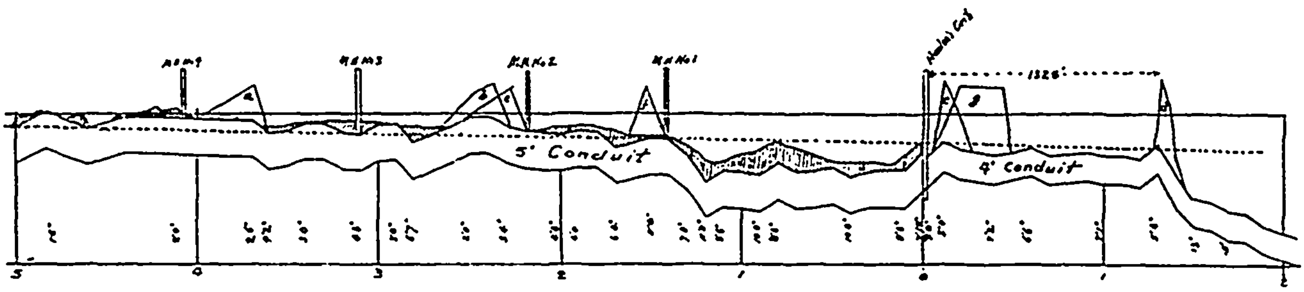
To test the filtering capacity of the basin on the Island, pumping through the 4-foot wooden conduit was commenced on November 25, 1875, and continued until December 7, 1875, when portions of this pipe came to the surface. This rising was doubtless due to lack of sufficient covering above the pipe. The contractors when the accident occurred claimed that it had been covered as specified, and attempted to prove that the specified covering was insufficient. The elevation of the lake was about 5 inches below harbor zero when the rising occurred. The contractors, however, paid the cost of re-laying and re-covering the portions that rose. This pipe was abandoned in 1890 on the completion of the parallel steel conduit, 5 feet in diameter.

On December 25th, 1892, the steel pipes suddenly rose at two points in the first section, near Hanlan's crib, and at two points in the second section. At this time the lake elevation was about 18 inches below harbor zero.

(For description, see City Engineer's Report, 1893, pp. 5, 6 and 35 to 53; also W.W. Superintendent's Report, 1892, p. 9; for capacity of conduits, see City Engineer's Report, 1893, pp. 31 and 32).

regarded as an "accident," caused directly by the pump-house engineer not following his instructions to stop the machinery if the pump well lowered beyond a certain point. A float in the well could have been connected with a throttle valve, thus automatically stopping the engines. The pipe rose, however, and it cost $50,000 in money, and three months' time to repair it. If the cause of the rising were fully understood why were not automatic registers placed in the different manholes along the conduit, and at the pump well, to record the fluctuations in friction head? Why was the conduit not covered with sand at all points that were above the hydraulic grade line, loaded with stone filled cribs, or anchored down with piles? Why, if the department knew the danger of an accident occurring, were not daily inspections made of the conduit after it was repaired in 1893? One inspector could have examined the conduit daily at each manhole along its course, noted the velocity, the elevation of the water, and could have thus detected any evidence of foul play or symptoms of an accident?

Official reports were made to the city council warning that body of the danger in not having a more perfect conduit, yet no steps were taken to lower the high points to grade, to load it, or to even guard it by patrolling. It was claimed that it was leaky, that large quantities of sand had found entrance to it,



PROFILE SHOWING PART OF THE TORONTO WATERWORKS CONDUIT, MARCH, 1893.

The pipe rose at points "a," "b," "c" and "d," in 1892, and at points "e," "f" and "g," in 1895. The upper horizontal line is 18 inches below "zero level" of the lake, and the dotted line is the approximate hydraulic grade line. The vertical numbers give the depth to the top of pipe below "zero level" of the lake, and the shading slum the covering of sand over the conduit

On the morning of September 5th, 1895, the conduit rose in the first section at the same point as one of the breaks in 1892, also at two points in the second section. The lake at this time stood at 9 inches below zero. (For description, see City Engineer's Report, 1895, p. 68).

From 1888 to 1893 there was no experienced civil or hydraulic engineer at the head of the waterworks department of the city of Toronto. During this period the city spent about $200,000 on these conduits, which were designed and constructed under the department staff. After the rising of the conduit in December, 1892, the waterworks department was re-constructed, and on January 30th, 1893, the works were placed under the direct supervision of the city engineer.

The large amount paid for engineering and engineering advice in 1895 was simply the arrearage due the engineering profession.

The accident to the wooden conduit of 1875 was doubtless caused by an insufficiency of filling over it. The contractors had notified the city engineer that this work was completed, but the engineer had not satisfied himself of the correctness of their statement. The contractors endeavored to prove that the covering specified was not sufficient, and claimed upon engineering advice, that if the water were drawn down to a depth of seven inches below the top of the pipe the upward pressure of air on inner surface exposed would more than equal the weight of 2½ feet of sand above it. After the pipe was re-laid and the re-filling completed, the water was drawn down much more than the seven inches, but the pipe did not rise. The contractors then acknowledged that their expert's demonstration was incorrect, and that the uprising was due to insufficient filling. The uprising of Christmas Day, 1892, was a surprise to everyone. In the report of the waterworks superintendent for 1892, p. 9, will be found a very brief statement as to the cause of this rising. A quantity of weeds was found at a screen that had been temporarily placed in the shore crib, where the 6-foot wooden conduit connected with the 5-foot steel pipe. The examination and tests then made to determine the cause were of a very superficial character, and it is now more than doubtful if the official reasons were the correct ones. It was apparently

and that it was in danger of being broken at any time by vessels. The experiment made in 1894 (see report for that year, p. 99), demonstrated that the conduit across the harbor was practically water tight. Neither bay water or sand could therefore enter this section. In the second section the surrounding water is much better in quality than in the harbor, and the pipe is partially bedded, and in places covered with sand. The official reports withhold all information respecting the actual leakage into this section. The leakage in the lake section would be trifling owing to the low head, and the water entering it would be of comparatively good quality. Until proven to the contrary it may be claimed that the conduit in 1894 and in 1895 to September 5th was not leaking, and that no sand was entering it.

In repairing the breaks in 1893 and in 1895 large quantities of sand were found in the conduits in the vicinity of the breaks, but there is no reason for assuming that this sand was there before the pipes rose, but every reason for believing that it entered at the time of the upheaval. The danger from the vessels was slight, and could have been practically eliminated by proper buoying and marking of the line of conduit. The rising of the conduit on September 5th, 1895, in exactly the same way as on December 25th, 1892, was doubtless a shock to the waterworks department. The following is the alleged combination of circumstances that caused the "accident." (City Engineer's Report, 1895, p. 69):

First.—Enormous accumulations of sand in the conduit.

Second.—The unprecedented low state of the water in Lake Ontario.

Third.—By a vertical plank obstruction found in the lake shore manhole.

Suggestions of foul play were circulated at the time of the accident, but they do not appear in the official report. An explosion of dynamite would have caused effects that could not have been overlooked. This charge against unknown malicious parties was soon dropped, but the search for the point where the dynamite was applied disclosed the fact to the public that the conduit had not been properly or regularly inspected.

A piece of planking about 16 inches wide, 3 inches thick and 8½ feet long was found in a vertical position in a manhole near the lake, in the 6-foot conduit, the lower end being imbedded in sand. The newspapers at the time reported that the engineers had stated that this was doubtless the cause of the accident, but it was then assumed that the reporters had manufactured the item, in their sanguine efforts to fathom the mystery. We find the statement repeated on page 69 of the City Engineer's Report for 1895. The capacity of the 6-foot conduit is there stated as being reduced 40 per cent. by the plank and the sand. The depth of sand is not given in the text, but the newspaper at the time gave it as 18 inches at this point, which agrees with the depth shown on the profile of the conduit given in the Engineer's Report. How much of this 40 per cent. was due to the sand and how much to the plank?

The sand accumulations would be gradual, and examinations after the uprisings showed that they were chiefly in the 6-foot conduit, and in the vicinity of the broken joints. The average depth of sand in the 6-foot conduit was probably 18 inches. (See page 88, City Engineer's Report, 1895, also profile, page 68). At the time of the rising the water stood at 13½ inches below zero, and a few inches higher than in December, 1892. A glance at the chart of the lake elevations during the preceding forty years would have shown that the elevation in September, 1895, was not "unprecedented," as it had been lower than this in no less than four different years. The lower the water the lower the hydraulic grade line, and therefore the greater the risk of rising. Gaugings of the lake are taken several times per day, and the engineer at the pump-house keeps a record of the level of the water in the pump-well. It cannot be claimed, therefore, that the department was not aware of the low stage of the water, yet the conduit was not kept from rising. It had been reported against and condemned, yet little had been done towards making it safe as the lake lowered. If, therefore, low water were the cause, it could not have been fully appreciated by the department.

It is a well-known fact that all surface waters contain small particles of air, without which it is claimed fish would die, and possibly all subaqueous animal life cease to exist. In laying conduit pipes on land engineers place at all apices, air valves to permit the escape of air that collects at such points. These valves may be automatic. Small pipes carried from each apex to a point above the hydraulic grade line serve the same purpose. Referring to the profile of the conduit immediately north of Hanlan's crib there are two points or apices that touch or pass the hydraulic grade line. It is evident that air would gradually accumulate at these points. The conduit has risen twice at one of these points and once at the other. If it be granted that air accumulated so as to fill more than one-third of the volume of the pipe at one point, then it is easy to show that the pipe would rise. The 4 foot conduit was laid in lengths of 57 feet, of Scotch steel plates, ⅜-inches thick, each length weighing about 12,000 lbs. (See Report, 1890, p. 18). This gives a weight per lineal foot of pipe of 210 lbs. The water contained in one lineal foot of this pipe weighs 785 lbs. If, therefore, one-third of this water becomes replaced with air the pipe must rise, unless loaded. The 5-foot pipe weighs 300 lbs. per lineal foot, and the contained water 1,230 lbs. In this case a removal of one-fourth of the water would jeopardize the pipes' stability. Every engineer who has had experience in testing waterworks distribution systems, pumping engines and long conduits, knows that the theoretical pressures are frequently increased enormously by what appear to be comparatively small changes in conditions, caused by the inertia of the moving mass of water. If there be air in the pipes, these fluctuations will be aggravated.

Now, is not this what occurred at each of the two risings of the steel conduit: First, the conduit was above the hydraulic grade line at some points, and close to it for a great distance. Second, air had accumulated at many apices. Third, fluctuations in the head caused variations of pressure on the air pockets. Fourth, a bubble of air escaped from one or more of the high points, ran to a higher point, and caused a disturbance in the water, a surging backward and forward. Fifth, this surging of the water produced alternate compression and expansion of the air, at one of which expansions the pipe rose, the water hammer contributing to loosen the pipe from its bed. Sixth, by rising at one point a violent commotion was instantly set up at other points where air had accumulated, and the conduit rose at several such points.

If there were a leaky point at an apex it is possible that the air might have escaped. This in reply to the query: "Why did not pipes rise at all high points?" In 1893 the conduit was replaced and repaired, but the cause of the rising was certainly not understood, or if so not made public. By carrying small pipes from the principal apices to a few feet above high water level, the air can be removed and the full capacity of the pipe utilized, to the hydraulic grade. The sand deposited over the conduit would tend to improve the character of any water that might leak into it. It was officially announced in 1892 and 1893, that the first uprising was caused by the clogging of a screen at the shore crib with weeds. This was generally believed at the time, but since the second accident when nothing of the kind was discovered, the thinking public became skeptical as to the correctness of the reason given in 1892-3. The conduit was in continuous use nineteen months before the accident of 25th December 1892, and about thirty months after the repairs following this rise. The greater length of the second period may be accounted for by the higher lake level in 1893, the strengthening of the weakest high points, and the gradual silting up of the channel in which the conduit was laid. Loading the pipe by sand, by cribs, or by driving piles and bolting cross-timbers above the pipe, will prevent an uprising, but cannot prevent the accumulation of air, and a reduction in the capacity of the conduit.

BOATS OF THE DOMINION TYPE

Editor CANADIAN ENGINEER:

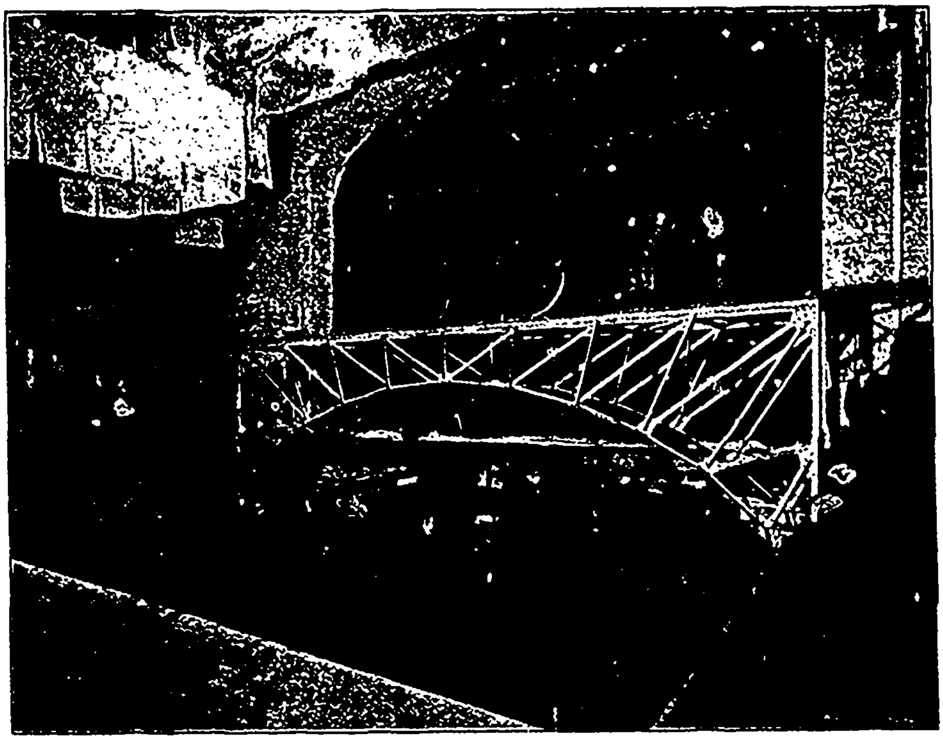
It is remarkable how often minds in diverse positions will run in nearly parallel lines on some subject. Your November article upon the latest defender of the Seawanhaka Cup recalls an idea I developed in 1894 for what I termed "hollow-keeled boats," consisting of a fine lined shell, barely enough to float the crew, while over it was superimposed a wide shallow hull, with easy lines, of which the former would represent a hollow-keel. Say a boat 15 feet long, 4 feet wide, 10 inches deep, with a shell keel 12 feet long, 12 inches beam, and 4 to 5 inches deep, will float one man with feet in the run aft, seat on the floor of the larger boat, and centre of gravity lowered the amount of depth of keel. This gives extra depth for stepping mast, centreboard, rudder, etc., while leaving a very light buoyant skiff on the top of the water. If the keel be made detachable, one skiff may have a flat keel for duck hunting and shallow streams; another for rowing and paddling of light draft; while for sailing, a sharp, deep, heavy keel and centreboard will be most satisfactory, giving virtually three boats in one. I built one eight feet long, which runs very well for its size; and I intend trying one with detachable keels, when time permits. I have tried double keels, but find that in a head sea they are apt to fill between hulls and deaden headway. For small motors the hollow keel gives deeper immersion of the propeller, and lower centre of gravity, than in the canoe model of craft. Probably some of your nautical readers may improve upon the above suggestions.

THOMAS FROOD.

ELECTRICAL STAGE APPLIANCES.

(Correspondence Canadian Engineer).

The proposed application of electrical power for mounting plays in the Drury Lane theatre, London, on the lines advocated by Edwin O. Sachs, architect, has taken a tangible form in the completion of the first section of the stage installation in time for the season's pantomime. Mr. Sachs' present work refers principally to the stage floor, and its movability in sections above and below the footlights. The total area now already movable by mechanical power exceeds 1,200 square feet. The electrical appliances just completed take the form of so-called "bridges," each working independently. Each individual section measures 40 feet by 7 feet and weighs about six tons, of which about four tons are counterbalanced. They can travel about 20 feet vertically. The motive power is from the ordinary electric supply mains over a four pole motor developing 7½ h.p. at 520 revolutions per minute. The "bridges" are suspended from cables, and these, working over the motor allow the former to be raised with the necessary live load at rates varying from 6 feet to 20 feet per minute. Every possible safeguard is provided against accident, the "bridges" themselves being so constructed that in the event of derangement of current the appliances can be worked by hand gear. Automatic switches are provided so as not to be entirely dependent on the attendants, and automatic catches will work in case of rope-breaking. Special locking gear has been installed to hold the "bridges" stationary at certain points, such as stage level, and a very large factor of safety has been allowed in apportioning the strengths and weights in the various parts of the mechanism, having special regard to the ever-increasing scenic requirements. As regards the economic aspect of the electrical installation the initial outlay on Mr. Sachs' system is about half that of continental hydraulic work, and this is allowing for English contractors as against foreigners. The maintenance is minimal, whilst the actual working only costs a few pence per performance. The saving in manual labor on the stage is very considerable, whilst the hygiene of the theatre is materially raised by the absence of woodwork. For the successful execution of this work Mr. Sachs is primarily indebted to the enthusiastic encouragement of Arthur Collins, who is the first manager to introduce modern methods on the stage, and deserves the congratulations of the technical professions. He has been ably seconded by the Thames Iron Works, their engineers, Messrs. Stewart & Grove, having to meet innumerable difficulties, as most of the work was carried on at odd moments or at night during the run of the "Great Ruby."



THE STAGE, DRURY LANE THEATRE, LONDON—ELECTRICALLY OPERATED

THE STEAM BOILER AND ITS SAFETY.*

The modern demand for high-pressure engines is fostering sectional and water-tube boilers. The more rapid adoption of such boilers is retarded on account of so many of their parts being made of cast iron, together with so many joints and connections. These are objected to by the old-type manufacturers, and those unwilling to accept something new. Nevertheless the external horizontal tubular boiler will soon be out of the modern class as a steam generator. It is limited in the thickness of sheet, therefore, in its diameter. Consequently on account of its being externally fired, its pressure and power is limited. This alone has turned the attention of boiler manufacturers to a more perfect arrangement for stationary, as well as marine purposes.

At the present day, the choice is for high pressure in stationary boilers, embracing several designs of water tube and internally fired boilers of different type. From an economical standpoint there is little difference, notwithstanding the claims and reports of efficiency tests advanced by the makers of the different designs. On the other hand the safe working pressure of the boiler, we are compelled to take the maker's figures as there is no law in this province formulating the proper rules, founded on mechanical principles, to determine the safe working pressure of the steam boiler. An instance of the above occurred to me quite recently when called upon to inspect a horizontal, tubular, externally fired boiler. The dimensions of the boiler were 72 inches diameter and 16 feet long. The plates of steel 3/8-inch thick with a tensile strength of 60,000 lbs. per square inch. There were 114 3-inch tubes, and the heads were of flange steel ½-inch thick. The longitudinal joints were double riveted; the rivets being ¾-inch in diameter, and the pitch 3 inches, and it is fair to suppose the holes at 13-16 inches. The efficiency of the joint so far as net sections of plate is concerned is 3-in.—.8125÷3 in.=72.9%. The area of a 13-16-inch hole being 0.5185 square inches, the single shearing strength of one rivet is .5185x38,000=19,700 lbs., and as there are two rivets in a unit section of the joint (the joint being double riveted), the total shearing strength of the rivets in a unit section is 39,400 pounds. The strength of a strip of the solid plate, 3 in. wide, being 3x3/8x60,000 lbs., equal to 67,500 lbs. Then for the efficiency of the joint so far as rivet area is concerned is 39,400 divided by 67,500=58.4%. This is much less than the efficiency of the net section, therefore it follows that the joint is badly proportioned. The rivet area is too small; notwithstanding this the builders had no hesitation in recommending this boiler for a safe working pressure of 100 lbs. per square inch. Whereas with a factor of safety of 5 the safe working pressure on it is 73 lbs. per square inch. The safety valve was set at 100 lbs. per square inch, and the owners of this boiler congratulated themselves on their new steel boiler. Really the boiler was no stronger with the 60,000 lbs. steel than it would have been with 50,000 iron. Now a proper double riveted lap joint for this boiler would be diameter of rivet 7/8-inch, pitch 3 7-16-inch Efficiency of joint 69.4%. This would give a safe working pressure (with a factor of 5) of 87 lbs. per square inch. Many years ago Sir William Fairbairn stated the efficiency of a single riveted joint to be 56 per cent., and that of a double riveted joint to be 70 per cent. No doubt he meant it to be understood that this was the limit practically obtainable with careful design and construction, and I am sorry to say that it is a common practice among engineers who should know better, to allow 56 and 70 per cent for single and double riveted joints respectively, without the least regard to the actual proportions of the joint.

*A paper read before Hamilton Branch, C. A. S. E. by F. G. Mitchell, London

Another case which came under my observation not long ago, was a horizontal tubular boiler, externally fired, 48 inches diameter and 12 feet long, the plates were of steel 60,000 lbs. tensile strength, 5-16 inches thick and single riveted. The diameter of the rivets was 5/8 inches and the pitch 1¾ inches, the heads 3/8 inches thick. The workmanship of this boiler was excellent in every respect, and I believe the material was also. The only objectionable point about the boiler was the riveted joint. The diameter of the rivets being 5/8-inch we will suppose the holes to be 11-16-inch or 0.6875. The pitch being 1.75, the efficiency of the joint so far as the net section of the plate is concerned is $\frac{1.75\text{-inch}-0.6875}{1.75}=60.7\%$. The area of a 11-16-inch hole being 0.3712 square inches, the strength of one rivet (assuming the shearing strength of rivet iron were to be 38,000 lbs. per square inch), is $.3712 \times 38,000 = 14,100$ lbs., and the strength of a strip of the solid plate 1.75 inches wide, being $1.75 \times 5\text{-}16$ inches $\times 60,000 = 32,800$ lbs. We find that the efficiency of the joint so far as rivet section is concerned is 14,000 divided by $32,800 = 43\%$, whereas if properly designed it should be 56%. Now, why is it that an otherwise good boiler manufacturer will allow construction such as this? He might as easily and without any more expense, have turned out a much better and safer boiler. It may be possible that the templets used had been arranged for 40,000 or 45,000 lbs. per square inch iron. This does not explain the whole thing, for now-a-days the manufacturer will go even a step closer by using only a factor of 4 with practically the same externally fired boiler.

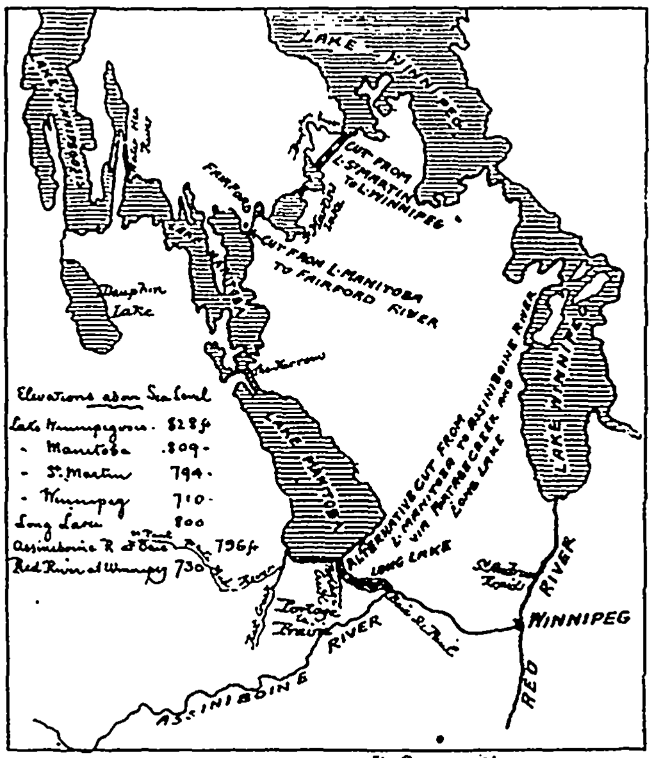
There are many defects that are likely to be found about a steam boiler and the ones most common are corrosion and grooving along the girth seams, generally on the bottom sheets and cracks extending from the edge of the sheet to the rivet holes. On the outside landing, this is more often found where heavy plates are used. The most serious form of corrosion is that which attacks the plates along the water level, forming a continuous line of weakness. This is, of course, due to the acids in the feed water, and can only be remedied by improving the supply. External grooving is often due to leaky calking and is very often caused by the use of what is known as a split calking tool having broke the skin of the metal. Buckled or boged sheets usually result from neglect in keeping the boiler clean. Soft deposits are allowed to accumulate over the fire and become hard, allowing the plates to become over-heated and be pushed down with the pressure. In iron boilers this has been attended by ruptures, while in steel boilers the buckled part grooves thinner at its lowest point until a small hole causes a leak.

I wish to mention before closing, a very important consideration about the steam boiler, and that is, the so-called mountings. How many boilers do we meet with that have a perfect working safety valve, one that will permit the escape of steam as fast as the boiler will generate it, and not allow the pressure to exceed at least 10 lbs. above what it was set for. Anything else is only an excuse for a safety valve. It is also quite a common thing to see water columns connected to the boiler with ½-inch and ¾-inch pipe, and with three and four bends in it, and a small pet cock at the bottom to blow it out. This is another excuse. Also how often do we see a common plug cock put on for a bottom blow off. There are no mountings or fittings too good for a boiler, and none other should be used nor allowed to be used.

THE LAKE MANITOBA CANAL.

The question of lowering or controlling the water level of Lake Manitoba has been agitated for a number of years. The volume of water running into Lake Manitoba is considerably greater than the outlet capacity. A number of rivers and creeks flow into the lake, while its only outlet is the Fairford river to Lake St. Martin and thence via the Dauphin river to Lake Winnipeg. An important matter to be taken into consideration in connection with the lowering of the lake is its value as a navigable body of water. Some persons who have made a study of the question, claim that the lake is of greater value for purposes of navigation than the flooded land in its vicinity. The Winnipeg Commercial recently discusses the matter at some length, and we reproduce the accompanying illustration from its pages. Lake Manitoba is quite shallow, and if the water is materially lowered it will destroy navigation on the lake.

As early as 1881 the late Thos. Guerin, one of the most able hydraulic engineers in the employ of the Dominion Government, made an extended examination of the lake, with the object of discovering what could be done to reclaim the flooded lands and prevent a recurrence of the trouble. Mr. Guerin made a very full report as to the result of his work. He recommended that the outlet be enlarged by cutting a channel about two miles long, from the lake to the Fairford river, below the rapids on that stream. This would increase the outflow to Lake



The Commercial

LAKE MANITOBA CANAL.

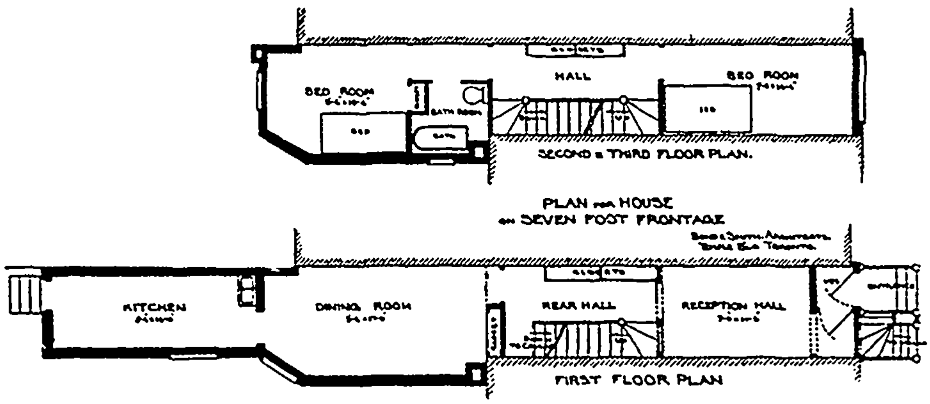
St. Martin. In order to provide for the carrying off of this increased inflow to Lake St. Martin, he also provided that another cut should be made from the latter lake to Lake Winnipeg, otherwise the country about Lake St. Martin would be flooded. Mr. Guerin found that 14,833 cubic feet per second of water was being discharged by the Fairford river into Lake St. Martin, while the outlet from the latter lake to Lake Winnipeg, via the Dauphin, or Little Saskatchewan river as it is sometimes called, is only 12,486 cubic feet per second. The land around Lake St. Martin, which is quite as valuable as the flooded territory around Lake Manitoba, was therefore also subject to flooding. To increase the outflow into Lake St. Martin without providing for an additional or larger outlet into Lake Winnipeg, would simply result in flooding the country around Lake St. Martin. Mr. Guerin estimated the cost of the short cut from Lake Manitoba to the Fairford river at $36,000, while the cost of the cut from Lake St. Martin to Lake Winnipeg he placed at $245,000, or a total cost of $281,000 to reclaim the 200,000 acres of flooded land around the lake.

The Dominion Government, it now appears, has decided to go ahead and make the first short cut, without providing for the vastly more costly cut which it will be necessary to make to prevent the flooding of land around Lake St. Martin.

It seems to be agreed that Lake Manitoba might cheaply be part of a system of communication between the Red and North Saskatchewan rivers. The securing of navigation between Winnipeg and Edmonton via Lake Winnipeg is a matter of the utmost importance to the farmers of the Northwest. It is not necessary to abandon these lands in order to preserve the navigable value of Lake Manitoba. By the cutting of a canal from the southern end of Lake Manitoba to the Assiniboine river, the level of the lake can be reduced or regulated, and the flooding of lands in the Lake St. Martin region would be prevented. It would give such a flow of water as would greatly assist in rendering the Assiniboine river navigable between Winnipeg and Portage la Prairie; it would also improve navigation on the Red River between Winnipeg and Selkirk. It would give a sufficient flow of water to render it possible. The Commercial states, to develop a minimum of 15,000 horse-power on the Assiniboine river at Winnipeg. From Lake Manitoba to the Assiniboine river the distance across from the lake to the Assiniboine at Baie St. Paul is about seventeen miles. The fall is about fourteen feet. Long Lake forms a natural canal for about one-third of the distance, and Portage creek also forms a natural canal for a considerable distance from Lake Manitoba toward the Assiniboine river. The sketch map shows the Lake Manitoba basin with the outlet of the lake via Fairford and Dauphin river to Lake Winnipeg, also showing where the proposed cuts are located, whereby it is intended to lower the level of the lake. As noted, the intention is to make only the first short cut at Fairford now. This map also shows the alternative cut to the Assiniboine river, by which the level of the lake could be controlled as readily as by the two cuts at Lake St. Martin.

A VERY SMALL HOUSE.

This engraving shows plans prepared by Bond & Smith, architects, Temple Building, Toronto, for a house to occupy the narrow strip of land left in a city terrace to serve as a lane but no longer needed for that purpose. It will probably be the smallest modern house ever built in Canada.



A VERY SMALL HOUSE.

WIND MILLS AND PIPES.

BY WILLIAM PERRY, MONTREAL.

During the past few years considerable attention has been given to pumping machinery in its various details; and personally I have given it much time so as to derive from it information on a practical basis. Nothing is more generally disregarded in erecting a pumping outfit than the proper size of pipe, and the proper size of cylinder to be used with a particular size of pipe. Men, who for a number of years have had the old style wooden wind-mill running slowly, with pump larger than can be used on a modern steel wind-mill, do not realize that the pump for a modern fast running wind-mill, with a stroke twice as long, must have a reduced diameter of the cylinder, and a larger discharge pipe to carry off the greater quantity of water. With the old wooden wind-mill, which has 5 or 6 inch stroke, inch or three-quarter inch pipe has been used for the discharge without bad results; because the wheel has not had power to injure itself. You could hitch it to the pump rod, and it will stand like an old horse. I frequently have correspondence on the subject as follows: "I have been using my mill on one inch pipe with a 3-inch cylinder and 5-inch stroke for years, and do not see why I should change it to put in a fast running steel wind-mill. It did the work before the old mill wore out." It is quite the general belief that it is easier to elevate water 50 or 100 feet through one inch pipe than through 1½-inch pipe. The fact is not taken into consideration that while the weight of water in the 1½-inch pipe is 2¼ times as great as in the 1-inch pipe, still the water in the 1-inch pipe must be raised 2¼ times as fast, and by the increased speed there is more than six times as much friction.

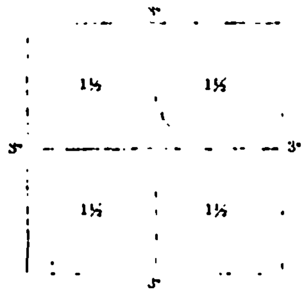


FIG. 1.

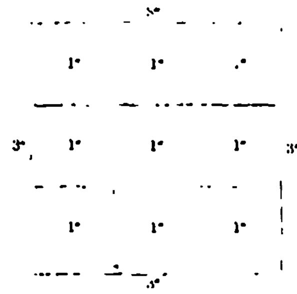


FIG. 2.

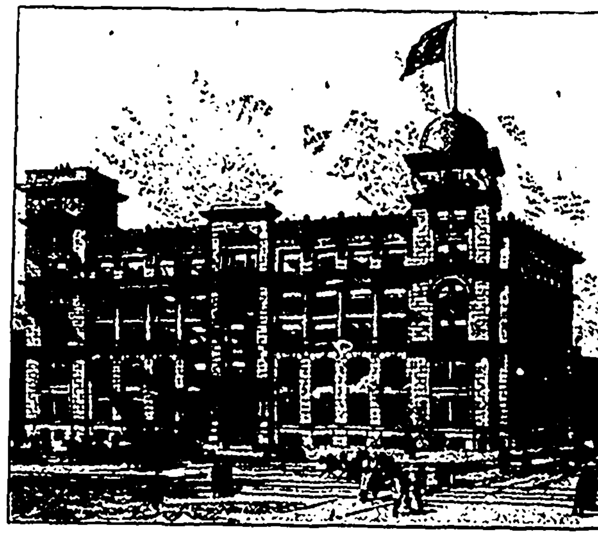
For the purpose of illustration, take a square cylinder and pipe, instead of round, the larger squares in the diagram representing the cylinder, and the proportions are between a 3-inch cylinder and 1½-inch pipe, as shown in Fig. 1, the area being four times the area of the pipe. Fig. 2 shows the proportion between a 3-inch cylinder and 1-inch pipe, the cylinder having nine times the area of the pipe. The same proportion exists between the cylinder and pipe of the usual form having corresponding diameters. As a consequence where 1-inch pipe is used with a 3-inch cylinder the water must rise in the pipe nine times as fast as it rises in the cylinder. When it is taken into consideration that an 8 foot steel wind-mill with 8-inch stroke at its maximum speed will travel 48 feet per minute, or on the down stroke 24 feet, it is plain that with a 3-inch single acting cylinder, with 8-inch stroke, and 1-inch pipe, the water in the pipe must travel 216 feet per minute. Taking into consideration the fact that friction increases according to the square of the velocity it will be seen that it is necessary to reduce the speed as far as possible by using larger pipe.

In comparing the proportionate speed in different sizes of pipe used in connection with 3-inch cylinder with 8-inch stroke, and the proportionate amount of friction in raising water 50 feet vertically with the same cylinder, it must be understood that this proportion is for a direct lift of only 50 feet—in forcing water long distances the friction in small pipes would be very much more. For instance where water is to be forced 2,000 feet horizontally to an elevation of 50 feet, using a 3-inch cylinder with 8-inch stroke and 1-inch discharge pipe, the least possible friction under the most favorable conditions with check valve and straight pipe, and a large air chamber, would require as much power as to raise water with the same cylinder and pipe vertically 193 feet. In actual practice the circumstances could not be found to reduce the friction to so small an amount if no air chamber is used or if it is insufficient, and there are several elbows or short turns in the pipe. The friction will amount to a lift of from 4 to 600 feet; by using 1½-inch pipe under the same conditions, the friction with everything in a satisfactory state would be reduced so that the total power required would equal a vertical head of about 72 feet, which is so reasonable an amount that it would not endanger the safety of the plant. The use of 3-inch pipe under the same conditions would be a barely noticeable change. I have repeatedly had such arguments as follows advanced: "I operate my pump by hand with ease, and it will not work as well with the wind-mill." This does not necessarily follow in operating by hand. The stroke is much slower and the power applied not as positive. If the pressure becomes too great the man will work more slowly and will often stop to rest. The wind-mill works right along and the stronger the wind the greater the pressure and the less possibility of checking the speed. Wind as a motive power for driving machinery and pumping water now occupies a large field, and the improvements recently made render the wind-mill more reliable, and in action less liable to damage by storms, as it is self-governing. These mills are used for pumping water, grinding, sawing wood, etc. They are most efficient in exposed situations, but they can be utilized anywhere if placed at an elevation where they can get the full force of the wind. It is necessary to have a storage reservoir capable of holding six or eight days' supply of water when they are relied on as the only source of water supply.

AUTOMOBILE PROGRESS.

The December developments in the matter of mechanical traction have been strikingly sensational. For the first time in the history of the horseless carriage enterprise in the United States the daily papers have had the opportunity of recording genuine transactions on a large scale; and these have been of such a nature as to discount the policy of ridicule which on the part of the English newspapers has retarded the progress of the enterprise in Britain. An American journal recently remarked that the motor carriage problem would find its solution in the United States, the common roads in that country being so atrociously bad that mechanical vehicles that were able to navigate them could go through anything. This is rather rough on the road-makers, though a compliment to the motor makers. Up to date the prediction has not been fulfilled; yet recent photographs of American rigs, run by both gasoline and electricity, show them successfully ploughing through mud, slush and snow during the recent storm in Boston, Chicago and New York, while it is notorious that the automobile cabs in New York stayed out on the streets when cab horses were unable to fight the elements, and street traffic generally was demoralized. The most notable development of the month, because it is undoubtedly genuine, and backed by ample capital, is the purchase of the Fifth avenue stage line in New York. This line has been in the hands of a receiver for some time, its manager being W. G. A. Hemming, formerly of Toronto. The 'busses, about 100 in number, were in a rather dilapidated condition; but under the new management the old equipment and hack horses will be cleared out and electrical omnibusses put on the avenue. There never was such a splendid opportunity for automobiles. Fifth avenue is asphalted for nine miles, has no grades exceeding 10 per cent., is the thoroughfare for the wealthiest New York people, and as The Electrical Engineer remarks, "the line should prove a howling success." The three purchasers of this old Stage Line are millionaires many times over, and represent a wealthy corporation—the Third Avenue Railroad Company—that intends to extend its franchise the entire length of the avenue, thus allowing transfers to the cable road on 125th street, and reaching also the Desbrosses street ferry. There is some talk of the new proprietors installing compressed air; but this is not likely in view of the fact that the company now runs a magnificent electric plant in connection with its street car system, and could thus charge the batteries for the auto-cars at a nominal cost. Prof. Louis Duncan of the Johns Hopkins University, Baltimore, is in conference with the new owners of this Fifth avenue line as to electrical installation. Joseph Leiter, jr., who made such a sensation a few months ago in the Chicago wheat pit, is exploiting compressed air for all it is worth—and a great deal more. He has got control of the foreign patents on the Knight-Hoadley system, and is asking for them the modest sum of $100,000,000. The English journals thus far are poking fun at him in all directions. In New York the compressed air system is reported to be having a boom in the form of "auto-trucks," which are to be run on the streets, and one enterprising journal gives an illustration of the new vehicle, which seems to be a cross between a traction engine and a street car. From the most reliable reports we can gather, the fact appears to be that President Vreeland, of the Metropolitan Traction Company, is going to give compressed air a trial. At present it stands about on a par, for traction purposes, with an enormously heavy battery, but lacking the long series of experiments and the mass of data which are available in connection with its heavy rival. In comparison with hydro-carbon propulsion, compressed air is nowhere, and we predict that it will never get a footing as a tractive power.

The month's news has been enlivened by "scare-heads" in the newspapers giving elaborate accounts of the movements of a lively French Count, named Jotemps, who, it appears, represents a European company that seeks to control the entire output of automobiles. This is a large contract indeed. The United States newspapers, which tell (on the authority of Mons. Jotemps), that the American motor patents are the only ones



NEW OFFICE BUILDING OF THE GRAND TRUNK RAILWAY SYSTEM, MONTREAL.

that are of any value, seem utterly oblivious of the fact that the Frenchmen have the lead of the Americans by some years, are pushing enlargement of their factories at tremendous speed, command unlimited capital, and have legislated a prohibitive duty on all imported motor vehicles. The newspaper report, however, is that the French Count has contracted with all the American auto-car manufacturers for a large number of automobiles per year for ten years, the total amount of his purchases running into fifteen millions of dollars! This is a good piece of news—almost too good to be true, in view of some facts which we happen to know. Here is one: Mr. Jenatzy, with his ordinary electric vehicle, with accumulators weighing 1,800 kilos. (say 4,000 lbs.), developed 28 horse-power in going up a steep hill on a wet day at a speed of nearly 30 kilometers an hour. Per contra: An American electric vehicle with battery weight over 1,400 lbs., going up only 10 per cent. grade, could not develop power sufficient to carry itself up empty, its total weight being only 2,700 lbs., and not an ounce of load except the driver! Yet the makers of this American vehicle claim to have sold the French Count five million dollars' worth of their vehicles. Until we have some corroboration from a reliable source, we must treat the French Count and his exploits as a romance.

In France the motor carriage industry is going rapidly. One firm alone—that of DeDion and Bonton—has orders on hand aggregating $600,000, and others being added daily. Of this total, $125,000 worth are from Germany. The factory is turning out each month a total of $100,000 worth, and enlargement of premises is being made so that 2,000 workmen will be employed, and the monthly output increased to $300,000. In England the London Electrical Cab Co., and the Motor Van and Wagon Co. have made reports to their shareholders, which are to a considerable extent satisfactory, but not indicative of the vivacity which characterizes the French makers. Mr. Pennington, the American inventor, whom The Canadian Engineer has paid some attention in past years, seems to be having the call in England now, orders for 376 of his gasolene motors having been received within the past few months. The report of the British commissioners for light railways shows quite a boom in electric tramways. Of the 54 applications during November, the motive power of 32 is electricity and 22 steam.

Joseph H. Leiter has secured control of the Rhode Island Locomotive Works, and the company capitalized at $7,000,000; will employ 1,200 hands day and night, and will make 50,000 trucks for New York and Brooklyn at $2,000, and 70.000 for London, whither Mr. Leiter goes in February to arrange for the consignment of output. It has been cabled from Europe that the municipal council of Stuttgart, Bavaria, has passed a law forbidding the use of horses for trucks or heavy freight wagons within the city limits, the automobiles having proven very successful. Even the farmers are interested in them.

PUBLIC OPINION.

Editor CANADIAN ENGINEER :

Sir.—I have received your card of the 19th inst. and have carefully and profitably noted your remarks regarding the elements of nature as well as those of the publishing business. I would add concerning the latter that there is another element quite as important, if not more so than the two you have mentioned—namely, brains, or what is perhaps synonymous with brains—enterprise. During the time I have been a reader of your excellent publication, The Canadian Engineer, I consider that you have furnished this most indispensable element. I, therefore feel it not only a duty but a pleasure to supply you with my portion of that other essential, which you have a right to expect from your subscribers, and accordingly enclose herewith postal note for $1 to renew my subscription for 1899.

Yours truly, F. R. WILFORD.

Iroquois, Ont., Dec. 20th, 1898.

SHERBROOKE GAS AND WATER CO.

The Sherbrooke Gas and Water Co. has recently started up its new water power equipment, and has found it very satisfactory in operation. The new plant was designed to largely augment the company's facilities for supplying electric light and power, there being an increasing business in sight, one contract, for example, being the electrical driving of the machinery in the new shops of the Quebec Central Railway at Newington, when completed. The construction and installation of the water power machinery as a whole was placed in the hands of the Jenckes Machine Co., Sherbrooke, and the finished work reveals an excellent example of progressive ideas and good workmanship. Two 40-in. Crocker turbines in horizontal setting are contained in one steel case, 10 feet in diameter, and over 20 feet in length, and are supplied with water under 31 feet head from the dam some 70 feet away, by two feeder pipes, 80 inches in diameter. Each wheel will develop 518 h.p. The whole wheel case and shafting is supported by steel girders and solid masonry. All bearings are of the self-oiling ring type, and the gate mechanism is operated from a suitable point in the dynamo room overhead. The main driving pulleys located at each end of the wheel case are 108 inches in diameter, 36 inches face. The weight of the entire plant is about 125,000 lbs. Taken altogether, the starting up of this plant marks an important point in Sherbrooke's industrial history, and emphasizes the ability and energy of both of the companies concerned, the one in promptly keeping pace with a growing business, and the other in furnishing the necessary means to this in the shape of an equipment so thoroughly constructed and fully in line with the latest practice.

THE YUKON GOLD DEPOSITS.

The Department of the Interior has received from the Geological Survey a preliminary note on the gold deposits and conditions of mining in the Klondyke region by R. G. McConnell and J. B. Tyrrell of the survey staff. They say that the productive part of the Klondyke gold district as at present known covers an area of 1,000 square miles, and is situated between the Klondyke and Indian River tributaries of the Yukon, and east of the latter river. The approximate area of 1,000 square miles of the known gold fields refers to the district traversed by the gold-bearing creeks, and not to the actual area of pay gravels. The latter are confined to the bottoms of a few of the valleys and the lower slopes of the adjoining ridges, and occupy a much smaller area. The gold occurs in the gravels flooring the bottom of the valleys, in stream terraces lining the lower slopes of the valleys, and in a remarkable moraine or glacial deposit which forms a southern slope of El Dorado and Bonanza Creeks for some miles and which was also found north of the latter creek for some distance above its junction with El Dorado. The stream gravels have a thickness of two to eight feet, and a width along the most productive portions of El Dorado and Bonanza Creeks of from 100 to 400 feet. They extend across the valley bottoms and increase in width with the gradual enlargement of the latter towards their mouths. The gravels are everywhere more or less auriferous, but the concentration is irregular and the gold increases in quantity towards the bottom of the section. The greater part of the pay is usually found within a foot and a half or two feet of bed rock. A considerable portion of gold is also found in the soft decomposed and shattered country rock, on which the gravels rest, into which it has sunk often to a depth of two feet. The bench gravels are of less importance than the stream gravels, and, so far, are only worked to a considerable extent along Bonanza and along the lower part of El Dorado Creek. The benches only occur at intervals along the sides of the valley, and, as a rule, are rock-cut and not built up by stream deposits. They are found at varying heights, up to an elevation of 75 feet or more above the bottom of the valley. The gravels are mixed with sand and consist of flat and sub-angular pebbles of schist, often a foot or more across, and rounder than quartz pebbles. The gold is fine, but nuggets up to a value of $1.35 are reported to be found. The average yield of the bench gravels is stated to vary from five cents to twenty cents to a pan.

Discussing the probable sources of placer gold, Messrs. McConnell and Tyrrell say that the gold in its original habitat has beyond doubt been associated with quartz, for many masses of gold-bearing quartz have been found and many of the nuggets of gold contain particles of quartz. Whether the gold is chiefly derived from the heavy veins or from the narrow stringers has not yet been determined, but it is probable that in places both are auriferous. They found gold in a thick quartz vein north of El Dorado Creek, but as the abundance or scarcity of placer gold did not appear to depend on the size or number of these heavy veins, it is probable that the precious metal has been chiefly derived from the narrow stringers or leaves of quartz interbedded in the schist. The great ice sheet of the glacial period, which covered much of British Columbia, did not reach as far north as the Klondyke district, so that ever since the land was elevated above the sea, perhaps in the Miocene or Pliocene epoch, it has been cut down by atmospheric and stream agencies into deep valleys and rounded hills, the surfaces of which are covered by varying thicknesses of decomposed rock. There is no doubt that much of this decomposed rock in the Klondyke area contains a small amount of gold, and by constant washing for ages much of this has become concentrated in the beds of the streams. Nor can it be doubted that the work of concentration has been greatly expedited by small local glaciers, which at a period not very remote, have originated at the heads of these creeks and have filled the bottoms of the valleys through part, at least, of their lengths. The higher so-called benches have been formed either as lateral moraines along the sides of the glacier or by streams which flowed between the side of the glacier and the bounding slope of the valley. The great richness of the Klondyke placer ground depends, therefore, first, on the presence of a highly gold-bearing rock, and, secondly, on the occurrence of a set of conditions peculiarly favorable to the concentration of the precious metal.

—Wireless Telegraphy Across Paris is a recent article by Ducretet. He describes experiments in transmitting messages from the Eiffel Tower to the Pantheon, a distance of 2.5 miles; the direct view is interfered with by many aerial structures. The results obtained were perfectly clear, even in a thick fog. The signals could be read by their sound with great ease, or could be recorded, but no results were obtained in endeavoring to transmit in the reverse direction from the Pantheon to the Eiffel Tower, owing to the mass of metal in the latter.

A GREAT WATER POWER CENTRE.

If the 19th century may be called the American age, because it is that of steam, in which our southern neighbors have distinguished themselves, the 20th century bids fair to be styled the Canadian age, because that of cheap electricity, which can only be generated through cheap power. Nothing is cheaper than nature, and this Canada of ours is the most watered portion of the continent. Our attention has lately been drawn to a section of the Dominion which seems to have been richly endowed by nature in the shape of water power. We mean Northern Quebec, where streams of immense volume come down the slopes of the Laurentian mountains. U. Barthe, secretary of the Quebec Bridge Co., has devoted much time to a personal inspection of the larger waterfalls of his district, and has communicated to us a summary of the information thus collected, which may interest not only the engineering profession, but also the capitalists of this country, in view of the cheap production of wood, pulp and paper, calcium carbide, and also the use of storage batteries. The city of Quebec itself is surrounded by a remarkable water power system, the principal instances of which are: The Montmorency Falls, the property of, and operated by, the Quebec, Montmorenci & Charlevoix Railway Co., nine miles below the city, minimum power in lowest water with present plant, 5,000 h.p. with a head of 250 feet. They actually run the city electric light and power, the city electric railway, and the two factories of the Montmorenci Cotton Mfg. Co., and the Riverside Manufacturing Co., and will next summer operate the railway to Ste. Anne de Beaupre, which, with the city system, will make over 60 miles of railway. The Chaudiere Falls, six miles above the city on the south shore; property of the Canadian Electric Light Co., now preparing to develop them, minimum summer capacity estimated at over 5,000 h.p.; head, 110 feet. The Grand Falls of St. Ann, 24 miles below the city, also the property of the Canadian Electric Light Co., estimated to develop regularly about 7,000 h.p., head, 190 feet. Four or five miles above the Grand Falls, and on the same river, St. Ann, are the beautiful Seven Falls, already mentioned in this paper, total head, over 500 feet. The Valcartier Falls, on the Quebec & Lake St. John Railway, 20 miles northwest from the city, at present in course of development by the Jacques Cartier River Power Co., under contract with Ross, Barry & Co., of Toronto, estimated capacity at least 5,000 h.p. The St. Maurice water power system, actually operated or about to be developed, consists of the Grande Mere Falls, 10,000 h.p., operated by the Laurentide Pulp and Lumber Co., the Shawinigan Falls, where the Shawinigan Water & Power Co. has let a contract of $250,000 to Ross, Barry & Co. for a first development of 30,000 h p., with possible increase to 150,000, the Gres Falls, which will be utilized as soon as the Great Northern track reaches them. This railway will then strike the Maskinonge river, where very powerful falls also exist. In the Lake St. John and Saguenay region are several waterfalls of first magnitude, viz., the Ouatchouan Falls, height 225 feet; the Metabetchouan, the Ashuapmouchouan, the Mistassini and the Peribonka Falls, all flowing into Lake St. John, and now of easy access by rail and boat; the Grand Discharge and the Saguenay Rapids between the lake and the town of Chicoutimi; and last but not least, the 10,000 h.p falls of Chicoutimi river, already operated by the Chicoutimi Pulp Co. Other large waterfalls are reported to exist on both rivers, Manitou and Marguerite, on the North shore of the St. Lawrence below the Saguenay, one of which of an estimated capacity of 100,000 h.p., is to be worked up, it is said, by Geo. Taylor, Toronto. A careful estimate, generally considered very conservative, and limited to the dry season minimum, and to the points now accessible by rail or water, puts down at 250,000 h.p. the amount of water power available in that part of the country, of which only a very small portion is now being developed.

GRANDE MERE.

The plant of the Laurentide Pulp & Lumber Co. at Grande Mere, as seen a few weeks ago before the opening of the paper mills, comprised a high grade masonry dam, with .5-foot feeder pipes connected with 14-foot water wheels in the paper mills, a large stone-built pulp mill; a saw mill; a massive group of brick buildings, consisting of a 215x60 foot screen house, a 210x60 foot beater house, annexed at right angles to the paper mills installed in two parallel two-story galleries of an equal size of 200x70 feet, the paper machinery proper being Pusey & Jones machines, of Wilmington, Del., and the finishing and packing room, 170x60 feet; the acid tower, 40 feet square and 146 feet high, built on the edge of the hill, and containing nine vertical tubes of 3 feet diameter for preparing lime; the sulphur house, 160x25 feet; the filter house, 50x80 feet; the digester house, 90x70, besides the company's stores and offices, the machine shops, water reservoirs, rail elevators, coal slides, steam log drivers, freight sheds, etc. All the buildings, save the acid tower, are lighted by electricity, and are fire-proof, with arched brick floors and slate roofings. The Sturtevant heating system is exclusively used in the paper mills. Provision has been made as to space and power for future enlargement of the mills. During construction, the number of men employed has reached 1,400. The mills in operation will employ an average of 800 to 900 hands. A little town has grown on the adjacent hill around the mills; the population is now estimated at 2,500. The daily capacity of the Grande Mere mills is 40 tons news print, 100 tons dry pulp, 35 tons cardboard, and 50 tons sulphite pulp, and their daily consumption is given at 50 tons coal, 10 tons limestone, 15 tons general goods and 200 cords of wood. Grande Mere is a station of the Great Northern, giving direct connection with Quebec; to reach Grande Mere, the trains cross the St. Maurice on a beautiful cantilever bridge, about a mile below the Falls. Connection is made at Garneau Junction with the C.P.R. on Three Rivers.

PROPOSED DEVELOPMENT OF SHAWINIGAN FALLS.

The plan designed by T. Pringle & Son, civil engineers, Montreal, and on which a contract has been signed with Ross, Barry & Co., specifies the immediate development of 30,000 h.p., which may be hereafter increased to 150,000. The work is described as follows. Truss, boom and cribwork across the river, a little distance above the Falls, such boom of sufficient depth and at such angle as to deflect all floating ice debris over the Falls. Head race or inlet canal from truss boom in westerly direction, said canal to be 1,100 feet long, width varying from 100 to 400 feet at the entrance, excavated to such a depth as to contain in all seasons not less than 16 feet of water, with a speed inland of two feet a second for the 30,000 h p. development. Banks of head race to be protected where too low with cribwork piers, dry stone walls and filling embankments Bulkhead or dam of high grade concrete masonry, and fitted with suitable racks and steel inlet gates for feeder pipes, said bulkhead to be carried well up above the flood level. As to feeder pipes, first development contemplates installation of three large pipes of 13 foot diameter each, and one smaller pipe 4 feet diameter for operating compressors and exciters, the large ones having each a capacity of 10,000 h.p., and the latter about 6,000 h.p., all pipes supported at suitable intervals by heavy masonry saddles built in cement mortar Distance between bulkhead and power house about 500 feet. The power house foundations are built up with massive bed of concrete masonry, arched for feeder pipes, tail race, etc. Power units in first development consist of two turbines on horizontal shaft, direct connected to 5,000 h.p. generators of modern design. Two of the power units to be supplied from each feeder pipe; 120 feet is the nominal head under which turbines will operate. Provision is made for heavy valves between feeder pipes and water-wheel cases, and it is contemplated that all valves will be controlled either by pneumatic or hydraulic pressure. All feeder pipes will be provided with suitable air cushions and relief valves to take up any possible water hammer. Power house building to be a substantial steel frame building, filled in with brick and equipped with suitable traveling cranes to handle all the heavy apparatus. From power house into lower bay the plan provides for a tail race of sufficient capacity, the sides of which will be protected with rip rap masonry. The whole work to be of a most substantial and permanent character and design. The head race bottom, foundations of bulkhead, supports of feed pipes and powerhouse foundations to rest on solid rock. The future extension contemplated may consist of widening the inlet canal on one side inland, and extending bulkhead and power house in the same direction, and further extension can still be made by constructing bulkheads in upper bay carrying feeder pipes at different points and discharging in lower basin or in the mouth of Shawinigan river.

OTTAWA SHIP CANAL.

Editor CANADIAN ENGINEER.

It may be news to some of your younger readers that a survey of the Ottawa for a ship canal was made in 1855; and work upon it, near Arnprior, performed in 1858. The canal was located (for a political effect) on the Quebec side of the Rapides des Chats, but the rock proved so very hard and tough that little was effected at the time. The site for a canal is an ideal one, being almost an air line from the Straits of Mackinac to Montreal, the water supply is quite sufficient, except on the watershed between the French and Ottawa waters, near North Bay; while the general character is that of a series of lake-like expanses, separated by narrow ridges of rock, causing rapids. Thus French River, forming 80 miles of the route, needs only one lock, with a lift of 5 feet in the first 30 miles; and two 10 feet lifts bring us to the only cataract of 25 feet in a hundred yards, about ten miles from Lake Nipissing, which affords 20 miles more of free navigation about 18 feet deep. From North Bay to Trout Lake (emptying into the Ottawa), is 4 miles, with a rise of 19 feet, along a small river, affording a canoe route with a very short portage over a low flat rock. The descent of the Mattawa is the most difficult portion of the whole route, nearly all the cuttings being in Laurentian rock, and the rapids frequent. The water for lockage, too, might be scant for a ship canal. From Mattawa village to Pembroke, the bed of the Ottawa is generally a swift current, with frequent rapids, calling for a number of locks, but a few large dams may alter this portion materially for the better. From Pembroke to Ottawa city the greater part of the way consists of lakes separated by ridges of rock forming at Fitzroy Harbor a semi-circle of cascades nearly three miles in extent, with a fall of about 30 feet. The capacity of such a location for the development of power is almost beyond computation. Between the mouth of French River and Ottawa city probably a million horse-power might be developed and utilized, and thus give birth to a chain of manufacturing towns, similar to what has grown up along the Welland canal. Indeed, when the climate, minerals and timber are considered, with the shorter route to European markets, the advantage is decidedly in favor of the Ottawa canal system. Thus much in favor. On the other hand, it will cost a good deal to ensure a constant channel through Lake Nipissing, whose bottom consists of laurentian gneiss, overlaid with shifting sands, and subject to frequent gales. The long swift current between Mattawa and Les Alumettes Lake will be costly to deepen and regulate, while the rafts of timber will claim right of way for many years and impede navigation to some extent. The length of the season free from ice will be seriously curtailed in the vicinity of Mattawa, its most northerly angle. As a native of the Upper Ottawa, and long familiar with French River valley. I will earnestly hope that such a Klondyke of undeveloped possibilities—commercial, manufacturing, mining and agricultural—may yet prove Canada's brightest diadem.

THOMAS FROOD.

LITERARY NOTES.

The Niagara Falls, Ont., Record issued a special Christmas number this year of 20 pages, which is profusely illustrated, and also contains a history of the neighborhood, which is very interesting.

We have received a copy of the President's address for 1898, of the American Society of Mechanical Engineers, being a reprint of part of Vol. XX. of the published Transactions of the Society. Chas. Wallace Hunt, the president, discusses the subject, "The Engineer; his work, his ethics, his pleasures."

Theatre Sanitation, by Wm. Paul Gerhard, C.E., is an interesting pamphlet which contains the paper read at the meeting of the American Public Health Association at Ottawa, and is reprinted from The Sanitarian for December, 1898. Therein the theory and practice of theatre sanitation is taken up under the following heads: Drainage, plumbing, water supply, ventilation, lighting, general sanitation. Mr. Gerhard is also the author of a very interesting work of 500 pages, entitled Sanitary Engineering of Buildings; published by Wm. T. Comstock, 23 Warren street, New York, N.Y.

We have received a number of very handsome calendars for 1899, among others from the Boiler Inspection and Insurance Co., Toronto; the B. Greening Wire Co., Hamilton, Ont.; John Bertram & Sons, the Canada Tool Works, Dundas, Ont., A. F. Bury Austin, lumber and timber, Montreal

The Dodge Mnfg. Co., Limited, York street, Toronto, has sent us a copy of the 100 page catalogue which is issued from the office of the Dodge Mnfg. Co., Mishawaka, Ind., U.S. The catalogue is very finely illustrated with a large number of photo-engravings, which show the various applications which may be made of the rope method of transmitting power.

We have received a pamphlet of some 20 pages containing a graphical method for constructing the catenary, with exact drawing board constructions for all cases of the problem of plotting the curve of a flexible cord of uniform weight; including a review of notable properties of the curve with their graphical representations, by Walter K. Palmer, M.E., School of University of Kansas, Lawrence.

The Intelligencer, Belleville, Ont., has issued an almanac of some seventy pages, which contains all the information usually found in a volume of this kind In the space usually occupied by jokes, The Intelligencer almanac has printed copious extracts from its own editorial columns, and those of its leading contemporaries, under such headings as, "The Political History of 1898," "General Postal Regulations," "The Public Debt," "The Preferential Trade Failure."

The Philadelphia Museum is a national and international bureau of commerce, with large libraries of foreign government documents, with a public journal room containing over eleven hundred journals, and with an immense museum drawn from every country in the world. The periodicals are constantly referred to by persons in search of specific information. The Canadian Engineer is always to be found in the reading room The Philadelphia Commercial Museum has recently issued a pamphlet stating the objects of the museum and giving a list of its officers.

Walter K. Palmer M.E., School of Engineering, University of Kansas, Lawrence, has published "The Designing of Cone Pulleys; a non-approximate graphical solution for the problem of proportioning cone pulleys," with concise practical rules. The following are among some of the heads under which the discussion falls. General Analysis, Case I., Open Belts; Case II., Crossed Belts, Comparison of Existing Methods; the Reuleaux Analysis, the Final Diagram, Analysis for Crossed Belts, Rules for Proportioning the Steps of Cone Pulleys, Special Rules for Small Three-Step Cones.

The January number of The Canadian Magazine contains an article of great interest on "Great Britain vs. United States." by R. E. Kingsford. This is a thoughtful and well-considered attempt to throw light on the present craze in England for an alliance with the United States, and its bearing on Canada. The continuation of Johanna E. Wood's story "A Daughter of Witches," sustains the interest of the reader. The only flaw in the number is a mass of biographical details of second-rate actors, who were not, thank goodness, born in Canada. Such matter should be found only in ten-cent magazines.

NEWFOUNDLAND NOTES.

Some time ago J. S. McLennan, treasurer of the Dominion Coal Co., proceeded to Newfoundland to look into some iron deposits owned by his company, as well as to examine the large iron deposits at Belle Island, owned and worked by Graham Fraser and others for the Ferrona Company, of Pictou. A Newfoundland informant states that Mr. McLennan has succeeded in purchasing the Ferrona areas, as well as several other smaller areas north. Mr. McLennan has also made arrangements for the mining, next season, of 2,000 tons per week of the ore.

The St. Johns Herald stated recently that another great discovery of copper has been made in Green Bay, samples of which, on analysis, were found to yield 43 per cent. of the mineral. In evidence of the splendid position of Newfoundland copper in the British markets at present, we may quote the following extract from The London Financial Times, of Nov 9: The SS. "Regulus" arrived at Swansea on Monday from Little

Bay with the first cargo of copper ore raised in Newfoundland by the company. The consignment has been sold by Messrs. Henry Bath & Son at the top price of the day. Another cargo, which will be loaded as soon as the open water permits, is expected shortly.

Hon. Capt. Kean and H. D. Reid have returned from Glasgow, where they arranged for the building of the fleet of seven steamers called for by the Coastal mail service which forms a feature of the Reid contract. The steamers are being built with a view to the future development of the services and not to the existing conditions. They are all to be finished exactly like the "Bruce," both in their structure and interior fittings. They will be specially fortified to resist ice; they will have the very latest devices in machinery, their equipment will include electric search-lights, etc.

BRITISH SEWAGE COMMISSION.

In reply to enquiries by The Canadian Engineer regarding the issue of the report of the Royal Commission on Sewage Disposal, now sitting in England, a note from Lord Iddesleigh sets right some misconceptions on the subject. His Lordship, who is chairman of the commission, says: "It has been brought to the notice of the Royal Commission on Sewage Disposal that there is a tendency on the part of some manufacturers and local authorities to postpone the carrying out of woks for the purification of trade refuse and sewage until the Commission have issued their report, and I, therefore, think it desirable to state that a considerable time, perhaps even some years, must elapse before the Commission can arrive at any final conclusions on a subject which necessarily involves detailed and prolonged scientific investigation. Any such postponement would be viewed by the Commission with the gravest concern."

FIRES OF THE MONTH.

Dec. 8th. Northern Pacific and Manitoba Railway coal sheds, Belmont, Man——Dec 17th Ontario Wind Engine & Pump Co.'s works, Toronto; damage, $3,000; fully insured.——Dec. 17th. The Toronto & Hamilton Sewer Pipe Co.'s Works, Hamilton, Ont.; damage, $35,000; insurance, $25,000. Dec. 21st. S. Greenshields & Co.'s dry goods warehouse, Montreal; loss on it and adjoining properties almost $1,000,000.——Dec. 20th. The Gardner Tool Co.'s premises, Sherbrooke, Que.; damage about $25,000.——Jan. 2nd. Toronto Rubber Shoe Manufacturing Co.'s factory at Port Dalhousie, Ont.; damages between $75,000 and $100,000.——Jan. 5th Louis Brousseau's gas and electric lighting plant, St. Hyacinthe, Que ; damages about $10,000; partly insured.

THE DEPARTMENT OF CHEMISTRY, MCGILL UNIVERSITY.

The magnificent building devoted to chemistry and mining in McGill University, whose equipment has just been completed through the generosity of W. C. McDonald, whose gifts to the University have been so large and bestowed with such a wise discretion that McGill has been left in many directions with nothing to wish for. The portion of the building devoted to mining and metallurgy was described in The Canadian Engineer for June, 1898. The chemical department was opened with imposing ceremonies by Lord Strathcona and Mount Royal, Dec. 20th.

The chemistry building is now largely equipped and all the work of the chemistry department is being done inside its walls. The equipment is already extensive, but it is far from being what its managers intend it shall eventually become. Four floors in the new building are occupied by the laboratories, museums, class-rooms, offices, etc., and a fifth story, lofty and spacious, is designed for store rooms. Every part of the building has its separate connection with the ventilating fans in the roof, for the purpose of ordinary ventilation and for the speedy removal of the poisonous gases, etc. Internally the walls are finished largely in pressed and enamelled brick, with a free use of tiling both for floors and walls. The frames of the stairways are of iron, in ornamental designs, with slate steps, making them fireproof. The floors are mainly of polished hardwood, and handsomely finished wood has been employed in the ceilings. Several colors of enamelled brick are used in the halls and on the stairways, giving very pretty effects in the borders. Perhaps the handsomest portions of the interior are the entrance hall, the library and reading-room, the ladies' room, the large lecture theatre, and the private rooms of the professors. The entrance hall has a handsome mosaic flooring, and walls partially covered with beautifully grained and colored stone.

The library, with its cosy alcove corner gives a pretty effect. The floor, ceiling and fixtures are of light-colored wood, highly polished, and the walls are of a deep, soft red color, with borders of a creamy yellow tint. The electric light fixtures are of brass; the design is a very handsome one. The steel beams of the ceiling are cased in beautifully grained spruce dividing the expanse into square panels, bordered exquisitely in wood. The ladies' room offers to the students of the Donalda department more luxurious accommodation than any other part of the university. Dr. Harrington's rooms, situated next to the library, are similar to that apartment in finish, and, like the library, are very well lighted. The lecture theatre has ceiling, floors, seats and fixtures of oiled wood, very light in color, and in the walls cream and white bricks are largely used, the whole giving a marvellously bright effect. High up on the walls in a border of ornamental brick and tile in separate panels, are recorded the names of the greatest chemists at different stages in the development of the science. This border runs around three sides of the room. Above the platform is inscribed the name of Geber, the most illustrious of the chemists of the alchemistic order, which was in its prime in the eighth century, when chemical experiments were carried on mainly for the discovery of methods of making precious metals and stones. Following this came the Iatrochemical period, when the science was in the hands of men who delved into its secrets with a view to finding medicines for the cure of diseases. Then came the period of the Flogiston theory, represented on the walls by the name of Stahl, one of the greatest exponents of that famous but unsupported belief. The name of Lavoisier, who struck the secret of combustion, marks the beginning of the modern period when chemistry began to be studied along the present broad lines. Lavoisier, by the way, was beheaded during the French revolution. Some of the names inscribed of the great chemists who have become famous since are, Davy, Dalton, Gay, Lussac, Faraday, Wohler, Liebig, Bunsen, Hoffman and Fresenius. A lantern is also included in the lecture room equipment as lantern slides are used to illustrate the lectures. The theatre will accommodate 250 students.

An enumeration of the rooms of the building gives some idea of the work which is carried on. Beginning at the bottom and omitting mention of the mining department's quarters at the rear, there is the sub-basement. Here are set up the furnaces for the heating of the building and a fan room from which fresh air is forced through many flues into every part of the building. A clever device has been used to heat this air. The exhaust steam from the engines in the engineering building is brought over and entering clusters of coils heats the fresh air as it enters the buildings. This action condenses the steam and the hot water resulting is automatically conveyed back into the boilers whence it came. On the next floor is the lower entrance to the lecture theatre and adjoining the theatre the rooms where are prepared the apparatus used in the lectures. On the same floor are the lavatories and locker room, the former of the most modern type, well tiled and commodious. All the rear portion of the ground floor is taken up by the elementary laboratory with places for eighty students. The accommodation for each one includes a sink, cupboard and drawers for apparatus and self-room for bottles containing the ordinary solutions used in the determination of the more easily handled elements. On the ground floor is the students' entrance to the lecture theatre and an entrance to the balcony of that apartment. There is also an instructor's room, a balance room, a room for water analysis or special research, the students' reading room, the janitor's office, the ladies' room already described, and a waiting room for visitors.

On the first floor is the laboratory for quantitative analysis. Here the advanced students are working; the apartment is as large as the elementary laboratory and will accommodate forty persons at work. Adjoining is a balance room, instructor's room, a lecture room and the electrolytic laboratory. In these days of electricity, electrolysis has become an important study, and it is gratifying to have a special place for the work with all the necessary apparatus of the newest design at hand. There is also a room for the analysis of iron and steel and a large apartment laid out as a museum of chemical products. In the front of the building are the library and Dr. Harrington's rooms. On the second floor are the large qualitative laboratories, with accommodation for sixty men, balance room, Mr. Evans' office and private laboratory, organic chemistry classroom, combustion room, a room for gas analysis, supply rooms and Dr. Walker's office and private laboratory.

The third floor includes an optical room for the study of crystals and rooms devoted to the study of physical chemistry, which department of late has attracted a good deal of attention. Dr. Adams' petrographical laboratory is also situated on this floor and everything necessary for the microscopic study of rock specimens provided. There is also a large museum for economic minerals, a lecture-room for mineralogy and a special room for blow-pipe determinative mineralogy, which we have already described. Here also are the photographic rooms, including two dark rooms on the maze principle, without doors. There are several fine cameras and an enlarging camera included in the outfit. The attic is by no means a rough, unfinished room. It is lofty with walls painted white and an oiled hardwood floor. Here also are the larger store-rooms, the ventilating fans run by an electric motor, and a large still for the production of distilled water; this machine is automatic in action, of large capacity and supplies distilled water to all the laboratories through tin pipes with tinned joints.

The apparatus of the chemistry department consists very largely in a large number of small implements and devices for particular uses, hard to describe to anyone but a chemist. Outside of this class some portions of the equipment are notable. Balances are provided in generous numbers in the balance rooms adjoining each of the laboratories. The more delicate of these enclosed in glass cases to prevent vibrations caused by currents of air, weigh accurately down to the tenths of a milligramme. The equipment for research in the department of physical chemistry is very complete, particularly such apparatus as is required for the chemical determination of molecular weights. The quantity of material used in lecture illustration is already very large, but further large shipments are now on their way from Europe. The photographic equipment includes lanterns for projection and a projection microscope, so that views of microscopic objects may be thrown upon the screen before a whole class. The set of platinum dishes and crucibles represents a very large amount of money, a bowl about three inches across costing $15[illegible] There are several hot air motors in the laboratories, and automatic devices for many purposes, such as maintaining a bath of uniform temperature for a year without any attention whatever. In every laboratory there are pipes connected with the large vacuum pump, so that vacuum is easily obtainable in a very short time. A perfect telephone system throughout every part of the building saves a great deal of time

METAL IMPORTS FROM GREAT BRITAIN.

Following are the sterling values of the imports of interest to the metal trades during November, 1897 and 1898, and the eleven months ending November, 1897 and 1898:—

	Month of November.		Eleven months ending November.	
	1897	1898.	1897.	1898.
Hardware	£5.224	£2.126	£63.817	£24.168
Cutlery	..	4.111	..	49.525
Pig iron	2,724	1,401	9.209	11,280
Bar, etc.	751	1.506	8.629	11,662
Railroad	11	64	45.789	25.218
Hoops, sheets, etc	6.562	10,847	77.823	63.229
Galvanized sheets	3.620	9.981	52,606	65.267
Tin plates	54.450	35.094	217 421	158.976
Cast, wrought, etc., iron	3,090	3.241	31.979	31,894
Old (for re-manufacture)	1,201	..	7.684	3.574
Steel	4.455	3.681	51.956	47.111
Lead	3.451	3,851	27.401	35.876
Tin, unwrought	2.386	1,862	17.369	17.269
Alkali	8.390	6,397	43.039	48.872
Cement	1,306	1,620	19.797	25.382

Industrial Notes.

Cranbrook, B.C., is to have a system of waterworks.

Orillia is to have a new high school to cost about $9,000.

The Aylmer Iron Works have built an extension to their foundry.

Hospital extension is contemplated in Brantford, at a cost of $5,000.

Work is to commence at once on the Ymir, B.C., waterworks.

W. A. Kribs, M.L.A. proposes to start a box factory at Hespeler, Ont.

H. & F. Giddings & Co., Granby, Que., have put in a large Leonard boiler.

M. Beatty & Sons, Welland, Ont., are now running their works by natural gas.

Merritton, Ont., has passed a by-law applying $6,000 to waterworks extension.

The new pulp mill at Mispec, N.B., will be ready for operation next March or April.

The Sydenham Glass Co., of Wallaceburg, Ont., has begun to manufacture flint glass.

A. W. Law is taking charge of the Facer Car Wheel Works, Perth, Ont.—Perth Expositor.

Adams, Burns & Co., of Bathurst, N.B., are looking into the prospects of a pulp mill there.

A new steel canal bridge, the full width of the street, will be built on Maria street, Ottawa.

Jno. Bertram & Sons, Dundas, Ont., are shipping largely to European markets this winter.

T. H. DeCew, Essex, Ont., is about to establish a large stave factory at Fenelon Falls, Ont.

The ratepayers of Belleville have passed the by law to bonus a carpet factory and rolling mill.

The Stayner, Ont., waterworks by-law has passed. The system is estimated to cost $24,000.

The Ottawa Steel Range Company, Ottawa, has offered to compromise at 50 cents on the dollar.

Dowling & Ottewell, Clover Bar, contemplate erecting a 100 barrel flour mill at Edmonton, Alta.

A canning establishment is proposed at Sussex, N.B., as a branch of the Woodstock, N.B., canning factory.

It is proposed at London to build a $75,000 breakwater to prevent flooding in the western part of the city.

The Imperial Oil Co. has bought out the Bushnell Co.'s refineries at Sarnia and will carry on its business.

A by-law to raise $12,000 to construct main sewers in Pembroke was carried January 1st by a majority of 27.

A system of waterworks is to be put in Cascade City, B C.

Secord Bros., machinists, are starting business in Winnipeg.

A new summer hotel to cost $40,000 is in contemplation at Danville, Que.; the land around the hotel is to be laid out as a park.

A large number of local companies are being organized in Ontario to manufacture peat fuel on the system recently patented.

A number of Canadian furniture manufacturers have orders from British houses and from firms in South Africa, Australia and India.

The foundry belonging to the estate of John Ledingham, St. John's Nfld., has been sold to Terra Nova Engine & Boiler Works, Limited.

The Sawyer-Massey Co. has decided to remain in Hamilton, and contemplates extending its agricultural implement works in the spring.

The Yule and Tate estates want $50,000 for the bridge over the Richelieu river at Chambly, Que., which after 50 years has reverted to the crown.

Rider & Kitchener, veneer and excelsior manufacturers, Brampton, Ont., are negotiating, with a view of establishing their plant in Lindsay, Ont.

The Nova Scotia Carriage Co. has ordered a 50-h.p. engine and boiler from the Robb Engineering Co., for the new factory it is building at Kentville, N.S.

The Carborundum Company are just finishing an addition to their Canadian branch, and it is expected will be calling for more power in the near future.

The Rand Drill Co. has accepted the $15,000 bonus offered by Sherbrooke, Que., and will remain in that town, and will erect large works in the early spring.

The Londonderry Iron Co. has gone into liquidation, and met its creditors January 5th. The order for liquidation was granted on petition of John L. Reay.

The representative of a woolen company has been in Brantford looking at the old Wincey mill as the possible site of a new woolen mill or knitting factory.

The Aptees Collapsible Box & Veneer Co., West River, Albert Co., N.B., have bought a 125-h.p. boiler from the Robb Engineering Co., Ltd., Amherst, N.S.

Judge Morgan, Toronto, has recently given a number of decisions against users of gas lamps, which has been decided as infringing the Auer Light Co.'s patents.

The Berlin Brush Works, recently burnt out, is being reorganized and located at Waterloo, Ont. The factory starts up this month with fifteen hands to begin on,

Grantham, Fisher & Co., Ltd., Yarmouth, N.S., are applying for incorporation to manufacture cordage. W. H. Avis, formerly of Toronto, is one of the promoters.

An evidence of the prosperity of Toronto is the subscription of $250,000 for the establishment of another paving brick company near Mimico. J. W. McBride is manager.

St. Catharines will offer inducements to the Toronto Rubber Co. to rebuild in that city the works recently destroyed at Port Dalhousie. Merritton is also after the works.

The power plant for the new butter factory at Cowansville, Que., has arrived, and is now being installed. The plant was furnished by the Jenckes Machine Co., Sherbrooke, Que.

Stratford will soon vote on a by-law granting a loan of $30,000 to the Whyte Pork Packing Co., a concern that promises to spend $50,000 in the erection of buildings, machinery, etc.

Alphonse Pallascio, dealer in hardware and house furnishings, Montreal, has assigned and filed his statement. The list of creditors includes 135 names and the total liabilities amount to $228,000.

The St. John's, Nfld. Gas Light Co., is remodeling its plant and doubling its capacity, which in the spring will be 125,000 cubic feet. Gas for fuel and power is now supplied there at $1.50 per thousand.

The Standard Drain Pipe Co., St. Johns, Que., has lately improved its facilities for handling raw stock by the installation of a Dake Hoisting Engine, from the Jenckes Machine Co., Sherbrooke, Que.

The John Gillies Estate Co., Carleton Place, Ont., has secured the patent on a new gas and gasoline engine for steam launches—a simple and economical power—and will put them on the market at once.

The town council of St. Lambert, Que., have considerable difficulty in deciding whether the waterworks have been installed according to contract. McConnell & Marion have reported against the work as done.

L. L. Sheldon, of Aylmer, Ont. has disposed of his interest in the Aylmer Iron Works to E. C. Jenkins, Springfield. The new firm will therefore consist of Henry Sheldon and Mr. Jenkins, who will at once add a lot of new and improved machinery.

The De Laval Manufacturing Company, with capital stock of $10,000, is asking for incorporation in Quebec for general trade in centrifugal machinery and other purposes. The applicants are: J. S. Clunie, W. Carey, C. W. Schnare, M. J. F. Quinn, Montreal, and F. J. Arend, New York.

A by-law to authorize the issue of debentures for the sum of $110,000 for the construction of waterworks and sewerage systems for the Town of Oshawa, is to be submitted to the ratepayers to vote upon on January 21.

An American syndicate has bought five acres of ground at Thorold, on which it is proposed to erect works for the manufacture of caustic soda and bleaching powder. It is reported the capacity of the works will be 100 tons per day.

The last car-load of old plates, bolts, etc., from the old Victoria tubular bridge was shipped to Hamilton, Ont., Dec. 15th, consigned to the Ontario foundry of that city. This completes a shipment of 477 car loads of this material.

The large boiler for the new mills of the Frontenac Milling Co., Kingston, have arrived from Sherbrooke, Que., and are being set in. The compound condensing engine is expected shortly, and the whole plant it is expected will be in operation early in 1899.

The Massachusetts Institute of Technology, Boston, has during the past year received gifts amounting to almost one million dollars. A travelling fellowship in Architectural Department has been established. There were 1,171 students in attendance during the year.

Sewrey's foundry, Barrie, Ont., which has been practically idle nearly three years, and has a capacity and machinery for eighty workmen, has passed into the possession of Dyment & Butterfield, who will manufacture engines, boilers, mill machinery, ploughs, and other farm implements.

George McAvity and G. G. Ruel, St. John; J. D. Chipman, St. Stephen; Hon. F. P. Thompson, Fredericton and Joshua Peters, of Moncton, are seeking incorporation as the New Brunswick Cold Storage Company, Limited; capital, $250,000; Rothesay is to be the chief place of business.

The Canada Screw Co., located at Hamilton, which was owned by the American Screw Co., of Providence, R.I., has been disposed of to a Canadian company, with C. A. Birge, the present manager, at the head. The concern has a capital stock of $5,000,000 and the business will be carried on as usual.

The Northey Mnfg. Co. has recently shipped a hydraulic mining pump, weighing 40,000 lbs., and having a capacity of 2,000 gallons per minute, to Ashcroft, B.C. It has also built a triplex power pump of 5,000,000 gallons capacity for the Montreal Water and Power Company. This is the largest pump of its kind ever made in America, and will be operated by a 450-h.p. motor.

A number of men are busy at the Standard Chemical Co.'s works, where Mr. Chute is rushing forward the completion of the new bench of retorts. There are fifty of these huge retorts in a row. Mr. Butler is arranging for laying down the railway tracks through the new sheds, and the old works have been practically rebuilt.—Deseronto Tribune.

Arnprior, Ont., has offered a Cleveland, Ohio, firm, manufacturers of tacks, nails, bolts and files, which are looking for some suitable place to locate outside of Cleveland, a free site, consisting of four acres lying south of the C.P.R. track and having as one of their boundaries the Madawaska river. An exemption from taxation would also probably be given.

Prof. Ruttan and Prof. Nicholson, of McGill University, Montreal, are making tests in connection with Emerson's process for the extraction of different products from sawdust and for the manufacture of calcium carbide therefrom. Prof. Ruttan is stated to have said that the machine is a success, but the products are new, and consequently it will take some time before he will be able to report as to their commercial value.

R. H. Buchanan & Co., Montreal, who represent the Blake & Knowles steam pump for Canada, have received the contract for the fire protection plant for the Protestant Insane Asylum at Verdun, Que. They have supplied the Montreal Rolling Mills Co. with one hydraulic steam pump; Linton & Co., boot and shoe manufacturers, a boiler feeder; a pumping plant to the St. Vincent de Paul Penitentiary. The suction pipe, 2,000 feet long, for the Merchants' Mnfg. Co., St. Henry, Que., was completed on the 14th Dec. Buchanan & Co. have put in the longest suction pipes in Canada and all are giving thorough satisfaction.

The Dominion Radiator Company, Dufferin street, Toronto, is selling its wares in all parts of the world. Among the notable buildings and institutions which are being warmed by radiators made by the Dominion Company are the Palace of Justice at Praetoria, South Africa; the Park Hospital at Lewisham, near London, England, an institution composed of 29 separate buildings and covering 56 acres; the Edinburgh County Hospital and the Imperial Board of Trade building, Berlin. The orders for some of these institutions were obtained in the face of the keenest United States competition. Royalty owes its comforts during cold weather to Canadian radiators in some instances at least, for the Dominion Company supplied the entire heating apparatus for the German Emperor's palace at Berlin, and for King Oscar's at Stockholm. The Old Parliament Buildings at Dublin were also entirely equipped with heating apparatus by this company.

The exploring party under Alex. Niven, P.L.S., left Haileybury, on Lake Temiscamingue, on 23rd of May last, to complete the survey of the boundary between Nipissing and Algoma. In 1896 the line was run north from the northeast angle of the township of Lumsden for a distance of 120 miles. During the past summer the boundary was further surveyed for a distance of 180 miles from the point where operations ceased two years ago to a point four miles north of Moose river, on James' Bay. Having successfully accomplished the work allotted to them, the party started on the 10th of October on the return journey by way of the Abitibi river and Abitibi lake and Lake Temiscamingue. Had the weather proved favorable, the journey, which is about 425 miles, would have been accomplished in six weeks. But severe weather set in earlier than was anticipated, and the water stretches began to freeze, rendering canoeing a difficult matter at first, and afterwards an impossibility. The consequence was that the explorers did not reach Bay de Pierre, on Lake Temiscamingue, which was practically the end of their journey until the 25th November, or a month and fourteen days after leaving Moose Factory.

Electric Flashes.

Prescott, Ont., has passed a by-law to raise $15,000 for a municipal electric light plant.

Vancouver, B.C., wishes to purchase the electric railway. It is stated the report is denied, however.

The Barrie Electric Light Co. difficulty has been settled by an agreement by which the town will acquire the works for $22,501.

The Packard Electric Co., Ltd., St. Catharines, Ont, has sent out a handsomely printed New Year's greeting to its friends and customers.

Thomas E. Hillman, engineer, Hamilton, has been instructed to survey two lines for an electric railway from that city to Guelph and Berlin.

The municipality of Chatham, Ont., intends to install a new dynamo for arc lighting. It runs the arc lights and the Chatham Gas Co. the incandescent.

The Robb Engineering Co., of Amherst, N.S., has received an order from New York parties for two 300-h.p. engines for an electric railway in Australia.

Wm. Stuart, Ottawa, has been awarded the contract for building the electric power house on the Soulanges canal. The amount is in the vicinity of $50,000.

It is stated that electrical iron smelting is being successfully carried on at Sault Ste. Marie. F. H. Clergue states that as yet there are no exact details available for publication.

By-laws relating to the establishment of electric lighting plants at Forest and at St. Thomas, Ont., have been defeated; Thorold has passed one to raise $5,000 to extend its plant.

The electric lighting plant recently sold to the corporation of the town of Campbellton, was started up for Christmas lighting. The driving power is water, and the electrical apparatus is of the Royal Electric Company's S.K.C. two-phase type for arc and incandescent lighting and power.

The Trail smelter is now run by power furnished by the West Kootenay Power & Light Co. from Bonnington Falls.

The large elevator of the J. G. King Company, of Port Arthur, Ont., is being lighted throughout by electricity, the entire plant being furnished by the Royal Electric Company of Montreal.

The Yarmouth Times says the Street Railway Company of that town intends making quite extensive improvements in their cars. New motors of the latest type have been ordered and will probably arrive shortly.

The Gurney-Tilden Co., Hamilton, Ont., is now operating its entire works by electric power. It has installed two 20-h.p., and one 30-h.p. S.K.C. two-phase motors, and gets the current from the Cataract Power Co.

The 60-k.w., S.K.C. generator of the Dundas Electric Co., has been placed in position. They expect to have their water power in operation in a few days, and will begin the lighting of the city by the 15th of January.

G. H. Carroll, J. F. Boultbee, A. N. Parney, E.E., Paris, Ont., and W. J. Clark, T. McLaughlin, Toronto, have been incorporated as the Grand River Electrical Power Co., Ltd.; capital, $95,000; chief place of business, Paris, Ont.

E. A. C. Pew is negotiating with capitalists to start manufactures at Jordan, and thus afford a market for the power to be developed by the raceway from the Welland river, which enterprise he has been promoting for some time past.

The Kingston News urges the municipalization of the gas and electric works of the city, and the appointment of a commission to find out what water powers are available within range of the city for increasing the city's electric power.

M. Letheule, an electrical engineer of Paris, France, was in Quebec recently. He was sent by the French Government to visit Canada and examine and report for French capitalists on the application of electricity for industrial purposes.

The Dominion Bridge Company, Montreal, has just completed the installation of an arc lighting system in its large works at Lachine, Que. The dynamo and arc lamps were manufactured by the W. A. Johnson Electric Company, Toronto.

The Cannington Echo reports that the newly formed Victoria Telephone Co. will apply for incorporation and erect poles in the spring. The first lines will run between Beaverton and Argyle, Cannington and Sutton, and from Oakwood to Lindsay.

The flour mill of Lake & Bailey, Hamilton, is being driven by a 75-h.p. S.K.C. synchronous motor, which has been in operation two weeks, and is giving perfect satisfaction. They have shut down their steam plant and hope they will not have to go back to it again.

The W. A. Johnson Electric Company is installing an alternating plant for the corporation of Acton, which includes 55 street lamps, and all wiring for the town. The generator will be one of the inductor type alternators, which are meeting with much success.

The B. Greening Wire Works, Hamilton, have installed in their works a 50-h.p. S.K.C. induction motor. This motor is driving on to the same shafting as their engine, and is working very satisfactorily. They intend to replace their steam power entirely with electric motors.

The proposal to extend the Scarboro Electric Railway to Whitby and Oshawa with a connection to the C.P.R. at Myrtle is again being agitated. The extension to Oshawa and Whitby was provided for in the original charter. The line is controlled by the Toronto Railway Co.

The Gendron Manufacturing Company has recently installed a direct connected 600 light generator for lighting its factory. The order was placed with the W. A. Johnson Electric Company for both the generator and the wiring of factory. A 10x10 engine manufactured by the Goldie & McCulloch Co., of Galt, Ont., will be used.

Hull, Que., will operate and control a civic lighting plant, the by-law authorizing the City Council to raise debentures for the plant having been carried. The work of putting up the poles and wires will be commenced immediately. The Ottawa Electric Light Co. will probably supply the current for lighting until the town has its own dynamos ready for operation.

Wm. McKenzie, Fred. Nicholls and other Canadian capitalists have been negotiating for the street railway franchise in Havana, Cuba.

Galt, Ont., voted down the by-law devoting $67,750 to the purchase of the gas and electric light plants from the private company operating them.

The Eagle Knitting Co., Hamilton, Ont., has installed in its factory a 30-h.p. S.K.C. two-phase induction motor, which drives their knitting machinery, and has replaced their steam plant.

The Montreal Street Railway Co. has, it is stated, decided to build all its own cars at its Hochelaga workshops, and will add brass and iron foundries to the present plant. Cars will also be built for the Toronto and other lines.

The directors of the Hamilton, Chedoke and Ancaster Electric Railway have decided to apply for an amended charter to build a line to Brantford, Ont., to change the name to the Hamilton, Ancaster and Brantford Electric Railway Company, and to increase the capital stock from $100,000 to $200,000.

The plant for the town of Norwood, Ont., recently installed by the W. A. Johnson Electric Company, is giving much satisfaction to the purchaser. The machine is of the single-phase inductor alternator type of machines, which the company claims are practically indestructible, and have the excellent advantage of a very low speed.

The Alliston Electric Light Co., Alliston, Ont., is making changes in its lighting station, and has decided on increasing its incandescent light capacity, and for this purpose has placed an order with the Royal Electric Co., for one of its 60 k.w. S.K.C. two-phase machines, from which it will serve both arc and incandescent lights as well as power, which has heretofore been served by two machines.

Beeton, Ont., recently decided to install an electric light plant and are now highly pleased with it. The plant was installed about two months ago, and since then the number of lights have increased to nearly the capacity of their present machine, which is one of the W. A. Johnson Electric Company's inductor type of alternator, which are claimed to be so suitable for a plant where a repair shop is not near by.

The Wallaceburg Electric Light Co., Wallaceburg, Ont., which has been supplying arc lights for the town of Wallaceburg for a number of years, has decided to go into the incandescent lighting business, and has placed an order with the Royal Electric Co., for a 30 k.w. alternator, and 900 light capacity in S.K.C. transformers and material. It expects to have the lights in operation by the first of the new year.

The Hamilton Electric Light & Power Co. is installing in its lighting station two 240 k.w., and one 350 k.w. S.K.C. synchronous motors. These are to drive the shafting from which is operated the arc machines and the motor power service. The current for these motors is to be supplied by the Cataract Power Co. It is expected that the steam plant will be entirely shut down by the first of February. The incandescent light has been furnished from the Cataract Power Co.'s current for the past three months, and has been very satisfactory.

We are advised that since the purchase by the Westinghouse Manufacturing Company, of Pittsburgh, of the Walker Company, the Canadian representatives of the latter company, W. A. Johnson Electric Company, of Toronto, will continue to represent the combined interests of those companies in Western Canada. The advantages of this arrangement are quite plain, as the Westinghouse Company manufactures a most complete line of apparatus for long distance power transmission, including A.C. D.C. generators, rotary transformers, induction and revolving field generators.

In referring to the fire at the Greenshields warehouse on Victoria Square, Montreal, The Witness stated that the fire gave proof of the underground system of the Lachine Rapids Company being superior to overhead mains. The poles carrying the lighting mains of this company were broken and fell to the ground, together with the Street Railway and other companies' wires, which lay in a mass on the ground, but notwithstanding this, the Lachine Rapids Hydraulic & Land Company were enabled to give every customer on their system light long before daylight, owing to the fact that they have an underground system. Before giving their customers light, broken wires and poles had to be replaced.

The Montreal Gazette recently stated that the Graburn and Blaney Canadian patent of the Graburn electrical thawing process has been sold by the inventor, Nelson Graburn, of Montreal, to the Electrical Thawing Syndicate, Ltd., London, Eng., for £7,000, and one-quarter interest in the company. The patent is intended to be used in countries like the Klondyke, where mining is carried on with the ground being frozen to a considerable depth. It provides for specially constructed dynamos and electrodes, the latter being placed against the walls of the shaft, with a space of from five to six feet of ground intervening; so that when the current is turned on, it has to cross the face of this space to complete the circuit and the ground contained therein, forming a resistance to the motion of the electricity, heat is generated and the ground thawed.

The Niagara Falls Power and Electric Company has won in the suit against the Niagara Falls Park Commissioners. The Park Commissioners claimed that the company had forfeited its charter because one clause, which said that by Nov. 1 it should have completed water connection for 25,000 horse-power and have ready for transmission 10,000 developed horse-power, had not been fulfilled. A series of questions were asked the Court of Common Pleas, and to-day the judgment of that court was: (1) That the agreement is not void by reason of the failure of the works by Nov. 1, 1898; (2) the Government or Commissioners may not, by reason of the non-generation of electricity by that date, declare the agreement void; (3) the Government and Commissioners are not relieved from the agreement not to grant any other company the right to take or use the waters of Niagara river.

W. A. Johnson, of the W. A. Johnson Electric Company, reports the recent sale of Westinghouse apparatus to the Metropolitan Railway Company, Toronto, for the extension of the present railway to Lake Simcoe. In the power house at Bond Lake will be installed two 60 cycle three-phase, A.C., D.C., generators, each of about 400 h.p., and a full complement of switchboard apparatus, step up transformers, lightning protection, etc., will be provided. The transmission voltage will be 16,-500. There will be two rotary transformers, 60 cycles, three-phase, giving 570 volts on direct current side, these will be located in sub-stations about 14 miles from the generating stations, step-down static transformers being provided to reduce the voltage to that suitable for the rotaries. The generator switchboard will consist of eight marble panels, the sub-station switchboards of five marble panels with non-arcing and tank lightning arresters. In addition to the above there will be passenger and freight car equipments, including one quadruple equipment for heavy freight car and double equipments for two light freight cars; two double equipment for ordinary passenger cars and two quadruple equipments for heavy passenger coaches; the motors being used in these will be 38 B 50 h.p. each. The sale includes one 45 ton Baldwin-Westinghouse electric locomotor.

Marine News.

A Government engineer is examining the breakwater at Richibucto. If trade warrants it the entrance to the harbor will be deepened to 19 or 20 feet on the bar.

P. C. Jones, Belleville, Ont., has ordered from the Davis Dry Dock Company, of Kingston, a 16 h.p. fore and aft compound engine for a new steam launch to be completed by April next.

It is proposed to organize a local company at St. John's, Que., to build a steamer of a speed of 15 miles per hour and a capacity for 450 passengers, as an excursion boat on the Richelieu river.

Nagle & Hislop, traders of Fort Resolution and Fort Rae, have purchased the steamer "Sparrow," now in winter quarters at Grand Rapids. They will take her below Smith rapids in the spring and will run her from Smith rapids to the Arctic Ocean. This is the best built of all the steamers put on the Athabasca last summer.—Edmonton Bulletin.

It is said that Carrier, Laine & Co., the well-known Levis foundry and machine men, have undertaken to supply Captain Bernier, the would-be discoverer of the North Pole, gratis with the aluminum boats needed.

The Calvin Company launched at Garden Island recently the largest steamer ever built thereon. She is named the "India," and is intended for the timber carrying trade between western lake ports and Garden Island.

At a meeting of the directors of the Richelieu & Ontario Navigation Co. it was decided to add another boat to the present Saguenay fleet, and that the steamer "Saguenay" should be renovated before the opening of navigation. She will be lighted by electricity, and, when finished, be equal both in speed and accommodation to any of the company's other boats. A boat will be run, commencing at the opening of navigation, every day, including Sunday. This decision on the part of the board will be received with general satisfaction, as it will permit business men who have their families staying at Murray Bay to spend Sunday with their families, and return to business on Monday. A hotel at Murray Bay, to cost $30,000 and accommodate 300 guests is in contemplation by the company. The new steamer "Toronto" has had her trial trip, and will be put on the Lake Ontario route in the spring.

Personal.

Jno. Fisher, president, Small & Fisher Co., Ltd., iron founders, Woodstock, N.B., is dead.

E. T. Wilkie, C.E., Carleton Place, Ont., was married recently to Miss K. Snedden, Almonte.

Alex. Bowie, Ottawa, who was well-known among the early navigators of the Ottawa river, died January 1st.

David Higgins, an employee of the St. Lawrence Foundry, Toronto, fell into a vat of boiling water recently and was fatally burned.

F. C. Armstrong, who went to London last year to take an important position with Dick, Ker & Co., has returned to Canada to be married.

C. H. Mitchell, town engineer, Niagara Falls, Ont., has returned from Potsdam, N.Y., where he has been engaged on extensive public works now going on in that city.

C. E. Moore, son of C. P. Moore, proprietor of the R. Spence & Co. file works, Hamilton Ont., died very suddenly at Ottawa, recently. He travelled for his father's firm.

Hugh Muckleston, a graduate of the Royal Military College, Kingston, Ont., now in Victoria, has been ordered by the Government to go to Alaska on a survey expedition

On Christmas Eve Raymond Smith, superintendent of the Sherbrooke, Que., street railway, was presented by the employees of the company with a fine gold ring as a token of esteem.

John H. Campbell, mining engineer, who has of late been working with the Virginia Gold Mining and Milling Company, of Arizona, has been engaged as mining engineer and superintendent of the Smuggler mine.

P. F. Hodgson, late chief signal engineer of the Grand Trunk, sailed on Jan. 8 for London on the Parisian from Halifax, and will look after the management of the Saxby & Farmer signal works at London, which appointment he received a month ago.

A. G. Allison, chief despatcher of the Grand Trunk at Toronto, has been dismissed on account of a recent accident to a freight train at Belleville. Mr. Allison has been forty years in the service, and is said to have been the oldest railway operator in America.

J. E. Muhlfeld, general foreman, motive power, machine and car departments of the Wabash, stationed at St. Thomas, Ont., has been appointed master mechanic of the western division of the Wabash, with headquarters at Fort Gratiot. He will be succeeded by F. Whitley, late of the Illinois Central.

Dr. S. A. Mitchell, son of John C. Mitchell, contractor, of Kingston, has been appointed research assistant at the Yerkes Observatory in connection with Chicago University. He is a graduate of Queen's College, where he secured the degree of M.A.; he also won the degree of Ph.D. at Johns Hopkins University, Baltimore.

The Quebec Telegraph says: Chevalier Chas. Baillairge, F.R.S.C., addressed a letter to Mayor Parent recently, tendering his resignation of the post which he has held so long as city engineer. Mr. Baillairge, who is 70 years old, and whose services to the city have merited the rest which he is now seeking, is the first city engineer, having been appointed to that post some thirty years ago under the mayoralty of Hon. Jos. Cauchon, subsequently Lieut.-Governor of Manitoba, previous to which he had held the position of city surveyor, succeeding Mr. Hamel.

Railway Matters.

The new Union station at Ottawa will cost about $130,000.

A company will, at the next session of Parliament seek incorporation with power to acquire and operate the Niagara Central Railway, and to extend it to Hamilton, Toronto, the Niagara River and Lake ([illegible]).

A handsomely illuminated address was last month presented to Charles M. Hays, general manager of the Grand Trunk, by the Brotherhood of Locomotive Firemen of America, in acknowledgement of courtesies received in connection with the last annual convention.

Orders have been placed with the Nova Scotia Steel Co. for 5,000 tons of steel rails for the I.C.R., weighing 80 pounds to the yard, which is 13 pounds heavier than that generally in use on the I.C.R.—New Glasgow Bulletin.

Jas. Hobson, the chief engineer of the Grand Trunk Railway, who was in charge of the reconstruction of the Victoria bridge, has received great praise for the eminent skill displayed in the manner in which the work was carried out under his direction. The fact that during the progress of the work, including the removal of the great tube, there was no delay of the business of the Grand Trunk, and that the trains passed over the bridge as usual, on schedule time, has been selected for special admiration, which has been expressed in the British engineering journals and elsewhere. Sir Charles Rivers-Wilson has recently, in England, drawn attention to this splendid piece of work, at the same time indicating that English engineering was behind so far as similar work and problems were concerned.

J. A. Macdonell, chief engineer of the Public Works Department of Manitoba, gives the following summary of railway extensions during the past year, and the proposed extensions of 1899: "The railroad mileage constructed this year is the Dauphin extension from Sifton, 55 miles, the Southeastern to Marchand, 46 miles, Rockwood extension on Stonewall branch, 20 miles, the Pipestone extension to the boundary of the province, 3 miles of track, and 17 miles of grading, Belmont-Hartney extension, 46½ miles, switch connection between N.P. and C.P.R., ¼ mile; making in all a total of 178¾ miles. The probable extensions of next year are: The C.P.R. Pipestone branch from the end of track at present, 50 miles to the Moose Mountains, the continuation from Toulon, the end of the present Rockwood branch to Gimli, on Lake Winnipeg, a distance approximately of 20 miles, extension of the Southwestern to the Lake of the Woods or Rainy river—if the former be chosen, 75 miles; if it be decided to go around the southwest corner of the Lake of the Woods to Rainy River, the length of construction will be in the neighborhood of 125 miles. If the season is favorable about 100 additional miles will be constructed on the Dauphin line, carrying it to the northern limit of the province, and beyond. The construction of the Belmont branch will be continued to Hartney or a point on the Souris river in that vicinity. Other extensions are also being considered by the Northern Pacific, the particular location of which it is not at present possible to indicate."

In an interview with a local journalist recently, J. M. Shanley, C.E., who has charge of the construction of the Atlantic and Lake Superior Railway along the Baie des Chaleurs route, is reported as giving some interesting details regarding the work now being done at the harbor of Paspebiac. The large wharf which is being built at this point by Heney and Smith, of Ottawa, will be, when completed, 1,800 feet in length and 80 feet in width, and will accommodate two steamships of the largest tonnage, besides smaller craft further landward. A large elevator, to have a capacity of 1,000,000 bushels, will be situated near the end of the wharf; this has already been contracted for. The steamers will be protected from all winds while lying in the harbor, where, according to Mr Shanley, the anchorage is of the best possible kind. Mr. Shanley also stated that what was known as the Baracho's Lagoons would be reclaimed, a work which could be done with but little trouble or expense, and the land in question used as a shunting ground Six hundred men are at work blasting the cliff which lies between New Carlisle and Paspebiac, and half of this work has already been accomplished. The railway, Mr. Shanley said, was in good condition and the stone work for the new bridge over the Big Bonaventure river was completed and awaiting the superstructure.

Mining Matters.

The Iron Mask Mining Co., Rossland, B.C, has ordered a ten-drill compressor plant.

Gold in Guysborough County is looking up. The mines at Goldenville are working all the time.

A company of Lunenburg, N.S., and Mahone Bay capitalists have been formed to work the rich gold find which has been made at New Cornwall.

A school of mining instruction has been opened at Kamloops, B.C., by A. J. Colquhoun, M.E., who is known in connection with the British Columbia School of Mines. The classes were started January 9th.

J. D. Chipman, who represents the English capitalists now in control of the St. Stephen, N.B., nickel properties, has received a cable message directing him to send forward twenty tons of the ore.—Fredericton Reporter.

The Glencoe Oil and Gas Company, of Glencoe, with a capital of $20,000, has been incorporated, the following being the provisional directors: Geo. Parrott, W. J. Small, S. H. Small, R. J. R. Aldred, A. E. Aldred and Geo. Hay.

The old iron mines at Woodstock, N.B., have been purchased by a Chicago firm, and a tramway will be built to the ore beds. As the ore is well suited for the manufacture of high grade steel, the industry may be a large and permanent one.

L. Sherk, Son & Co., of Hamilton, who are operating the Wallbridge Hematite mine, Hastings County, have contracted to supply 50 tons per day to the Hamilton smelter. The ore is said to be the best shipped to Hamilton, averaging as high as 62 per cent.

B. Kelly, of Ottawa, claims to have made a valuable discovery of gold-bearing quartz in the county of Lanark, about three miles from the Kingston and Pembroke railway. He has purchased the property. Assays taken, he says, far exceed anything known in Eastern Ontario.

The Dominion Coal Company is sending one of its most experienced engine drivers to South Africa to practically demonstrate that Cape Breton coal is excellent fuel for steam purposes. It may be remembered an experimental shipment was made there early in the autumn. There is said to be a large market for steam coal in Cape Colony.

The value of ore produced by the Rossland mines during the year just ended, reached the enormous aggregate total of $2,804,758.12. The shipments were 116,697 tons; for the year ending December 31, 1897, the shipments were 68,000 tons and the value of the ore mined was $2,100,000. In a single year the shipments from the mines were almost doubled, while the value of the output increased $700,000 or 33 per cent. The year has been remarkable for the influx of foreign capital, which absorbed some of the better Rossland properties. First in size comes the British American Corporation, with investments of nearly $5,000,000.

An innovation in treating free milling ore will, it is said, be made by the Oro Fino Mines Company, which has property at Fairview. After careful examination and reports received from some well known mining engineers, the board of directors has decided to put in one of the new Parks amalgamators. This will supersede the old plate method of saving and collecting the gold, and at the same time afford greater protection against stealing the amalgam. It is absolutely impossible to get at the amalgam, as one man, the superintendent, controls the whole machine. The Wm. Hamilton Company, of Peterboro, Ont., and the Parks claim to have effected a combination that will revolutionize the treatment of free milling ores.

Madoc village is the centre of active mining operations. The Review says. The Cordova mine in Belmont, ten miles northwest of Marmora, is being worked under option by a wealthy English syndicate. The mine was formerly owned by Carscallen and Lingham, and latterly by A. W. Carscallen, M.P., of Marmora. The mill of the Canadian Goldfields Company at Deloro will be running in a short time. Work is being prosecuted steadily at D. E. K. Stewart's "Diamond Mine." about six miles east of Madoc. A few weeks ago Meyer Brothers, representing wealthy Belgian capitalists, interested themselves in this mine, and under the direction of Leopold Meyer, mining engineer, of Brussels, Belgium, a three compartment shaft has been put in, building erected for boiler house, and machinery installed for hoisting the ore working steam drills, etc., and it is expected work will be pushed vigorously during the winter.

DISPUTED POINTS IN CONNECTION WITH THE CONSTRUCTION AND MAINTENANCE OF MACADAMIZED ROADS.

BY H. IRWIN, M. CAN. SOC. C. E.

The present paper was written in October, 1893, and was originally intended to be used as a private record of the opinions expressed by several members of the American Society of Civil Engineers during the course of a discussion on the subject before us, which may be found in the transactions of that Society for December, 1892, and February, 1893. The purpose of the paper is to compare the opinions of the engineers who took part in the discussion above alluded to, not so much with a view of bringing forward anything new, which would be almost impossible, but in order to ascertain how far the diverse opinions might be reconciled or accounted for by difference in the local conditions.

The principal points discussed are arranged under the following heads, viz.: 1. Grades. 2. Drainage. 3. Transverse section. 4. The necessity for using the Telford foundation and its construction. 5. The construction of macadamized roads without the Telford foundation. 6 Quality of stone, and the size of the macadam. 7. Blinding material and its usefulness. 8. Rolling—Whether by horse or steam rollers. 9. Repairs or maintenance. The writer proposes to take these up in the order given

First. Grades.—Mr. Owens states that any departure from an ideal grade of 1 per cent. is to a certain extent to be resisted, and that the minimum grade should never be less than ½ per cent. in order to secure proper longitudinal drainage; and that the maximum grade for ordinary country and general travel should be 4 per cent., which is the limit of an ordinary trotting gait. F. Crowell differs from Mr. Owen as to 1 per cent. being the ideal grade—and states that, in his opinion, if a uniform grade of 1 per cent. can be secured, without undue expense, it is preferable not to exceed it, but that where the road is undulating, with frequent reversions of grade, the horse will do equally well or even better with grades of 2 per cent. He also states that it is well known that horses as a rule travel better on a slightly hilly country than on a dead level. The other members who

*Extracted from a paper read before the Canadian Society of Civil Engineers joined in the discussion do not appear to have touched on this branch of the subject. The writer would venture to remark that both maximum and minimum grades might be made to suit the class of vehicles most likely to make the greatest use of the road to be constructed, and that the question of cost would have to be considered. In farming districts, where the large majority of the vehicles carry heavy loads and do not go faster than a walk, the maximum grade might well be raised to 5 per cent. and the extra cost of 4 per cent. grades either saved altogether or expended on the road surface. As to the minimum grade, water will flow so freely along a water-table or gutter with a fall of ½ per cent., that a similar grade might well be taken as minimum for long uniform stretches of road, short pieces of level being permitted to break grades or at summits. The fact that horses seem to travel better on undulating roads, where the grades are not over 2 per cent., than they would on the level is probably due to change in the muscles used in ascending and descending; this would apply, however, more to heavy than to light traffic, as a trotting horse, going at a good pace, would find a 2 per cent grade pretty hard, and would probably travel much easier on the level than on an undulating road, especially if allowed to walk a short distance occasionally. The writer would add that he has often heard drivers complain of a long uphill pull, even when the grade was light.

Secondly, Drainage.—Mr. Owen's opinion is that: "It is necessary at all times that proper and complete provision be made for thorough and perfect drainage of the water from the roadway; this, as well as the necessity of under-drainage in certain specified localities, either by pipes or blind drains, admits of no dispute, when the fact is remembered that one dollar spent judiciously in under drainage will save many dollars as a capitalized fund to meet the expense of repairing badly drained sections of the road." Latham Anderson, referring to the rainy and muddy part of the country east of Central Kansas, says that: "Given an earth road skillfully located, properly shaped for surface drainage, and with the roadbed thoroughly under drained with tile, say, to the depth of at least two feet, all that is necessary to make this a fairly good country road is to cover a strip in the middle, say 14 to 16 feet wide, with six inches of gravel or shale." Mr. Anderson also recommends the excavation of ample ditches, and using the earth thus obtained to raise the sub-grade above the surrounding ground and the construction of drains under the road surface in all clay or tenacious solid. J. E. Cooper states that: "Telford roads put together with loam and light rolling stand because the water, that will surely find its way through the metal, is drained away through the Telford," and that "the macadam roads put together in the same way will go to pieces because sub-drainage is not provided." W. C. Oastler on the other hand states that: "The suggestion that the earth sub-way being flattened instead of being an arc of a circle causes the drainage to be defective or insufficient is not correct in practice; that the stone road above the foundation will, if properly rolled, be practically water tight, and will preserve itself and the foundation against the inroads of water;" and also says "I do not believe it is worth time or money to make elaborate schemes for under-drainage of broken stone roads. Lateral drains, honey-combed foundations and other expenses for so-called drainage are wasteful excess and generally can be omitted." Messrs. Owen, Anderson and Cooper would thus seem to differ materially from Mr. Oastler as to drainage. On closer examination, however, the difference of opinion may be considerably reduced. All are agreed, of course, as to the necessity of surface drainage. With regard to under-drainage, Mr. Owen states that its necessity in certain specified localities, either by pipes or blind drains, admits of no dispute. Mr. Anderson's opinion evidently is that an earth road should be thoroughly under-drained with tile in order that it might be put into fairly good order with six inches of gravel or shale. Mr. Cooper seems to think that the Telford foundation will act as an under-drain, while Mr. Oastler saves himself from being too dogmatic by stating that lateral drains and honey-combed foundations can generally be omitted. Surely Mr. Owen's statement last referred to admits of no dispute, since under-drainage is an absolute necessity where there are springs under the road surface and in wet clayey soils where the side ditches will not drain the centre of the road-bed. Mr. Anderson's opinion as to earth roads might be modified by stating that in open gravelly soils the side ditches, when not too far apart, may be counted on to drain the road-bed. Mr. Cooper's idea that the Telford foundation will act as an under-drain may hold good for a year or two after the road has been constructed, but the writer does not think that it would hold good for any length of time, as he has never yet seen an old foundation dug up in which the spaces between the stones were not completely filled with earthy material, so that it could not possibly act as a drain. Indeed, even when the foundation was quite new, it is almost certain that the water, on passing through it, would soak into the earth below, unless some special provision were made to carry it off at the sides. Mr. Oastler's scheme for avoiding under-drainage altogether by keeping the surface well rolled would also involve constant repairs to prevent water standing in slight hollows, would probably be more expensive in the long run than under-drainage, and could only be carried out in rich districts. The writer's experience, though rather short, so far as actual practice goes, certainly goes to show that less depth of stone is required on a firm, well-drained road-bed. The approximate distance apart at which drains act might be given: In open gravelly soils, drains from three to four feet deep will act from twenty-five to thirty feet on each side; in such soils the side ditches will drain the road-bed perfectly if deep enough. Where the soil is marly loam, drains will act about twelve to fifteen feet on each side, in this case, unless the road surface is kept in good order so as to throw all rain water quickly into the side ditches, and unless the road-bed be originally dry, as on a side hill, or in embankment, a covered drain would be required along the centre. In stiff clay soils French drains can only be counted on for about eight or ten feet on each side, in which case, if the sub-soil be wet, V drains running from the centre of the road-bed diagonally to the sides may be needed. In making drains, it is well to remember that water will not flow through soil so nearly on a level as it will in an open channel. Drains, therefore, will only dry wedge shaped sections of ground, and the denser the soil the steeper will be the wedge. The subject of drainage might be closed by quoting Mr. Calvin Tomkins' remarks, viz.: "It is possible by making the road-bed sufficiently thick to ignore a wet bottom, but is cheaper to arrange for a dry base and place a thinner road on it. Drainage is of the first importance, but the cost of drains can be greatly modified by making the surface of the road as nearly water-tight as possible."

Thirdly.—The transverse section of the road-bed and of the foundation. Mr. Owen states that "it is agreed on all sides that the road-bed should be graded to a surface uniform with the finished roadway," and that his practice is to roll the road-bed when no foundation is used, but not to roll it previous to laying a Telford foundation, which he brings to a uniform surface by scooping out the earth below the deeper stones. Mr. Oastler does not agree with Mr. Owen as to grading the road-bed to a surface uniform with the finished road, and prefers to grade it level across; firstly, because it is cheaper, and, secondly, because it admits of using stones of different thickness, the larger stones being placed in the centre. Mr. Oastler also prefers to compact the road-bed by rolling, and does not agree with Mr. Owen's plan of laying the foundation, even by scooping out earth under the stones, as he does not think it necessary that the surface of the foundation should be quite even. Mr. Callanan stated that his practice was to grade the road-bed to a surface uniform with the finished roadway securing good lateral drainage. Thomas Codrington, formerly General Superintendent of Roads in South Wales, after stating that, since timber hauling and other heavy traffic generally takes the sides of a road, gives it as his opinion that it is usually better to form the road-bed with its surface either nearly or altogether parallel to the finished surfaces so as to have a uniform or almost uniform thickness of metalling. Mr. Codrington also states that this method of formation is attended with the advantage that a dry formation surface is prepared for the road materials.

The writer thinks, therefore, that it might be fairly concluded that where there is likely to be heavy traffic extending over the entire width of the road, the road-bed should be graded either exactly, or almost, parallel to the finished surface, and that this method of grading the road-bed will help to keep it dry during construction, but that it cannot be counted on for drainage purposes for any great time after the road has been finished; but that, in the case of roads for lighter traffic, which should of necessity be cheaper, the road-bed might be made flat, and the crowning of the finished surface obtained by making both the foundation and the macadam thinner towards the sides. As for the completed surface, in the district of which the writer had charge in Ireland, the usual rule was to raise the centre above the sides at the rate of one inch per yard of width from the centre to the side, the slope being steeper at the sides than in the centre. Mr. Owen states that for a sixteen-foot roadway, an average crowning of four inches is desirable, which is at the rate of one inch in two feet from the centre to side, or a grade of one in twenty-four. The other members who took part in the discussion did not question the statement. Mr. Codrington's opinion is that the fall from the centre to the sides need not be more than six inches on a thirty-foot road, or one in thirty from centre to side, and should never exceed nine inches or one in twenty; and that for a road eighteen or twenty feet wide three or four inches, or from one in thirty-six to one in thirty is enough. He also remarks that, if the surface be neglected and allowed to wear into ruts, no amount of convexity will clear the surface of water. This latter statement can be fully endorsed by the writer, who saw a gravel road last winter, about fourteen feet wide, in the centre of a sixty-six foot road allowance, and raised about two feet above the level of the water tables at the edges of the sidewalks, the water tables being quite dry, and yet the roadway, which was badly rutted, was full of water, and amost impassable. Had this road been well harrowed and rolled, it might have been kept in good condition. As there was no discussion on this subject, it might be taken for granted that on the level, or on easy grades, a fall of from one in thirty to one in thirty-six is sufficient, and that on hills the slope from the centre to the sides might be from one in twenty to one in thirty, and that it is useless to try to make higher crowning take the place of an even surface for transverse drainage

(To be continued).

—"The G. A. Robertson" catch basin and tap, described in our November issue, is already receiving substantial recognition of its merits, the Montreal Pipe Foundry Co. having had an order from the Corporation of Westmount, Que., for 50, which are now in position, and giving complete satisfaction.

—Owing to the increased demand in Canada for the Norton Ball-Bearing Jacks, A. O. Norton will enlarge his plant at Coaticook, Que., and equip it with special machinery. Export business will also be handled from this point, shipments having recently been made to Japan, South America, Hawaiian Islands and New Zealand.

—This primitive conveyance seems rather to mock the improvements of the age. A horse railroad, about a mile in length, accommodates the residents of a suburb of San Francisco. The grade is about 3½ per cent. A horse draws the car and passengers uphill, the car descends by its own gravity, and then carries the horse on the rear platform of the car. The ascent is made at the rate of 3½ miles an hour, the descent is at the average rate of 15 miles an hour.

—The Hamilton, Ont., Blast Furnace Company has decided to install a steel plant in connection with the blast furnace at once, and employment will be given to a large number of skilled workmen. When the blast furnace was proposed, the city passed a by-law granting a bonus of $65,000 and an additional sum of $60,000 was to be granted if the steel works were in operation within a certain time. The latter bonus lapsed, but the company does not intend to ask any further favor from the city.

—George Waring intends going to Quebec to erect and drive into the woods a novel machine for hauling logs on the snow by steam power. The machine is made in Michigan and is to be sent by rail to a station on the I.C.R. east of Levis, where Mr. Waring will put it together and drive it about seventy-five miles to its place of operation in the forest, on the head waters of the St. John river. George Cushing of St. John is the enterprising lumberman who is starting this new method of handling logs in the woods. The weight of the machine is upwards of twenty tons. It is said that several of these engines are operating about Winnipeg and in the western States. This new departure will be watched with interest.—St. John Sun

—It is probable that for the first time in our history the United States will this year be surpassed by Russia as a producer of petroleum. Reducing the totals to the common standand of metric tons, we prodlced in 1897 a total of 7,708,236 tons, while the quantity reported for Russia was *6,919,000 tons*. For the first half of the present year, however, according to Russian official figures quoted by The Chemiker Zeitung, the output was 3,993,300 metric tons, which points to a total for the year approximating 8,000,000 tons. The output of the United States for 1898 will not differ greatly from that of 1897; if anything it will be somewhat less, so that we may expect to fall to the second place.—The Engineering and Mining Journal.

—A burnished finish on the journals of axles for railway carriages and locomotives has given good service, and has been used on many roads for a long time, says The American Engineer. The advantage of it is to smooth the surface of the journal after the finishing cut, and to shorten the period of breaking in The burnishing is done by three rollers carried on a tool rest and bearing against the journal, considerable pressure being obtained by a screw. The rest is fed along so that the finishing cut and the burnishing are done at the same time. Mr. Atkinson, of the Canadian Pacific, uses the burnisher on piston rods, and intends to use it on valve rods, as well as on journals. He stated, at the recent Master Mechanics' Convention, that it gave the best finish that he knew of for piston rods.

—Although so recently brought to the notice of the South African public, the adoption of acetylene as an illuminant is making steady progress. It is recognized that there is a distinct field open for it in South Africa among the smaller towns, and in the suburban districts of larger towns where paraffin or candles are still the chief illuminant. At the present price of imported carbide, £32 to £36 per ton in Johannesburg, acetylene gas shows no economy over the electric light, but with the cheapening of prime cost and the lowering of freights—and we understand that the German-Australian Co. has now consented to accept it at a slight additional charge over ordinary cargo rates—a reduction in cost may be eventually effected that may lead to its competing even with the electric light. In the case of the manufacture of calcium carbide being undertaken in South Africa, the reduction in cost which would follow would enable it to successfully compete with all comers.—South African Mining Journal.

—The report of the James' Bay Railway commission, appointed by the city of Toronto, was handed to the City Council at its last meeting for 1898. The commission has embodied in the report not only the information obtained by the expedition sent out to examine the country along the route of the proposed line, but also deals with the question of Toronto's transportation facilities, with special reference to the proposed Collingwood Air line, the harbor improvements, the Sault Ste. Marie and James Bay Railway, and the connection at Scotia with the Parry Sound road. The conclusions arrived at by the expedition, which were conducted under W. T. Jennings and Major Villiers-Sankey, city surveyor, are as follows: That a new line from or near Toronto, Barrie, or Waubaushene north to or near Sudbury, etc., would open up a new section fully as good as that between Gravenhurst and North Bay, and that such a line would shorten the distance to Winnipeg by fully fifty miles; that a new line in the meantime from, say, Verner, northeast to Temogami Lake, would be of immediate benefit in developing that large section in its very near future; that a line from North Bay to Temogami and north to the Blanche river country, a hundred miles, would make an available outlet for the lands and forest products of these regions, including the extensive valley of the Montreal river; that a through line to James Bay should be constructed by way of the last named route; that the ultimate extension of the line from the divide to James Bay is a matter for future consideration.